The Dynamics of Convergence, Disparity, Mobility, and Persistence of Output Gaps across Economies: A Pairwise Comparative Study

By

Archana Kumari

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Bristol Business School, Faculty of Business and Law,
University of the West of England, Bristol

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Abstract

The ongoing impacts of the COVID-19 pandemic have reiterated the existence of regional inequalities across the World. The United Nations (UN) underlines the importance of reducing inequalities and ensuring equal opportunities for everyone and for the achievement of the Sustainable Development Goals (SDG). Countries across the world are striving to attain sustainable growth to promote economic, social, and territorial cohesion. Regional income inequalities have been widely studied, and at the same time, a highly debated topic. The drive to reduce regional differences emphasises the need to stimulate regional convergence of income between regions. In this regard, economic convergence becomes an important principle behind regional cohesion policies across the globe because the convergence hypothesis highlights the need for faster growth of relatively poor regions to catch up with the richer ones. The proposition of convergence has been constantly evolving based on factors such as the development of new conceptual underpinnings, the development of methodological techniques to measure convergence, and the availability of data. Consequently, the topic of regional convergence draws the interest of researchers from across the world. The thesis aims to examine the evolution of output convergence across countries and regions.

The ability to identify a dominant convergence trend in relation to key economic output variables (such as regional income) has been discussed in the existing literature. We cannot understand the effectiveness of regional economic development policy (or indeed any regional policy tackling regional inequality) without being able to set out a conclusive output convergence trend. Convergence trends critically depend on factors such as the convergence indicators used, the period under study, heterogeneous mix of regions, geographical levels, and statistical techniques employed. Research in this domain use these factors differently and hence yield inconsistent findings. Additionally, how individual regional economies change ranking within a distribution (mobility and persistence behaviour) can lead to erroneous inferences on aggregate convergence trends. Researchers have highlighted the significance of measurement of regional mobility to gain insights into the intricacies of economic disparities, however, they also underline a lack of techniques to quantify mobility. Therefore, one of the

contributions of this study is to provide detailed insights into the mobility behaviour of regions.

The thesis employs a pairwise technique proposed by Webber and White (2003, 2009) (known as X-convergence) which can simultaneously assess the important dynamics of convergence, divergence, mobility, and persistence. A comprehensive analysis of pairs of regions seems promising to unfold nuances of regional disparities. The patterns of convergence are identified and compared with the help of traditional measures of convergence (beta, sigma, and gamma convergence) and the X-convergence measure to validate its advantages and show that the employment of different techniques yield mixed findings. The assessment is conducted within three geographical locations—China, the US and the EU—and at the national levels over the last two decades. These locations are selected because they provide evidence of mixed dynamic behaviours. The effect of the 2008 global recession on the convergence trend is also assessed to get a clear picture of its impact on regional disparities.

The findings suggest high instances of divergence within China and the US before the 2008 global recession. For the EU, convergence is prominent at the national level but there are variations at the subnational levels. The effect of the 2008 global crisis on the convergence trend varied across different geographical locations. Findings on mobility dynamics of regions suggest persistence in groups of high and low-income regions suggesting the rich are still rich and poor are still poor.

The findings provide crucial information for evidence-based and place-based policy initiatives. The study assists policymakers to strike a balance between growth and equality. The findings of stagnating/slowing high-income regions, particularly after the global crisis, indicate that there should be a multi-pronged approach to help both low-income and high-income regions. The heterogeneous nature of regional inequality at the national and subnational levels suggest the need for a multi-pronged approach based on priorities and capabilities.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

There have always been differences in the patterns of income growth of regions across and within countries. It was only through the work of economists such as Solow (1956) and Myrdal (1957) that economists started to pick up on the theme of economic inequalities and the ways in which such inequalities persist. Decolonisation in the period 1945-70 raised issues of international action to explore and understand these inequalities. It was only in the late 1980s that we started to see political jurisdictions such as the European Union start to consider policy responses to tackle regional (territorial) inequalities within and across nation-states (the emergence of the concept of Territorial Cohesion as a policy objective). As policy-makers have attempted to understand and intervene in territorial inequality there has been an increasing demand to measure the degree of inequality within a territorial jurisdiction. Through this lens, measuring regional differences and measures of regional convergence/divergence trends have become more important over the past 40 years. The identification of convergence trends plays an important role in devising effective policies to tackle the problem of regional disparity. Convergence of regional income facilitates the gradual equality of regions, while divergence promotes inequality.

There has been a large number of studies identifying the convergence of income per capita across the world. However, the empirical evidence shows mixed or contradictory evidence of a dominant convergence/divergence trend. These findings vary based on factors such as different definitions and conceptual underpinnings of convergence, use of techniques and indicators to measure convergence, data availability, period under study, and heterogeneities among regions (Castro, 2003). Researchers have scrutinised these factors to understand their varied explanatory powers of the convergence trend (Te Velde, 2011; Quah, 1997; Martin and Sunley, 1998; Dvoroková, 2014). As a result, it is important to find a conclusive trend to satisfy the curiosity of economists and policymakers.

Faster growth in many developing countries during the 1990s and 2000s helped them catch-up with developed countries, however, faster growth seemed to promote disparity among regions within those developing countries (Ahluwalia, 2002). For instance, Bhattacharya and Sakthivel (2004) found that regional disparity in terms of State Domestic Product (SDP) widened drastically after the economic reforms in the 1990s in India. This led to an increase in regional inequality within countries and a decrease in inequality between countries.

Furthermore, the use of GDP as an indicator of economic well-being has been scrutinised by many researchers (Costanza et al., 2009; Kubiszewski et al., 2013). However, it has also been realised that data on GDP per capita are easily available for the low-income developing nations because they do not have the capability and resources to collect other sources of data, while developed countries like the US have resources to collect data on crime rate, divorce rate, etc. The unavailability of wide-ranging data in developing countries makes it difficult to compare developed and developing economies on similar grounds. Likewise, in defence of GDP as a measure of well-being, Oulton (2012) underscores that GDP is a 'component' of welfare as the volume of goods and services available to an average person contributes to his welfare in a wider sense. The study argues that it could be a part of social welfare alongside health, equality, human rights, etc. In a cross-country analysis GDP is highly correlated to other important welfare factors—life expectancy, happiness, health, equality, etc. (Fogel, 2004). Therefore, for a cross-country analysis GDP could be considered as an indicator of well-being.

The understanding of the dominant convergence trend to examine the increasing or decreasing regional equality is highlighted below.

1.2 Context and Rationale

Convergence is mostly assessed by two processes: first, by measuring aggregate trends where all regions (whether rich or poor) are considered to follow a single trend. Secondly, by calculating the convergence trend within and between clubs of rich and poor regions. Both of these processes give more or less the same result. However, the puzzle is that aggregate convergence within a heterogeneous country does not necessarily indicate income catch-up by the poor regions. Even though the aggregate trend shows the presence of income convergence, the poor regions may continue to lag behind instead of catching up as convergence could be driven by the convergence experienced by a few rich regions within the country. The true convergence picture appears to occur when the poorest of the poor regions catch up with the rest of the regions, as the convergence needs to occur within the group of poor regions. This emphasises the need to understand the convergence behaviour not only between the groups of rich and poor regions but also within the groups (Quah, 1997). Therefore, the focus of studies shifted to analysing the convergence behaviour within and between similar groups of regions rather than within the same country.

However, the widely used traditional measures of convergence—beta, sigma, and gamma convergence—are not equipped to explicitly compare the within- and between-group analysis for a sample. These measures provide an outcome for the whole aggregate sample which may converge to an average or benchmark economy (Margini, 2004). The problem of relying on a benchmark economy is that it may not be a leader/representative economy for the whole period of analysis (Beylunioğlu et al., 2015). Similarly, Gini coefficient, Theil index, and Atkinson inequality measures (with same conceptual underpinnings as sigma convergence) have been widely interpreted for interregional inequality examination but the decomposition of these indicators by population groups or income sources is not easy (Novotný, 2011). The decomposition is required to analyse inequality within and between groups of regions.

Another shortcoming that has been highlighted by researchers is the lack of consideration of interactions between regions or “churning” within the income distribution (Quah, 1996a, 1996b, 1997; Maasoumi et al., 2007). Regions are interacting constantly with each other via trade, investment flows, labour flows, etc. These interactions help regions overtake or lag behind with respect to others within the income distribution. In other words, the interactions between economies lead to change in regional dynamics in terms of overtaking, lagging behind and stagnating (persistence) with others.

The proponents of distribution dynamics emphasised the quantification of mobility within the income distribution (Castro, 2003; Ezcurra et al, 2005; Kar et al., 2011). Kernel density estimates and transition dynamics, to some extent, help assess the mobility of economies from a range of income/output values (e.g., high, medium, low) to another but are not detailed enough to do a comparative study of the movement of one economy with respect to another. In order to find the differential regional growth trajectories for a sample of economies, it becomes important to assess the frequency of overtaking, lagging behind, and stagnating economies within the income distribution. This helps in scrutinising the regional growth disparity between economies by identifying lagging and stagnating economies.

The literature highlights the importance of quantifying the mobility of economies and many approaches have been applied to investigate the mobility issue (Chan et al., 2019). However, in due course, a number of researchers have realised the complications of measuring and comparing mobility across economies, although no clear verification or refutation has been made. This is of no surprise as the term ‘mobility’ has not been concretely defined or measured. In this study, mobility is assessed as a change in rank order positions of economies with respect to their income per capita. This considers the importance of intradiatribution properties with the income distribution. More precisely, mobility is considered to happen when one economy grows at a faster/slower rate with respect to another leading to change in their rank positions reflected by overtaking, lagging behind or stagnating behaviours with others.

This calls for an examination of behaviour between economies with respect to each other in terms of relative behaviour. To understand their relative behaviour, a thorough comparison of the economic behaviour of one region relative to another is required. A detailed comparison of relative behaviours also addresses the problem of analysing within- and between-group trends and consequently inequality behaviour between regions. Therefore, there is a need to do a detailed comparison of regional dynamics to provide insights on the subtleties of regional inequality.

Realising the gap in the literature on measuring relative behaviour, Webber and White (2003, 2009) proposed a technique of pairwise comparison of per capita regional income. The technique used the concept of concordance and discordance to examine the change in behaviour of regional income between two time periods that came to be known as X-convergence. If the change in income of pairs of regions between two time periods is concordant, then they are converging towards each other. The technique helps compare the behaviour of economies by calculating the exact frequency of converging/diverging pairs. The outcome of the exact number/proportion of pairs of regions converging/diverging (with mobility) provides an opportunity to identify a conclusive convergence trend. In addition, it also makes it easy to do an inequality assessment within- and between-groups of similar regions.

Identification of the exact number of pairs of economies converging and diverging offers an opportunity to understand if one economy has overtaken or lagged behind or stagnated with respect to another. This makes it easy to measure the mobility of economies. In the thesis, the mobility of economies is extended to understand if there is persistence in the rich and poor groups of economies. As it is known that convergence is predicted when capital poor economies grow at a faster rate than the capital rich economies and divergence is supposed to occur when richer economies grow faster than poorer ones. In the real world, both these processes happen at the same time. Persistence in rich and poor categories of economies suggests that there is no exchange of rank order positions between the economies lying in the two categories. This boils down to the notion of persistence that suggests that the gap between the rich and poor remains intact. The idea of persistence from a mobility perspective in regional income groups has very limited empirical evidence in the literature. Therefore, this study addressed this gap and provides empirical evidence for regional mobility assessment.

In this regard, the X-convergence technique provides an opportunity to quantify and compare regional convergence, divergence, mobility, and persistence in terms of switching in rank order positions, all at the same time. The techniques previously used were criticised for not being capable of assessing all of the aspects of regional dynamics simultaneously. Therefore, one of the objectives of the thesis is to compare and contrast the findings obtained from traditional measures of convergence (beta, sigma, gamma convergence) with the findings obtained from the X-convergence technique. The originality of the thesis is that in comparison to the existing studies it assesses all the aspects of regional dynamics of convergence, divergence, mobility and persistence, simultaneously.

Recently, the X-convergence approach has been applied by various studies to understand the convergence in living standards, consumption expenditure, and public investment, among others (Liobikiene and Juknys, 2013; Liobikienė and Mandravickaitė, 2013; Ferreiro et al., 2014). It is evident that the X-convergence approach has been used to find convergence for many economic variables. The approach has been widely accepted because of its ease of interpretation. So far, studies by Webber and White (2003, 2009) and Webber et al., (2005) have looked at the mobility issues separately across global countries, US states and selected European regions. There is a lack of study exploring the mobility of regions using the X-convergence approach in one of the fastest-growing and largest economies—China. Moreover, there is a lack of cross-comparative studies in this domain.

Addressing the gaps related to the assessment of regional mobility, the thesis contributes to the knowledge by adding an element of regional mobility in addition to convergence and divergence in understanding regional income inequality. Studies on regional inequality mostly cover the assessment of convergence and divergence. The thesis argues that in addition to convergence and divergence, regional mobility is important to uncover the nuances of regional inequality. The thesis supports the argument by providing empirical evidence on understanding the behaviour of individual regions by employing the pairwise technique of X-convergence. The evidence provides a detailed analysis of pairs of regions on the dynamics of convergence, divergence, mobility, and persistence, simultaneously. To fill the gap on heterogeneous behaviour of regions, regions are divided into groups of similar performing regions that help in assessing the convergence behaviour within and between groups. This makes the study important in the area of regional income inequality. Therefore, one of the contributions of the study lies in the knowledge and assessment of mobility and persistence within and between groups of similar regions.

1.3 Research Aim and Objectives

The primary aim of the thesis is to examine the evolution of regional dynamics of convergence, disparity, mobility, and persistence in selected geographical locations (China, the US, and the EU). The thesis conducts a comprehensive analysis of pairwise economies to provide insights into various regional dynamics simultaneously. A pairwise comparative analysis helps address the problem of the inconsistent nature of findings of the convergence trend in the literature. The comprehensive literature review highlights the gap in the assessment of mobility dynamics of regions in terms of overtaking, lagging behind, and stagnating growth paths. The investigation of regional mobility dynamics is important for understanding the subtleties of regional disparity. The thesis sets out to provide empirical evidence on identifying conclusive convergence/divergence patterns of output in the selected locations. Consequently, the thesis will contribute to the knowledge of identifying a conclusive convergence trend using a pairwise comparative study to help policymakers attain regional economic, social, and territorial cohesion.

To achieve the aim of the research, certain objectives are laid out as below;

1. To provide evidence of how differential outcomes employing different convergence measures contribute to the inconclusive nature of findings on convergence patterns. (RO1)
2. To assess the mobility of regions within– and between-groups of identical regions to identify the presence of persistence in regional income groups. (RO2)
3. To identify regions that stagnate or lag behind and may need government assistance. (RO3)
4. To assess the role of the 2008 global crisis on regional convergence and disparity. (RO4)

The study, therefore, attempts to address the research gaps related to regional convergence and mobility and hence provide a valuable contribution in the area of regional economic growth disparity. Consequently, the thesis aims to address the following research questions:

RQ1. How have the regional dynamics of convergence evolved across the world and in China, the US, and the EU at the national and subnational levels over the last 20-25 years?

RQ2. How mobile were regions within- and between-groups of similar regions in these geographical locations?

1.4 Organisation of Thesis

The thesis is organised in the following chapters:

Chapter 2 summarises insights on the literature review. The chapter provides a detailed overview of the growth theories such as the neoclassical theories and new growth theories including new economic geography and their implications on convergence and divergence processes. These theories explain the convergence/divergence process through different mechanisms. This chapter highlights the controversy on these explanations that contribute to the disconnect between the theoretical underpinnings and empirical findings in the literature.

Chapter 3 provides a description of the methods used in the thesis. This thesis compares and contrasts the findings using the traditional convergence measures (beta, sigma, and gamma convergence) and the X-convergence measure. The thesis emphasises the need to identify a dominant and conclusive convergence trend to understand the efficiency of regional cohesion policies. Consequently, the chapter provides detail on factors that contribute to the inconclusive trend related to the methods employed, research scope, time period considered, convergence indicators used, etc. In the end, the chapter outlines the research design for each empirical chapter presented in the thesis.

Chapter 4 assesses the regional dynamics for 109 countries from 1970 to 2015 across the world. All empirical chapters compare the findings obtained from different convergence measures. One of the purposes of this chapter is to operationalise the use of the X-convergence technique. Accordingly, this chapter explains the matrix for pairwise regional income analysis and suggests the prevalence of dominant convergence/divergence trend throughout the period.

Chapter 5 assesses the regional dynamics for China at the provincial level. The evolution of the convergence trend for 31 provinces from 1993 to 2016 is presented in the chapter. The coastal and inland provinces income inequality has been analysed. The chapter supports the literature on declining provincial inequality from the late-2000s and persistence in regional income group dynamics.

Chapter 6 provides regional dynamics for the US at the State and Metropolitan Statistical Area levels. The complexity of data analysis is increased by introducing two hierarchical level data for the US. The evolution of convergence and regional disparity is analysed for 50 US States (1997-2017) and 383 metropolitan statistical areas (MSAs) level (2001-2017). The chapter also compares the effect of the 2008 global crisis on regional convergence and inequality.

Chapter 7 provides regional dynamics for the EU at NUTS0, NUTS1, and NUST2 levels. The complexity of the data analysis is increased by investigating the convergence and disparity trend at three hierarchical levels for Europe. Income per capita data for 28 countries, 86 NUTS1 regions, and 252 NUTS2 regions are analysed from 1991 to 2015. The chapter also compares the effect of the 2008 global crisis and 2009 sovereign crisis on regional convergence and inequality in the EU.

Chapter 8 compares the findings in the empirical chapters and presents conclusions. The chapter compares the findings from each of the above empirical chapters on the patterns of regional convergence and disparity, effects of the 2008 global recession, patterns of regional income mobility, and research contributions and policy implications of the study. The chapter, in the end, discusses the limitations and future research directions.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

The growth literature provides insights on the determinants of growth that help an economy grow at a faster rate including accumulation of human capital, technological advancements, and trade flows. These determinants of growth are necessary factors for regional growth and development. Identification and appropriate combination of determinants of growth suitable for countries are an important topic of research on public policy and regional development. However, some of these growth determinants like technological progress and trade had controversial impacts on the growth of countries. Researchers found that their effects were different for different countries based on their stages of development. Furthermore, the promotion of specific growth determinants did not always mean balanced regional growth within the country. The concerns for achieving balanced growth within a country became more difficult in the globalised world. Owing to the heterogeneities between the world economies, the problem of differences in levels of income, employment, and productivity became more acute across regions within as well as between countries.

In this line of research, the desirability to attain balanced growth between regions associated with faster growth rates of capital poor economies is highlighted. In this regard, the hypothesis of convergence as predicted by neoclassical growth models states that faster growth experienced by low-income regions help them eventually converge with their high-income peers. Convergence between capital poor and rich economies was inevitable in the long-run. However, empirical findings suggested that instead of convergence, the experience of divergence was predominant between regions. This disconnect between theory and empirical findings led a few researchers to scrutinise the conditions that were ignored by neoclassical models. This strand of researchers came to be known as the new growth theorists and they proposed a mechanism of divergence between regions. Applying the two strands of theory, certain empirical findings suggested the predominance of convergence while others suggested divergence making it difficult to make a conclusive suggestion on the trend. The understanding of theoretical controversies and mechanisms of convergence and divergence in the domain is important to identify the causes of inconsistencies in the findings of studies. In addition, the understanding of theoretical controversies will help to draw appropriate inferences from the empirical findings. Therefore, it is necessary to provide insights into the theoretical controversies to have a comprehensive view of convergence and divergence issues that need attention.

The aim of this chapter is to provide an outline of the state of the art in the domain of regional growth and convergence from the perspective of theoretical advances and their limitations. These are important for considering regional development policies to promote balanced growth. Regional development is a broad term that encompasses a variety of economic policy issues related to the need to reduce regional growth disparity and exploit productive resources. Regional development policies enhance the well-being and living standards in all urban and rural areas and improve their ability to contribute to national growth performance. To attain these objectives, there has been a dissemination of regional policies across the globe that are place-based, people-based, evidence-based, multi-sectoral, and innovative. According to the Organisation for Economic Co-operation and Development (OECD) website, regional policies concentrate on relevant territorial scales or geographies to focus on factors that help sustain competitive advantage; generate stronger, fairer, and liveable regional economies; and promote effective and innovative governance at all levels. As a result, regions could become self-reliant, competitive, resilient, and adaptive in their growth behaviours. Thus, the key feature of regional development policies is to look for opportunities to improve the efficiency of regional specific assets taking into account all regional and local stakeholders from governments to citizens (Roberts et al., 2006).

The chapter is organised in following sections: section 2.2 provides background on various regional growth and development issues highlighted by the researchers; section 2.3 provides the theoretical background and controversies on growth theories that predict convergence and divergence process; section 2.4 provides insights into the demand-led growth model that predicts convergence/divergence; section 2.5 discusses the gaps in the convergence literature; section 2.6 concludes the chapter.

2.2 Background

Since the 1960s and 1970s, the objectives of regional prosperity have been given extensive attention at different levels of governance and structures of government across and between the national, subnational, local, and regional levels (Pike et al., 2007; Pike et al, 2016). To realise the objective of regional growth and development many existing institutions have been reorganised, new institutions emerged, and new partnerships developed between the local and regional governance. Differing degrees of change in reshaping existing and developing new approaches and interventions through policies have been introduced to help the lagging regions perform better. It is emphasised that since regions act as an intermediate spatial unit between a nation and its citizens, regional economic growth studies should use features from both growth theories and regional/local development theories to understand the growth behaviour (Capello and Nijkamp, 2011; Stimson et al., 2006).

The concept of regional development has historically been dominated by economic concerns of growth (GDP per capita) and employment (Armstrong and Taylor, 2000; Pike et al., 2007). Gradually the concept of regional prosperity and wellbeing evolved to include the sustained increase in employment, income, and productivity that also became integral to economic development (Storper, 1997; Frenken et al., 2007). Researchers such as Costanza et al. (2009) and Kubiszewski et al. (2013) have constantly underlined the inappropriate use of GDP as a measure of national well-being. They advocate that a degree of society's goals such as meeting human needs for food, shelter and freedom should be included in measuring national progress and well-being rather than measuring the volume of marketed economic activity. In this regard, apart from reducing economic inequality, reducing social inequality, promoting environmental sustainability, and recognising cultural diversity have all been emphasised to different extents within a broader definition of sustainable regional development by many researchers including Haughton and Counsell (2004), Wheeler (2013), Counsell and Haughton (2006), Wang et al. (2012), etc. Some alternative indicators of economic well-being use GDP as the foundation and the add or subtract indices such as Index of Sustainable Economic Welfare, the Genuine Progress Indicator, Green GDPs, and Genuine Wealth, among others (Costanza et al., 2009).

Pike et al. (2007) argued that broader understandings provide new opportunities to think about and define regional development. Regional development is related to people in places making value-added judgments of priorities and what is considered appropriate for the development of their localities and communities. The literature does not provide any homogenous and universally agreed-upon definition of regional development. What constitutes regional development differs and changes within and between national boundaries, sometimes based on the focus/priority of governments across nations. Therefore, the concept of regional development is constantly evolving and changing based on debates, negotiations, practices of local governments, changing government agendas, etc. (Wyatt-Nichol and Antwi-Boasiako, 2012; Tjandradewi, 2016).

Researchers have highlighted that it is important to understand the relationship between regional and national growth performance (Agranoff, 2014; Cawley, 2016). Regional performance affects national performance through the logic of aggregate income generation. Regional effects generate static and dynamic comparative and competitive advantage for firms situated in the territory to determine the competitiveness of local production systems that affect economic performance at the national level (Capello, 2011). National performance influences regional growth through various channels including the interest rate, inflation targeting, exchange rate, public administration, policies related to trade, education and healthcare, etc. Capello et al. (2008) argue that an appropriate combination must be reached between the national and regional performance to understand the role of country effects and regional effects on stimulating aggregate growth.

Capello and Nijkamp (2011) associate regional development with equity objectives (for territorial cohesion) and efficiency objectives (for optimal use of scarce resources). These objectives are high on the agenda for most countries across the world. For instance, the European Union’s cohesion (equity objective) policy for economic, social, and territorial cohesion aims to reduce economic disparity and improve economic well-being and cooperation by exploiting efficiency objectives among member states through the reforms of structural funds. In this regard, the promotion of economic growth in lagging regions becomes important for their uplift through identifying appropriate determinants of growth. This would provide a mechanism to reduce regional disparity by using resources and endowments optimally to increase the efficiency/competitiveness of local production.

Over recent decades, the persistence of regional economic disparity and uneven distribution of income have been a source of concern for policymakers. In this regard, the growth of a region’s income and its development that reach its citizens become important. Regional growth and regional development theories co-exist to explain the differing economic growth trajectories from different theoretical perspectives (Capello, 2012). The macroeconomic view of regional growth theories focuses on the change in an aggregate variable (usually GDP) that lead to a change in growth trajectories. Whereas regional development theories have a micro behavioural approach and attempt to demonstrate the behaviour of individual economic agents and the dynamic interactions between spatial units (Capello, 2009).

The foundation of neoclassical growth theory can be found in the work of Solow (1956) and Swan (1956) in which they provide the conceptual basis for understanding whether regional economies would become more similar over time. These theorists emphasise the convergence of economies' growth paths due to higher per capita income growth rates for low-income regions and lower growth rates for developed economies, eventually converging with each other. For instance, GDP per capita in China and India (low-income countries) grow at around six percent per annum and the US, UK, and France (high-income countries) grow at around two percent rate per annum, and hence have the potential to become similar, eventually. On the other hand, the new growth theories and endogenous growth theories arguably imply a divergence of growth paths between regions through the high growth rates for high-income economies and low growth rate for low-income economies, thereby building a rift between rich and poor economies. For instance, high-income coastal and low-income inland regions of China grow at different rates and diverge away from each other. Using the different outcomes of regional dynamics of convergence and divergence, Quah (1993a, 1996a 1996b, 1997) emphasised the distribution of income as an important concept to understand the relative behaviour of economic equity and disparity. He used distribution dynamics of per capita income levels to underline the importance of mobility of economies within their per capita income distribution. The distribution dynamics have become a significant part of the regional growth and disparity literature.

In terms of regional growth theories, they throw light on various factors that help locations to excel in their economic performance such as local demand, technology, knowledge creation, and knowledge diffusion. At the micro level, highly productive and innovative firms are given preference and assistance to perform better and contribute further to regional development. The increase in the diffusion of knowledge and technology help surrounding or neighbouring regions to perform better and in turn, promote agglomeration economies. This increases job creation and competitiveness of regions, which in turn increase household income, consumption, and saving which is invested back in growing firms and increase their revenue/income via the circular flow of income and consumption. All these provide mechanisms to help regions perform better at the micro level. Capello (2009) states the regional economics incorporates the dimension of space in the analysis of growth. Space or location influences economic activities in terms of generating geographical advantages of endowments of raw materials and accessibility. The cumulative nature of productive processes, particularly due to the spatial proximity, help to operate agents in such a way that reduces the cost of production in terms of transaction and transportation costs. These considerations highlight the need to assess the dynamic and evolutionary allocative approach for development. Many local development theories are combined with regional growth models of endogenous growth and new economic geography to illustrate reasons for the divergence of growth paths. These theories are further discussed in detail in this section.

Different theoretical frameworks take different starting points and make a number of assumptions to clarify their perspective on growth and development. Theoretical explanations have evolved through time in response to critique, in light of ongoing empirical research and conceptual development, and changing political preferences and circumstances (Pike et al., 2016). The contribution of neoclassical models in explaining growth is immensely based on the role of labour supply, capital stock, and technological progress. Their emphasis on the supply side characteristics of the market to stimulate the long-term growth process hold the view that demand adjusts to supply. However, in the wake of underlining the importance of supply-side factors, neoclassical models relegate the contribution of demand-side growth factors. Many economies have experienced growth stimulation due to demand (trade/export) increases and the economies have diverged upwards away from others, which is contrary to the prediction of convergence by neoclassical models. Hence, there is a possibility of identical economies converging with one another and diverging from others. Therefore, it is worth exploring the demand-side factors to frame arguments related to growth and convergence.

Many of the theories explained below complement each other as well as research findings. Some of them are extensions of traditional theories. For instance, proximity and reduced transaction costs related to location theory is an automatic extension of resource-based export theories. That is, as economies advance based on the export of their commodities, businesses start to prefer places with low transportation costs for procurement and delivery of raw materials and finished goods. This calls for the preference of places that are near ports or have well-connected transportation links. Subsequently, the preferred regions attract more related and complementary businesses and help nearby regions to agglomerate and stimulate cumulative growth. This attracts workers from nearby regions to reside and commute to preferred regions, thereby enhancing agglomeration and spillovers. Economic activities surrounding preferred regions generate externalities that could be positive and help them produce more output. For example, the financial hub in London has attracted many banks, IT firms, consulting firms, research firms, and so on. Therefore, the advent of many recent or new growth theories is the logical extension of traditional theories that change the focus on the drivers of growth depending on the region’s stage of development. It has been argued that traditional theories of growth make sense for regions that are on early stages of development (Żuk and Savelin, 2018), but gradually, as economies grow larger many alternative theories are needed to explain the growth drivers.

This thesis presents an analysis of income per capita in a way that considers the dynamics of interactions between regions. It explains the varying regional behaviour with the help of regional growth theories including neoclassical and new growth theories. These theories will be explored to understand the differential behaviours of economies with respect to each other and underscore the possibility of unbalanced growth paths in terms of convergence/divergence. The regional dynamics of economies in terms of per capita income (includes overtaking, lagging behind, and stagnating) will be analysed through the investigation of the literature on distribution dynamics.

2.3 Regional Growth Theories

During the 1950s and 1960s, regional economics was still in its infancy and theories/models were conceptualised with an aim to investigate the determinants of economic growth (Capello, 2011). Growth models interpret development by using an indicator of the growth of per capita output or income (Capello, 2011). Higher GDP per capita implies higher development within an economy. The metric of GDP has been criticised for only including market transactions, and ignoring social costs, environmental impacts, and income inequality (Costanza et al., 2014). The metric was developed during the 1930s and 1940s amid the turmoil of the Great Depression and Second World War. Since the mid-1940s increasing GDP growth became one of the national goals to achieve in almost every country. However, the economic, social, and political environment has changed so drastically in recent years that fully relying on GDP metrics to determine development is no longer sufficient. Even though developing countries are still counting on GDP as a metric of development, the already developed countries are increasingly preferring economically, environmentally, and socially sustainable modes of development. There are many indicators proposed to measure income distribution, such as the Gini Coefficient and Theil index. Costanza et al., (2014) propose that genuine progress indicator (GPI) that has personal consumption expenditure as a major component plus more than 20 additions and subtractions of variables to account for social and environmental costs, such as the cost of divorce, crime, and pollution. However, the availability of data on these variables is not that easy, particularly for regional and sub-regional administrative units. The parts of this thesis are, therefore, constrained by the availability of data for these variables.

The thesis uses GDP per capita as an important factor to assess the convergence and divergence of regional growth paths within the world economies, including China, the US and Europe. The study findings in this domain vary substantially depending on the selection of time periods, spatial units, variables used, nature of regions' borders (such as administrative, functional, and travel to work areas), etc. The findings of the thesis will add to the ongoing debate on the inconsistencies in findings related to convergence patterns. The analysis will contribute to the regional growth convergence and disparity literature with an aim to provide insights into the lagging and stagnating regions in selected geographical locations.

2.31 Neoclassical Growth Models

The foundations of neoclassical growth models were laid by Solow (1956) and Swan (1956) to provide an explanation of the evolution of the growth of one economy over time (Solow, 2001). The growth models quantify sources of growth by measuring the rates of accumulation of factors of production and they also measure the pace at which a country's output converges to its own steady state level. As a part of macroeconomics, the growth theorists study the evolution of potential output growth of an economy (Solow, 1999). Some of the strong attributes of the neoclassical paradigm include analysis of the allocation of scarce resources, marginal utility maximisation through rational decision making and preferences, general equilibrium of an economy, supply-side factors (capital and labour) to stimulate growth and a mathematical approach to a problem (Colander, 2007; Dequech, 2007).

Capital Accumulation

The neoclassical growth model predicts that ceteris paribus, the growth of per capita income falls with the accumulation of capital. This is a corollary of the law of diminishing marginal returns to factors of production, in this case, capital and labour. The model predicts that the long-run growth of an economy depends on the level of capital, labour, and technological progress within an economy. The model assumes that the rate of growth of saving (hence capital accumulation) and population growth (for labour supply) are both exogenous. That is, the savings rate is a given proportion of disposable income irrespective of what is happening in the economy, such as a change in tax has no effect on the savings rate and likewise for the population growth rate. The model illustrates that the capital-labour ratio determines the steady state level of equilibrium of a country. Since saving and population growth rates vary across countries, different countries reach different steady states. In a steady-state equilibrium, the capital-labour ratio remains constant as there is constant capital and population growth by assumption. Another major assumption of the neoclassical growth model is that technology is freely or publically available. This suggests that the consumption of technology is non-rival, meaning that its consumption by others does not stop an individual’s consumption. In addition, the consumption of technology is non-excludable, meaning that it is impossible to prevent anyone else from using or consuming it. Therefore, if it is known how to make some commodity, the know-how is freely available to anybody who wants to make that commodity. Firms do not have to pay anything to make the commodity using publicly available technology. This assumption is invalidated in the presence of intellectual properties rights, e.g., patents, copyrights, and trademarks among others (Acemoglu, 2012).

Furthermore, Barro (1996) argued that a positive role of the investment ratio is important in a cross-country growth estimate but the reverse causation should also be considered noteworthy (i.e., growth affecting the investment ratio). A positive and significant coefficient on the concurrent investment ratio in a growth regression may simply imply a positive relation between growth opportunities and investment rather than a positive effect of an exogenous investment on growth. This is particularly important for open economies because even though cross-country differences in saving ratios are exogenous with respect to growth, the decision to invest domestically or abroad would come from the positive opportunities for returns in the domestic and overseas markets. Hence, domestic growth opportunities for capital rich economies may not attract more investment due to its low tendency to make a return. This suggests that diminishing domestic investment returns for capital rich economies would encourage the movement of capital to poor economies that provide higher opportunities for returns. Eventually, the mobility and equalization of factor prices would drive the convergence in output across economies.

Labour Augmentation

Another mechanism that supports the neoclassical convergence perspective is the assumption of labour augmenting technological progress. In an economy with two factors of production—capital and labour, a change in capital stock is not expected to affect the technological progress of the economy. However, looking at the effect of technological progress on economic growth, it is evident that technology improvements have a positive correlation with output as they stimulate output growth. Hence, technological improvements such as the quality of existing capital stock help the labour force to be more productive and in turn increase output per worker (Temple, 1999; Mankiw et al., 1992; Acemoglu, 2012). Therefore, technological progress in the neoclassical perspective is often argued to be labour augmenting, which help the capital poor (labour rich) economies to grow faster and converge with the capital rich economies. Technological progress, thus, influences an economy's output level indirectly through labour productivity improvement or enhanced human capital, and the neoclassical convergence hypothesis provides a mechanism for the automatic convergence between capita rich and capital poor economies.

Trade Theory

Another mechanism that promotes convergence between poor and rich economies is the neoclassical trade theory of comparative advantage (Heckscher, 1919; Ohlin, 1933). In this model of trade, economies export those commodities that intensively utilise their abundant factor of production (cheaper factor) and import commodities that intensively require relatively scarce resources (expensive factor). Trade between economies promotes the export of goods that have more comparative advantage and the import of goods that have a relatively less comparative advantage. This leads to the convergence or equalisation of factor prices. For a two factor economy (capital and labour), equalisation of factor prices is another mechanism of convergence as low-wage, less developed economies attract capital and high-wage, more developed regions attract labour when free mobility of resources is assumed (Petrakos et al., 2011). The process of factor mobility and convergence continue until factor prices are equalised. According to the neoclassical view of the convergence hypothesis, the divergence of growth paths is unlikely to persist because divergence would facilitate self-correcting movements in prices, wages, capital, and labour that disseminate strong tendencies towards convergence (Martin and Sunley, 1998).

The assumptions of neoclassical models suggest that convergence in income is inevitable as capital poor economies grow faster than richer ones (Solow, 1956; Mankiw et al., 1992, Barro, 2001; Durlauf et al., 2001). The main idea behind this notion is that the capital rich economies earn diminishing marginal returns on additional capital investments due to the assumption of the law of diminishing marginal returns. Over time the potential to earn profits on capital diminishes in capital rich economies reducing the incentive to save and invest and, thereby, reducing output growth. The saving rate is considered exogenous and equal to the ratio of investment to output. A lower saving rate decreases the steady state level of output per effective labour and hence declines the growth rate for a given initial level of GDP.

Iron Law of Convergence

Earlier literature supported the "iron law of convergence", which states that countries eliminate gaps in the level of real per capita GDP at the rate of 2 percent per year after controlling for differences in rates of accumulation of human and physical capital (Barro, 1991; Barro and Sala-i-Martin, 1991; Mankiw et al., 1992; Sala-i-Martin, 1996). Convergence at two percent means that it will take 35 years for half of the initial income gap to disappear and 115 years for 90 percent to disappear. More recently, Barro (2015) built on the iron law of convergence rate for post-1960 and post-1870 panels of 89 countries and suggests that the conditional convergence rate of per capita GDP was close to two percent, thus supporting the iron law of convergence. He emphasised that the conditional convergence rate of around two percent per year might be a robust empirical regularity. The evidence on "iron law" implies that as long as countries keep factors like government policy and human capital accumulation constant, the differences in incomes between economies would eventually disappear.

However, there are many variations in findings on "iron law of convergence". Some studies suggest faster rates of elimination of income gap while some suggest no presence of the law at all. For instance, Caselli et al. (1996) and Canova and Marcet (1995) have shown that countries are converging at a much faster rate of 10-11 percent than 2 percent per annum. An empirical exploration of regional economies also reveals that the income gaps between regions will also eventually disappear (Magrini, 2004; Badinger et al., 2004). On the other hand, Kant (2019) using Penn World Data (PWD) from 1951-61 to 2013 and showed that persistence in the income gap between countries confuting the prevalence of “iron law of convergence”. Similarly, Karnik (2018) analysed 25 high-income, 20 middle-income, and 28 low-income countries and found varying rates of convergence for different subgroups of countries based on their changing total factor productivity (TFP).

In addition, criticising the “iron law”, Quah (1996b) has suggested that the two percent rule was a ‘statistical artefact’ as convergence could arise from a lot of factors unrelated to convergence. The study argued that the face value of two percent implied uniform characteristics across economies in the suggested causes of convergence—technology, preferences, and endowments. In this regard, studies have shown that the per capita income of regions that was below average showed improvements but their relative position in the cross-sectional distribution was expected to be almost the same (Johnson and Papageorgiou, 2020; Le Gallo, 2004; Korotayev and Zinkina, 2014). Thus, poorer regions on average stay relatively poor over time and the gap in income is reduced by only a very small amount. This indicates persistence in the gap between rich and poor economies.

Evidence on convergence

Examining the evidence of convergence of income, European regions seem to show a common convergence rate of two percent until 1973; however, after 1975 several regions started to show weaker convergence (Tondl, 1999; Magrini, 2004; Badinger et al., 2004). As the focus shifted from between-country to within-country analysis post-2000, Gennaioli et al. (2014) highlight that regional convergence is faster within richer countries and countries with better capital markets. The result could be influenced by the addition of new members in the European Union from 1973 onwards associated with the need to cope with new rules and regulations. Tondl (1999) briefly mentioned that due to the complete integration of southern cohesion countries (e.g., Greece, Spain, Italy, etc.) in the European Union after 1981, the disparity in income increased. For instance, Greece experienced only modest growth due to strong foreign competition implied by the European integration process (Petrakos and Saratsis, 2000). Similarly, Davies and Hallet (2002) and Petrakos et al. (2005) provide evidence of growing regional income imbalances for the poorest EU countries. A report by the European Commission (2004) shows that regional inequalities have tended to rise in countries such as the Czech Republic, Hungary, Poland, and the Slovak Republic since 1995. Thus, it appears that incomes converge at the national level, whereas at the regional level income convergence is weak (Geppert and Stephan, 2008; Badinger et al., 2004). Therefore, there has been variation in the findings or mix of findings on convergence outcome reported in the literature.

The above instances question the validity of the neoclassical convergence hypothesis. Ordinary Least Squares (OLS) cross-section convergence studies (Barro, 1991; Barro and Sala-i-Martin, 1991; Barro and Lee, 1994) have been criticised by some scholars (Fischer and Stirböck, 2006; Chen et al., 2014) based on two aspects. First, most of the convergence literature suffers from omitted variable bias. For example, they ignore the influence of regions on convergence and focus on national level convergence more than regional level convergence. The importance of regional growth and its ability to influence national level parameters have been established by regional economists during the mid-1990s. It has been argued that regions could not be treated as isolated economies because their interactions and linkages need proper consideration when evaluating national growth (Rey and Janikas, 2005; Barrios and Strobl, 2009; Magrini, 2004). While studying European convergence, Rey et al. (2016), Le Gallo and Dall'Erba (2006), Armstrong (1995), López- Bazo et al. (1999) and Rodríguez-Pose (1999) reported the presence of significant spatial autocorrelation both for income levels and for growth rates. Thus, it is evident from a number of studies that the traditional convergence analysis suffers from misspecification of omitted variables bias (Badinger et al., 2004; Fischer and Stirböck, 2006; Magrini, 2004; Thayn and Simanis, 2013).

The second criticism of OLS cross-section analysis is related to the hypothesis of the same steady state across countries due to fixed exogenous technological development (Chen et al., 2014; Canova and Marcet, 1995; Bliss, 2000). The neoclassical model assumes that the long run growth rate per capita depends on technological progress which is determined outside the model. Chen et al. (2014) propose that the interactions between technology and the accumulation of capital and labour are ongoing phenomena and do not occur only in the current period and hence the model should consider dynamic and endogenous properties as well. Chen et al. (2014) develop a revised dynamic endogenous Solow model in which it is hypothesized that a moving steady state exists for a single economy due to the difference in the level of technological progress at different time periods. The actual economy might depart from the steady state in some periods or converge in another. The process is termed 'dynamic convergence' because it depends on the pace of technological advancement of the economy.

Żuk and Savelin (2018) highlighted that capital poor countries tend to easily achieve a higher growth rate at the early stages of development. The benefits of low labour costs during the early stage of development of countries provide them with a competitive advantage to produce labour-intensive products. In addition, these countries benefit from the reallocation of labour from the low-productive agriculture sector to the high-productive manufacturing sector. Thus, the convergence of growth paths becomes easy and the catching-up process prevails at an early stage of development. However, the benefits of low-cost labour hamper the competitive advantage when the labour costs match the international levels. The economic growth and productivity increase require a shift from labour-intensive production to more innovative, technologically advanced and knowledge-based production (Żuk and Savelin, 2018; Agénor and Canuto, 2015). These shifts for some countries become challenging and they fail to demonstrate high growth and hence diverge away from relatively high-income countries.

The evidence seems consistent with neoclassical growth models where the marginal product of capital varies with the level of economic development of a country (country-specific effect) (Durlauf and Johnson, 1995; Canova, 2004). The early stage of development promotes convergence as advocated by the proponents of the neoclassical hypothesis of convergence. Solow (2001) states that the parameters of an economy cannot be regarded as fixed and common growth drivers need to be considered while doing a cross-country analysis. The initial income distribution of an economy was identified as an essential parameter to determine the position of estimated steady-state income (Easterly et al., 1993; Levine and Renelt, 1992). Durlauf et al. (2000) concluded that studies that fail to allow differences in model parameters across countries are likely to produce misleading results, particularly when some country-level parameters are not valid at the regional level.

Differences in parameters and a big gap between rich and poor economies make the concept of multiple steady states more pronounced. Multiple steady states have been used as a basis for convergence while doing a cross-country analysis by studies such as Bartkowska and Rield (2012), Islam (2003), Artelaris et al. (2010), Monastiriotis (2011) and Halmai and Vásáry (2010). These studies explore the notion of unconditional (absolute) and conditional convergence emphasizing the possibility of differences in steady states. According to Islam (2003), unconditional convergence shows the property of one steady state to which all economies approach. In the case of conditional convergence, long-run steady state differs for every economy and they approach their unique steady state, dependent on policies, preferences, technologies, population growth rates, etc., which are independent of their initial conditions (Galor, 1996).

Another evidence on multi-equilibria comes from the club convergence literature (also known as polarisation, clustering, etc.) that is based on models that yield multiple equilibria. Club convergence occurs for a group of countries with identical structural characteristics with similar initial conditions (Galor, 1996). Researchers argue that neoclassical growth models yield conditional convergence against the prevailing knowledge of absolute convergence (Barro, 1991; Quah 1996; MRW, 1992; Quah, 1996). The source of conditional convergence lies within the assumption of diminishing marginal returns which comes into play after a certain period. The diminishing marginal returns are depicted with the help of a concave production function. Since the neoclassical production function is strictly concave in the capital-labour ratio, the evolution of the capital-labour ratio is characterised by a unique steady state. However, if heterogeneity is allowed across economies, then multiple equilibria exist instead of a unique steady state growth path (Azariadis, I996; Fischer and Stirböck, 2006; De Siano and D'Uva, 2006; Lim, 2016).

The model of multiple equilibria is contrary to the linear model of neoclassical growth theory which assumes a linear relationship between subsequent economic growth and initial income levels of countries. The implication of this assumption is on the framework where all countries converge to the same steady state. Researchers have criticised the linear relationship that gives rise to a single steady state equilibrium to which every country converge towards. For instance, Caggiano and Leonida (2007) used data for 15 OECD countries for the period 1900 to 2000 and found that the observed pattern of convergence was not explained by the simple linear model for 14 out of 15 countries. Similarly, Kremer et al. (2001) advocate a different approach (distribution dynamics approach) that allows growth to have a flexible relationship rather than the standard approach of assuming a linear relationship/function between the growth and income levels of countries. Therefore, the criticism on the assumption of linear relationships gave rise to the literature on club convergence and multiple-equilibria. Therefore, the assumption of a linear model of a single steady state for all countries was criticised in favour of multiple equilibrium models for different clubs of countries demonstrating similar characteristics.

To conclude, the neoclassical model of convergence is a corollary of neoclassical growth models. The neoclassical convergence hypothesis has attracted a lot of attention from researchers across the world. To summarise the neoclassical convergence hypothesis, the models favour the idea of inevitable convergence led by faster growth of capital poor economies. The models proposed a lot of mechanisms that are supposed to help poor economies catch-up with the richer ones such as through exogenous technology, diminishing marginal returns, augmented labour, and export-led growth. The conditional convergence rate was proposed to be two percent by many studies which came to be known as the “iron law of convergence”. However, many studies found evidence different from convergence law. Some even suggested that there is hardly any convergence or decrease in the income gap between rich and poor regions. Moreover, some researchers highlighted that the neoclassical convergence hypothesis is evident for countries only at the early stages of development as they are capable of experiencing faster income growth and hence catching up with the richer economies. Therefore, the evidence suggests that there is a disconnect between theoretical propositions and empirical evidence which gave rise to a great deal of debate over convergence predictions proposed by the neoclassical models.

2.22 New/Endogenous Growth Models

Even though the neoclassical models suggest that eventually income disparities between rich and poor economies would disappear, there has been a wide disconnect between the theoretical construct and empirical evidence (Durlauf et al., 2005; Webber and White, 2009; Temple, 1999). From the mid-1980s the empirical evidence has started to show no convergence or divergence for large samples of countries (Islam, 2003). The empirical findings of divergence of regional growth paths, instead of convergence as predicted by the neoclassical theory, initiated a huge debate on the viability of the neoclassical assumptions and predictions.

The literature started to reveal a wide variety of growth experiences across the globe such as growth miracles and growth disasters. Research has revealed that between 1960 and 1988, Hong Kong, Singapore, Japan, Korea, and Taiwan stood out as growth miracles rising to high levels of GDP per worker (Temple, 1999; Jones, 1997). These countries' steady state income distributions were higher relatively to others. On the other hand, countries that experienced large declines in their relative incomes (growth disasters) were mainly located in sub-Saharan Africa. Consequently, the steady state distributions for growth disasters were lower than many other countries (Temple, 1999).

The inconsistency in theoretical and empirical predictions of neoclassical models led to the emergence of another set of growth models known as new/endogenous growth models. The inability of neoclassical models to explain the process of divergence across samples of countries and an inability to generate long term growth from within the model were two major issues that endogenous growth modelers focused on. Essentially, these modelers tried to develop two neoclassical presumptions. First, new growth models emphasised that the assumption of diminishing marginal returns to capital was not enough to predict convergence across a cross-section of countries.

The new growth theorists posit that instead of the accumulation of factors, it was the technological improvements that had an increasing rate of returns which affects convergence (Acemoglu and Restrepo, 2016; Dosi et al., 2017; Romer 1994). Second, the assumption of homogeneous publicly available technological progress was not able to sustain long term growth within an economy (Aghion et al., 1998). This assumption implies that all countries experience the same rate of technological progress even though they begin with different initial levels of output. Under such an assumption, the heterogeneity of income was difficult to explain and encouraged new growth researchers to include differential technological growth rates and endogenously determined technology in their models (Grossman and Helpman, 1994). Hence, endogenous growth models have laid the foundations for models with increasing marginal returns to factors, endogenous technology, and externalities to support growth and thereby generate convergence/divergence (Romer, 1994; Aghion et al., 1998).

Endogenous growth models are based on ideas of broad capital and endogenous innovation. Broad definitions of capital include physical capital, human capital, organisational capital, social capital, technological capital, and institutional design. The endogenous innovation model pays a lot of attention to investment decisions related to technological change and innovation (De la Fuente, 1997; Crafts, 1996; Easterly, 2003). The consideration of these many inputs leads to an incremental capital-output ratio that changes with changes in inputs. As a result, a stable linear relationship between investment and capital as predicted by neoclassical researchers may not be valid (Easterly, 2003). Incremental capital-output ratios and increasing returns to scale both support the possibility of divergence or no convergence, as the rich economies would get richer and the gap between rich and poor would increase in absolute terms. Thus, endogenous growth models provide reasons for divergence or no convergence between advanced and lagging economies.

Reasons for Divergence

Myrdal (1957)-Kaldor (1970) view of endogenous growth concluded that economies of scale, increasing returns, and agglomeration lead to concentrations of capital, labour, and output at certain locations which is at the expense of other regions (Martin and Sunley, 1998). This promoted the view of cumulative causation and uneven regional growth which is self-reinforcing rather than self-correcting. The cumulative nature of the growth process was emphasised in endogenous growth models. The cumulative causation has a multiplier effect on regional incomes as well as induced or indirect effect on investment gains. For instance, suppose a region is attractively localised to afford higher factor prices to labour and capital. Higher factor prices attract more factors to move and work in the region either permanently or temporarily. Then increases in labour in the attractive region will stimulate local consumption as more goods and services will be demanded by the increased pool of workers. Complementary industries start to build their base surrounding the attractive region that experience greater inflows of factors. All these will have multiplier (also known as spillovers in certain contexts) or cumulative effects on the economic growth of the region attained through economies of scale, reductions in costs of production and distribution, diversification, mergers, etc. Thus, agglomeration helps the attractively localised region to grow, but the lagging regions where the factors migrated from, will suffer. The gap between these two types of regions continues to increase unless there are new growth opportunities like investment in industry set-ups or infrastructure developments in the lagging region.

Agglomeration economies help raise national economic growth but then growth is driven by the performance of a limited number of concentrated areas. These areas are the loci of economic activities that attract firms and individuals from elsewhere. Industrial production, skilled workforce, and higher wages come together to areas that have proximity advantages for interactions in terms of transportation, communication, free flow of ideas, knowledge development, technology diffusion, etc. These are important from the Marshallian perspective of agglomeration economies for knowledge diffusion (Capello and Nijkamp, 2010). Agglomeration economies produce positive externalities in the form of technology and knowledge spillovers which become important for regional growth and development as emphasised by Grossman and Helpman (1991), Romer (1986), Aghion et al. (1998), Romer (1994), Howitt (2000), Aghion and Howitt (2008), Klenow and Rodriguez-Clare (2005), Bloom et al. (2013), Jones and Romer (2010), etc. Therefore, agglomeration economies promote the convergence of economic activities in concentrated areas.

Endogenous growth models include externalities and spillovers generated by investments into broad capital that in turn stimulate output growth. Levine and Renelt (1992) found a correlation between average growth rates and the share of investment but the direction of the relationship was ambiguous. Even though Fournier (2016) found a positive relationship between public investment and long-term growth and labour productivity, growth gains from increasing public investment might decline from a high level of capital stock due to decreasing returns. Few studies reject the possibility that fixed investment is the main source of growth (Blomstrom et al., 1996; Alfaro et al., 2004; Paniagua and Sapena, 2014) and Pack (1994) emphasises that the presence of externalities is difficult to test. Similarly, Martin and Sunley (1998) highlight that endogenous models treat externalities in a general and abstract manner and do not control for potential sources of bias. For instance, increasing returns on a particular technology encourage lagging nations to replicate technology through the imitation effect. Moreover, original technology may become inefficient over time and the leading country may remain locked into that inefficient technology for long period. Endogenous growth modelers do not discuss these types of negative effects of technology on growth in their models even implications of these effects can support the convergence of leading nations with lagging nations, analogous to the diminishing marginal returns of the neoclassical model. Even though endogenous growth models began by predicting divergence, it is possible that the negative effects of technology can overpower positive effects and convergence prevail instead of divergence (Martin and Sunley, 1998; Giuliani, 2005).

The proposition of endogeneity was ameliorated in the neoclassical growth model through the application of the panel data approach by including lagged value instruments/variables on the right side of the regression equation. Instrument selection becomes important in this case. Studies find significant model efficiency gains using this approach (Arellano and Bond, 1991). Another issue that the neoclassical growth model address is the problem of omitted variable bias (Caselli et al., 1996). The bias was eliminated by taking account of differences in parameters such as technology and production functions based on country-specific characteristics and modify the equation by taking differences to eliminate individual effects. Then lagged values were added as instruments to control for endogeneity.

After fixing the endogeneity issue and omitting variable bias, Caselli et al. (1996) found that the convergence rate increases to 10 percent per year rather than two percent per year as proposed by the "iron law". However, a few researchers focused on removing these biases to understand the speed of convergence at national and regional levels and found very low speeds of convergence (Canova and Marcet, 1995; Pritchett, 1997; Magrini, 2004; Artelaris, 2015).

The new growth theorists emphasise that knowledge is a driving force of development that endogenously self-reinforce mechanisms of knowledge creation. According to macroeconomic models of endogenous growth, knowledge is embedded in human capital (Romer 1986, Lucas 1988) and the argument of endogenous growth model proponents is that technological progress is an endogenous response of economic actors in a competitive environment (Capello and Nijkamp, 2010). Factors generating increasing returns to scale, such as innovation, are included in neoclassical production functions too, however, increasing returns are assumed to offset the effects of diminishing marginal productivity of individual factors and hence diminish the overall marginal productivity. Diminishing marginal productivity yields lower returns for investment into capital leading investors to shift their resources towards poorer regions to gain higher returns. This process helps the poorer regions grow at a faster rate and converge with richer regions. The neoclassical assumption of diminishing marginal returns was criticised by advocates of endogenous growth models who show that factors (such as scale economies, innovation, and technological progress) are capable of generating increasing returns to scale and hence will make rich economies grow at a higher rate and diverge away from the rest.

Regional Studies

In terms of regional growth, studies related to regional competitiveness and development focus on national attributes and policies as drivers of growth. However, regional scientists and economic geographers have emphasised the substantial differences in economic performance across regions attributed to the essential determinants of growth found at the regional level, hence underlining the role of regions in national growth performance (Porter, 2003). In terms of the interaction and interdependence between regional and national growth, Richardson (1973) provided two ways to interpret the relationship—competitive and generative. In the competitive growth approach, growth of the national economy is assumed to be given and regional growth is a zero-sum allocation of production which gives an outcome of one region growing at the expense of another (Harris, 2017). It implies that the competitiveness of a single region is not supposed to add any value to the aggregate national growth. On the contrary, the generative approach treats national growth as an outcome of aggregate growth rates of regions, i.e., the national growth will be higher if regional growth rates are improved. Harris (2017) stated that neoclassical growth models mostly demonstrate the competitive nature of growth between regions in which better growth is attained through increasing the efficiency of factor inputs. To attain increasing efficiency, the models promoted the understanding of determinants of growth of regions. New growth approaches and endogenous growth models fall into the generative growth category in which agglomeration of activities and spatial efficiency help regions perform better, which in turn increases the national growth.

Exogenous shocks

Considering the effects of exogenous shocks on the growth paths of economies, studies have shown no obvious impacts of exogenous shocks on economic growth (Noy and Nualsri, 2007; Kilian, 2008; Cardia, 1991). The neoclassical framework predicts that the effects of shocks/recession would enhance the growth of an economy since the economy will be pushed away from its balanced growth path or steady state growth path. In that case, in order to revert to its steady state, the economy would work hard to accumulate capital. Thus, neoclassical growth models suggest quicker recovery after negative shocks (Noy and Nualsri, 2007). However, endogenous growth models predict a negative effect of shocks via increased uncertainty, increased expenditure to reallocate resources, negative impacts on particular sectors, redundancies, loss of investment, etc. Some studies relate shocks with reduced investment (like foreign direct investment) that induce reductions in capital stock and reduced growth (Ludvigson et al., 2015; Campello et al., 2010). Similarly, macroeconomic uncertainty plays an important role by amplifying the downturn caused by other shocks (Ludvigson et al., 2015; Dotsey and Reid, 1992). Thus, the effects of negative shocks may not be obvious but could be minimal for a resilient economy and intense for a non-resilient economy.

2.23 New Economic Geography

Regional economics entails features of both mainstream economics and regional science. During the 1990s, the research of mainstream economists showed interest in regional science, which is when new economic geography concepts developed. It was viewed in such a way that the combination of regional science and mainstream economic approaches had the potential to provide better insights to enhance regional growth and development. The spatial phenomena have become the top agenda items for policymakers that call for advanced conceptual and methodological approaches. Issues of economic growth convergence and regional disparity are now treated in new spatial ways for the attainment of territorial cohesion and not pure economic cohesion (Capello, 2012). In this respect, it becomes important to understand the strengths and limitations associated with economics and regional science approaches.

In terms of growth theory, the new economic geography (NEG) perspective has emerged as another school of thought which emphasises the spatial differences among economies as one of the vital causes of economic growth disparity (Krugman, 1991). Researchers of this perspective extensively combine product differentiation, positive externalities, increasing returns, factor mobility, international trade, imperfect competition, agglomeration, and spatial differential, among others, to explain imbalances across economies (Fujita and Thisse, 2009; Boulhol et al., 2008; Ducruet, 2016). The NEG and endogenous growth theories share the same framework of monopolistic competition, increasing returns and spillovers.

Inspired by location theory and agglomeration economies, Krugman (1991) highlighted that the reasons for industry localisation, as given by Alfred Marshall (1920), were valid for spatial economic agglomeration and specialisation. According to the NEG approach, the equilibrium spatial allocation of economic activity is decided by both the agglomeration forces as well as dispersion/spreading forces. The key parameter of transport cost determines which of the two forces will have an upper hand—when the transport cost is low, the agglomeration forces are stronger (Garretsen and Martin, 2010).

The concentration of firms at a single location attracts workers with specific skills from neighbouring regions, attracts complementary inputs and promotes information spillovers (Bosker, 2007). Agglomeration forces deal with localised externalities arising from the labour market, technological spillovers, supply and demand forces, etc. In terms of types of agglomeration externalities, specialisation, urbanisation, and localisation are some of the important positive externalities that drive the growth of regions. These factors lead to the clustering of economic activities around area that supports their growth through developed infrastructure, lower transport costs, greater availability of complementary goods, etc. Economic activities in one region may have positive spillovers to its neighbouring regions and, hence, facilitate agglomeration and growth (Funke and Niebuhr, 2005; Geppert and Stephan, 2008).

However, some researchers underline that the benefits of agglomeration depend on the development stage of the economy. For instance, Brülhart and Sbergami (2008) find that poor economies benefit in terms of higher growth if they have more concentrated geographies. The study found that agglomeration/urbanisation is good for the growth of economies with GDP per capita level of $10,000 (in PPP terms) which represents the development level of Brazil or Bulgaria. Brülhart, M. (2009) cites that for rich economies, agglomeration appears to inhibit growth (although effects are not statistically significant). Likewise, Duranton (2015) highlights that the productive advantage of large cities fade away after some time (similar to creative destruction) and needs new innovative jobs to sustain growth.

Furthermore, Scott (2017) underlined that the NEG is a deficient model in terms of the way it explains agglomeration. The study argued that agglomeration is dependent on the complex play of culture. The rise of the City of London or Silicon Valley could be understood by the relationship between economic and cultural dynamics. These places display distinctive traditions or cultural practices that have deeper roots in explaining phenomena like management styles, work-life balance, creative and innovative ideas, adaptability, and so on. Those who have these qualities (firms or individuals) would be able to survive in these places because not everyone could cope with the fast life of London. These phenomena have a greater ability to alter economic growth and convergence through stimulating output growth (Scott, 2017). In light of the industrial clusters, since the 1980s, national and local governments have used cluster policies to facilitate development. Martin et al. (2011) analysed the French firm-level data on the effects of cluster policy on firms' performance and found that there is no evidence of large expected gains from government intervention in favour of encouraging cooperation and competitiveness among firms to improve firms' performance. Moreover, that there is no robust impact on employment and exports owing to the cluster policy intervention. Furthermore, the NEG approach has been criticised for not adequately capturing social, institutional and cultural factors that define a landscape in a mathematical form which pose difficultly in assessing the true performance of a region (Garretsen and Martin, 2010).

Spatial Scale

For the distribution of economic activities, the neoclassical theories emphasise the role of "first-nature geography" that consists of the physical geography of climate, topology, and resource endowments, while the NEG approach highlights "second nature geography" emphasising the location of one economic agent relative to another in space (Redding, 2010). In other words, the NEG perspective of regional growth emphasises the importance of specifying the spatial unit of reference. Economists used words like location, region or place interchangeably without realising the risk of drawing conclusions on different spatial units by doing that. Combes et al. (2008) and Brakman and Garretsen (2009) highlight that the explanation of growth could be relevant at one scale (e.g., city) but irrelevant at another (e.g., national). Industrialisation is often presented as a regional phenomenon and globalisation as a national phenomenon, but both have direct and/or indirect effects on national and subnational levels. Studies drawing implications at different spatial units correspond to the different levels of regional aggregation and findings relevant for one level may not be relevant to another level. Thus, vague definitions of spatial units of analysis reduce the credibility of studies based on the fact that variables are not measured at the appropriate spatial scale (Behrens and Thisse, 2007).

Regional agglomerations give rise to regional specialization, and hence it becomes important to understand the contributions of geographical structures towards growth processes (McCann, 2013). It is evident that many smaller and less densely populated regions exhibit faster growth than many urban regions. This draws attention to the advantages of specialization and diversification of industries. Thus, it is important to understand the relationship between different types of regions and their roles in the national economy.

The empirical investigation of this relationship becomes difficult due to the unavailability of data at appropriate levels. Garretsen and Martin (2010) highlight that the conceptualisation of space is a challenge for NEG theorists and economic geographers. It has been emphasized that the statistical analysis of geographical data depends on subjective decisions made by the analyst about the units and levels of data aggregation (Sexton, 2008). The discretion of the analyst to choose data seems to be one of the reasons for a lack of coherence in findings prevalent in this domain. To deal with such shortcomings, many researchers have highlighted the significance of simultaneous considerations of parameters using dynamic models (Brakman and

Garretsen, 2009; Carlino and Mills, 1987; Breinlich et al., 2014). The use of dynamic models and the simultaneous consideration of parameters enable the potential to use more advanced and sophisticated techniques to improve our understanding of the spatial dimension of economic growth.

2.24 Multiple-Equilibria and Distribution Dynamics

Regional growth models have proposed mechanisms for convergence/divergence of growth paths of economies. They provide insights into absolute convergence which implies that the economies converge to one another in the long-run irrespective of their initial conditions, but the evidence of absolute convergence was refuted by many studies that were based on cross-country regressions and examination of the evolution of income distributions (Barro, 1991; Quah, 1996a). The literature started to focus on the structural factors that limit the convergence process of economies, such as preferences, policies, population growth rates, mortality rates, technological development, etc. Using these factors/variables, studies reveal the existence of conditional convergence for a group of economies implying the economies converge if they have similar structural characteristics irrespective of initial conditions. The absolute and conditional convergence hypotheses were related to the notion of the existence of a unique globally stable steady state equilibrium to which all economies converge. Durlauf et al. (2001) emphasised that the key limitation of empirical studies for a cross-country analysis has been the assumption of a single steady state equilibrium applied to all economies in the case of absolute and conditional convergence.

To address the limitation of a single equilibrium, Galor (1996) showed that by augmenting the neoclassical growth models by including a range of parameters to capture elements of human capital, income distribution, market imperfections, externalities, etc., the model would yield the club convergence outcome. Club convergence is a situation when economies with similar structural characteristics converge their growth paths in the long run if their initial incomes are similar. This hypothesis of convergence allows for locally stable multiple equilibria based on similar characteristics of economies in each club. Hence, club convergence has economy-specific equilibrium levels which could be different for different clubs. For instance, the high-income and low-income economies could form two separate clubs (or groups or clusters) with two equilibria based on their similar structural characteristics and initial conditions. Research demonstrates the multiple regimes of growth patterns in which different economies obey different linear growth paths when grouped together based on their region-specific or club-specific characteristics instead of one linear model commonly used across all economies (Durlauf and Jhonson, 1995; Fischer and LeSage, 2015; Monastiriotis, 2011; Liu and Stengos, 1999; Maasoumi et al., 2007).

Martin (2001) underlined that under such circumstances there might be convergence among similar economies within a club but little or no convergence between the clubs. Convergence within and divergence between groups could yield different aggregate convergence conclusions based on the mix of converging and diverging economies, which contribute to the inconclusive nature of findings in this domain. Therefore, to understand the evolving equality or disparity between economies it is important to understand how economies are behaving within and between groups.

In this line of research, distributional dynamics studies highlight that the shape of distribution provides a lot of insights on clubs/groups/clusters of economies converging together with each other. The distributional dynamics proponents emphasised that considering the dynamics of growth and distribution together could reveal the underlying dynamics of convergence and inequality (Quah, 1993; 1996a; 1996b; 1997). After scrutinising the world income per capita distribution, many researchers concluded that the world per capita distribution of economies has changed from single cluster to two clusters (See Fig. 2.1) comprising of high- and low-income countries (Quah, 1993; Kremer et al., 2001; Im and Rosenblatt, 2015).

In addition to the evolution of the shape of the per capita income distribution, what is happening within the distribution is equally important. The study of income distribution dynamics helps us understand the nature of cross-country interactions by demonstrating the phenomenon of mobility of countries from one position to another (also called churning) within the cross-section income distribution. Quah (1993a, 1993b, 1996a, 1996b, 1997) claimed that to understand the dynamics of the poor catching up with rich economies, it is important to understand the intra-distribution dynamics, as illustrated in Figure 2.1. The intra-distribution dynamics help to further investigate issues, such as the poor stagnating within poverty traps, displaying persistence in poor or rich states, poor overtaking some rich economies, and economies forming clubs with similar economies by converging towards each other and diverging away from other clubs.

Therefore, it becomes essential to understand how economies interact with each other through factors such as trade flows, labour migration and technology diffusion. The study of interactions/behaviours of economies within any distribution is known as intra-distributional dynamics. In terms of intra-distribution dynamics, Quah (1996a) highlighted that there were some countries that had been rich all the time, some countries had moved from the poor to the rich class (growth miracles), some countries had been trapped in poverty, and some countries had formed clubs or groups with member countries converging towards each other and diverging away from another clubs as shown in Figure 2.1. Therefore, there could be a broad range of intra-distribution dynamics characteristics that would be interesting to explore.

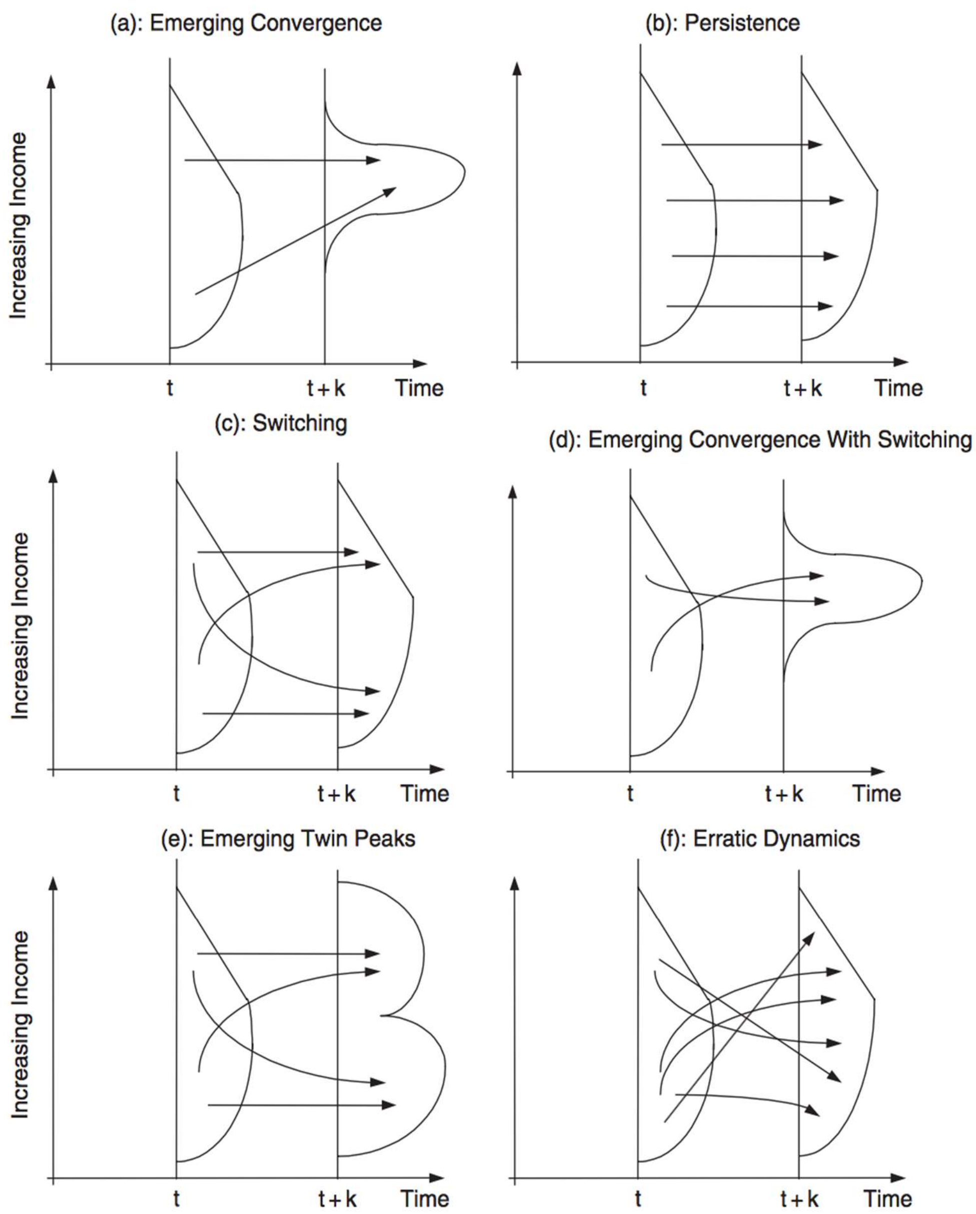


Figure 2. 1: Different possibilities of emerging distribution dynamics

Source: Webber et al. (2005; pp 6)

Quah (1996a) hypothesised the tendency towards twin-peakedness among world economies. The study considered the income distribution between extant period *t* and future period *t+s*. If time *t+s* is within sample data, then twin-peakedness is directly observed otherwise a clear model is needed to reach a conclusion. Quah (1993a) cited that the time dimension of the data for cross-country growth studies need not be large to assess long-or medium-run growth.

Quah (1997) study on world income distribution showed that in 1961 nascent twin-peakedness emerged which became pronounced in 1988. The countries were grouped into high income and low-income categories and also the countries continued to remain in their groups for a while. The high variation in incomes between low and high categories shows the influence of ongoing disturbances or shocks within economies. Following Quah (1997) and Bianchi (1997), Holzmann et al. (2007) analysed 127 countries between 1970 and 2003 and found twin peaks formation. Recently, although not for the world economy but for 15 Middle East and North African (MENA) countries for 1990-2015 Hadizadeh (2019) found the formation of twin peaks in the MENA region. Hence, the existence of stratification or clustering of world economies was established which reflected the presence of divergence or an increasing income gap between economies (Kharas and Kohli, 2011; Flaaen et al., 2013; Paap et al., 2005; Acemoglu and Ventura, 2002; Kerekes, 2012).

Providing details on 'twin peaks,' Quah (1996a) found evidence of polarisation of countries into two clubs—high income and poor income countries as shown in Figure 2.2. The density of the income distribution is plotted at time t and t+s. The distribution at time t shows a single peak indicating convergence, while at t+s the distribution shows two peaks suggesting the formation of clubs. The above figure shows that rich countries are in the upper part and poor countries are in the lower part of the distribution. At time t+s, it is shown that the income distribution is forming a bimodal distribution with twin peaks. The distribution also shows a dip in the middle which indicates separation, implying the middle-income group of economies moving to either high- or low-income groups, thereby disappearing over time. Quah (1996a) briefly mentioned trade relations and spillovers as two main reasons behind this phenomenon. Furthermore, his argument of twin peaks clearly illustrated that the traditional approach of convergence to a common steady state was not evident; instead, there was a presence of multiple regimes of growth patterns.

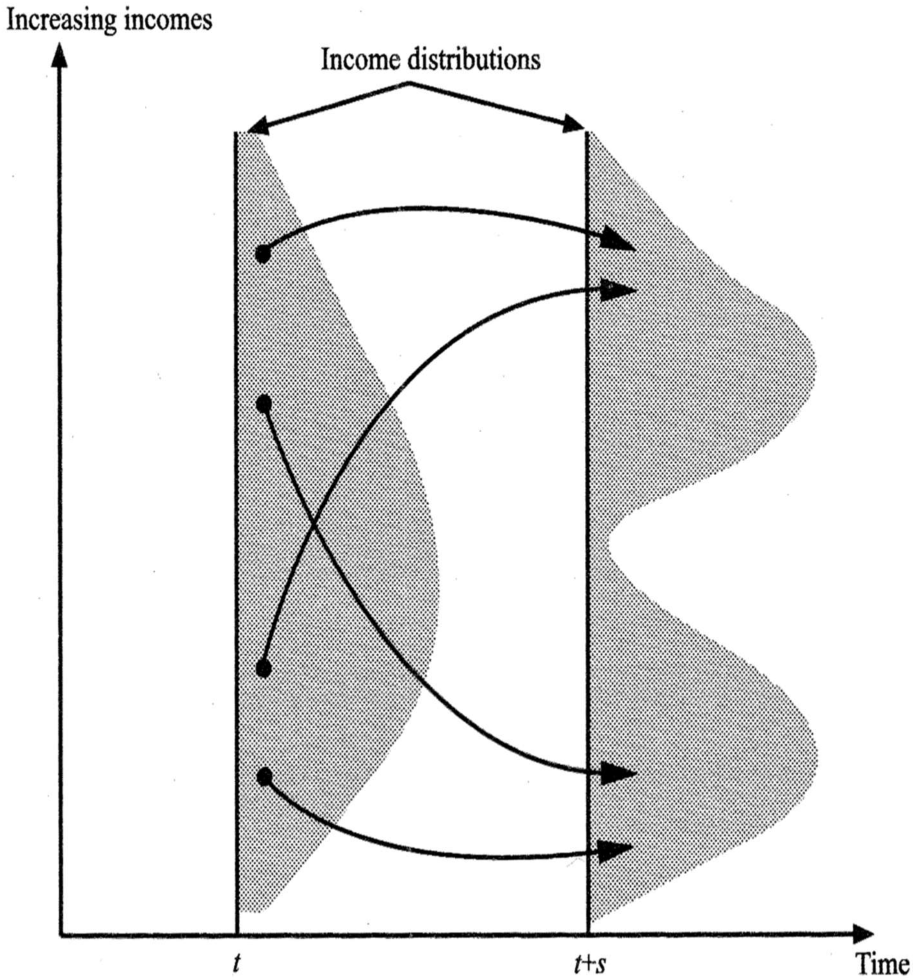


Figure 2. 2: Twin-peaks distribution dynamics.

Source: Quah (1996b; pp 1369)

Literature alludes to a vast majority of studies following Quah's lead in understanding the income distribution dynamics. Kremer et al. (2001) found evidence of twin peaks using ergodic income distributions (as applied by Quah) with transition probabilities spread over five-year intervals rather than one year as used by Quah (1996a). Kremer et al. (2001) revealed that most countries would move eventually to the richer state and it is the transition phase that makes stratification and clustering prominent. Azariadis and Stachurski (2005) predicted the evolution of cross-country income distributions using a stochastic parametrisation that enabled them to compute future projections of the income distribution. Consistent with Quah (1996a, 1996b) and Kremer et al. (2001), they found that bimodal distributions are caused by non-linearities in the growth process.

In this research line, Im and Rosenblatt (2015) have shown that countries are likely to remain in their relative income groups. In other words, the probability of being in a high- or low-income country and remaining that way was high. This indicates that if a country joins a high-income country club then it is very likely to remain in that club. It also signifies that low-income countries are subject to poverty traps (Kraay and Raddatz, 2007). This depicts a wide gap between rich and poor, and potentially no convergence or divergence over time.

One of the main reasons for poverty traps has been barriers to adopt more productive technologies due to institutional failures (e.g., state, legal systems, social norms, conventions and so on) (Azariadis and Stachurski, 2005; Pritchett et al., 2013; Gradstein, 2008; Flachaire et al., 2014). It has been highlighted that some countries, like Haiti and Liberia, have little state capability to carry out basic functions of security, policymaking and service delivery, among others, which makes progress very slow to reach high productivity levels (Pritchett and de Weijer, 2010). Another reason for being in the poverty trap that has been emphasized include low savings and productivity levels. Researchers have found that low-income countries have low investment levels and low investment capability and hence they remain trapped in poverty (Kraay and Raddatz, 2007; Pritchett et al., 2013; Andrews et al., 2013). The evidence from certain regions of Africa and Asia trapped in poverty suggests that they are diverging away from the other regions that are growing at a fast rate.

Studying the middle-income group, Im and Rosenblatt (2015) found that the probability of being a middle-income country and remaining as such was lower than the probability of being a low- or high-income country and remaining in that group. This finding is very much in accordance with Quah (1996a) which has found that the middle-income group vanished eventually, and the income distribution was divided into two peaks—high and low income. It has been evident that middle-income country growth slows down and their transitions into a low-income group are not frequent. According to Im and Rosenblatt (2015), some of the middle-income countries that successfully became high-income countries are Ireland, Korea, Singapore, Spain, and Taiwan; and those countries that have failed to climb up the ladder are Greece, Israel, Portugal, and Puerto Rico. Several authors have suggested that middle-income countries appear to be at a junction between low skilled-low wage activities associated with the low-income group and more sophisticated high skilled activities are associated with the high-income group (Kharas and Kohli, 2011; Flaaen et al., 2013). Therefore, the middle-income group may need to develop from a low skilled unproductive structure to a highly skilled innovative structure. Kerekes (2012) highlighted that the initial human capital stock, the quality of institutions, geographic conditions and trade relations are the major causes for differences in transitions from one income group to another.

Middle- and low-income traps and underdevelopment traps have been associated with the notion of multiple equilibria or club convergence (Berthélemy, 2006). The economies trapped in a low-level income equilibrium need a big change in their structure to help them climb up from a low but stable equilibrium to a high and equally stable equilibrium. One of the sources of change requires a big impetus to follow reforms or policy initiatives that help economies cope with the poverty trap. When one economy overtakes others and jumps to a higher-level equilibrium, so it provides information on their strategies and policies for the lagging economies to follow. For example, the European Bank for Reconstruction and Development (EBRD) reports that South Korea moved from a low to a high-income group with the help of government support that mobilised resources and channelized investments for industrial development. This provided motivation to other South-east Asian economies that started imitating the strategies of South Korea.

Club convergence and multiple equilibria studies have been translated into policy recommendations (Berthélemy, 2006). First, by increasing the available income through capital transfers and funds. International institutions, such as the World Bank and International Monetary Fund (IMF), have been helping many African and Asian underdeveloped countries by granting them foreign aids since 1950s (Collier, 2004). It has been highlighted that fund transfers have different effects on different regions based on their abilities and capacities to adapt to changes.

Second, enhance the abilities and capabilities of regions to change by implementing reforms that support the transfer of funds. Reforms could focus on people and place-based policies on education, vocational training, knowledge diffusion, trade, technology, imports, infrastructure, business restructuring, flows of investment, and so on. The reforms are supposed to improve the ability of lagging regions to cope with changes that are required to give a ‘big push’ to the economy (Umoru and Onimavo, 2018; Collier, 2004; Easterly, 2003). These reforms and policy changes would take some time to show results, as happened in China after the reform of 1978 when the country started to grow at a decent rate during the 1980s and faster during the 1990s.

Thus, the existence of multiple equilibria partly explains the varying findings related to converging and diverging economies in the growth literature. Intuitively, if a sample consists of a high number of regions that form one group and a small number of regions that form another group and both the groups are diverging away from each other, then the overall convergence/divergence of the sample will depend on the proportion of converging economies. Therefore, any analysis of within and between groups requires an understanding of the relevant interactions among economies.

To conclude the regional growth theory and development section, there is a continuing debate on the reasons behind varying rates of output growth and convergence among economies. Neoclassical theorists seem to find the differences in human capital, factor endowments, investments in capital, technological advancement, total factor productivity, etc. (supply-side factors) as reasons behind the economic growth disparity (MRW, 1992; Barro,1991; Barro et al., 1991). Proponents of endogenous growth models cite institutional factors, creation and diffusion of ideas, policy implications etc. as reasons behind economic disparity or growth divergence (Azariadis and Stachurski, 2005; Pritchett et al., 2013; Gradstein, 2008; Flachaire et al., 2014). Advocates of new economic geography emphasise the differential nature of spatial units promoting agglomeration, clustering, specialisation, urbanisation, and localisation lead to disparity in regional economic growth.

Growth theories set a foundation for predicting the convergence/divergence of economic growth that is applied to make inferences about economic growth disparities across regions. The convergence (catching-up) hypothesis, from the neoclassical perspective, states that poor/lagging economies grow at a faster rate due to improvement in human capital, factor productivity, etc. that enable them to eventually converge with rich/developed economies. The divergence hypothesis, from the new growth theory perspective, predicts faster growth for rich/developed economies due to better institutional factors, innovation, diffusion on knowledge, etc. that keep distancing them from the poor/lagging regions. Thus, mechanisms of convergence promote growth equality through the process of catching up, while divergence promotes growth inequality/disparity between economies, as shown in Figure 2.3.

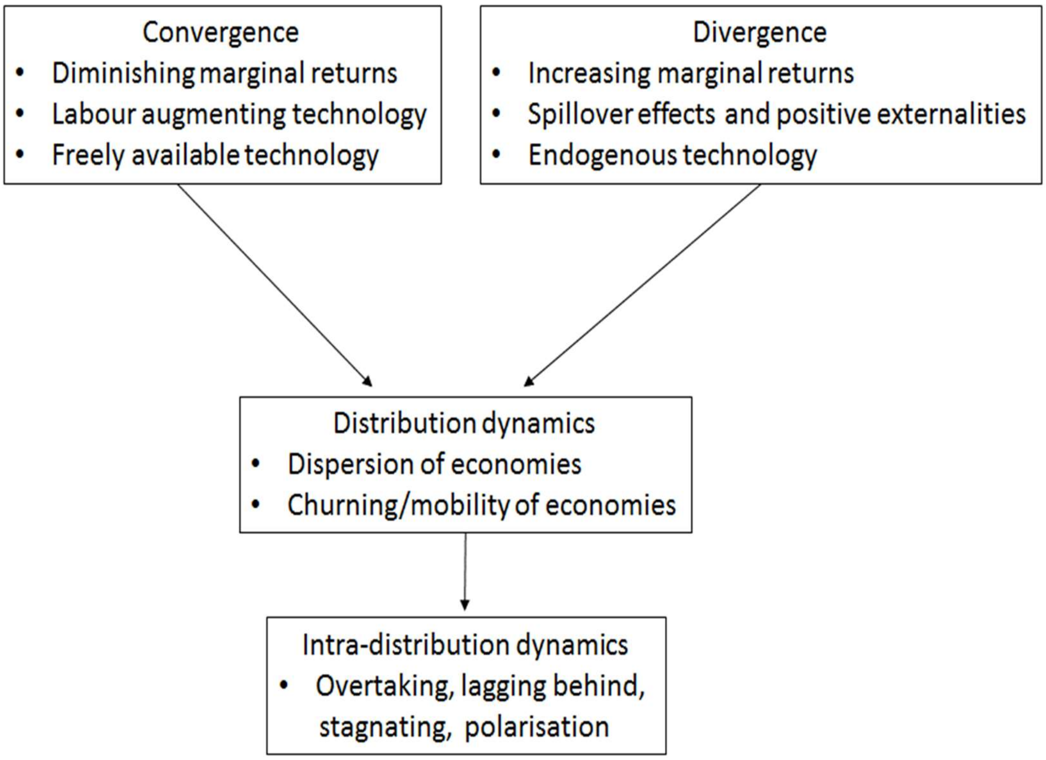


Figure 2. 3: Summary review of convergence and divergence literature

Source: Author's own work

2.3 Demand/Export-Led Growth Models- Keynesian Approach

The export-based model underlines exports as an important engine of growth. The model emphasises that the factors of production such as capital and labour are attracted to regions that are rich in natural resources. This theory is designed to explain the growth and development of resource-rich regions. Initial stimulus in growth is related to the exploitation of natural resources. Demand increases expand the necessary transport infrastructure to connect resource-rich regions with world markets. It has been emphasised that exporting larger shares of output induce faster rates of growth for economies through industrialisation (Michaely, 1977; Fosu, 1990; Feder, 1983; Marin, 1992; Awokuse, 2005), and the differential distribution of resources helps to explain why different regions grow at different rates.

It has been emphasised that economies that are good at exporting have higher wages (Marin, 1992; Singh, 2010). The combined effect is higher GDP levels for economies. The stimulating influence of exports on productivity can be assessed through exploiting economies of scale, technology transfer, and by increasing competitive incentives (Melo and Robinson, 1992). Export-led growth is supposed to generate a win-win outcome for both developing and developed economies based on the principles of comparative advantage (Palley, 2011). The increased efficiency due to the exposure to international markets and the exploitation of economies of scale by process and product specialisation can lead to positive externalities for related businesses in both developing and developed economies. Similarly, larger exports increase stocks of knowledge, technology advancement, learning by doing, know-how, skills, among others, that could benefit firms in neighbouring areas and lead to agglomeration of regions.

On the contrary, it is argued that productivity improvements are diminished when the over-investment in technology leads to higher costs of production (Martin, 1992; Martin and Sunley, 1998). As the level of exports increases, excess profits are reinvested into technological advancements. Technological advancement in turn helps firms to be highly productive and to reduce their costs of production. However, it has been highlighted that the original export activities with a low cost of production may not develop indefinitely (Ekholm et al., 2007). Some regions that started as low-cost regions may develop into high-cost ones. In addition, changes in the preference of people for the exported product may affect the demand for that product. In this case, if the factors are sufficiently mobile, then overall regional exports could switch into producing other viable export commodities or the region may lose its production factors to other more successful regions. Therefore, the beneficial effects of export-led growth appear to be short-term. The adoption of a dynamic approach based on the change in market demand is necessary for this type of analysis.

Dynamic model

The dynamic effects of technology transfer from developed economies involving externalities become important in export-led growth models that are missed in the static model of neoclassical growth theory. Melo and Robinson (1992) suggested introducing externalities to the standard neoclassical growth model to provide an explanation of observed differences in economic performance. In many countries, including China, export-led growth strategies have taken place with active government participation in terms of implementing policies related to taxes/subsidies or building the necessary infrastructure. Exports of manufactured goods, in turn, generate huge potential external benefits such as learning, training, quality improvement, economies of agglomeration, and technology acquisition. Furthermore, externalities increase not only by exporting commodities but also by importing technologies embodied in intermediate capital equipment (Melo and Robinson, 1992). Increases in imports content of exports give an opportunity to assimilate and master huge technological improvement techniques to meet world-class standard specifications and quality. In this regard, judicious combinations of selective industry, export promotion, intervention, etc. becomes important to realise the benefits of export-led growth. Export-led growth introduces increasing returns to scale at the economy-wide level and constant returns to scale at the firm level (Melo and Robinson, 1992, Romer, 1986). Thus, the benefits of trade are realised by the low-income regions (Rassekh, 2007).

Exports strongly connect economies across a country through flows of trade, finance, and factors of production; and through transport, communication, and information linkages (Baddeley, 2006). This has a very important implication on convergence within a country. The regions that are export-oriented are capable to grow faster together

(Kaitila, 2013) and their growth paths converge towards each other. In this regard, economies belonging to the same regional trade area or bloc agreement would club together with the member countries as found for ASEAN countries by Jayanthakumaran and Lee (2013). The link between increases in export and growth and development within a country can be assessed through the extent of convergence and divergence in output per capita across regions within a country. Baddeley (2006) gave an indication of convergence within clubs and divergence between clubs due to trade by highlighting that globalisation in terms of trade and financial flows have increased international inequality and benefitted the rich countries at the expense of poor countries. Literature alludes that export-oriented regions become advanced and overtake other regions, implying a subsequent divergent growth path. For instance, Chinese coastal provinces are growing at a fast rate because of factors supporting exports such as convenient geographical location, skilled labour, and better economic foundations compared to the other inland regions (Hao and Wei, 2010).

Moreover, by analysing the impact of trade on interregional inequality across countries, studies found a positive and significant association with regional inequality when combined with certain country-specific features, such as interregional differences in sectoral endowments, government expenditure, and foreign market access (Rodríguez-Pose, 2012). These country-specific inequalities are more prominent in the low- and middle-income countries which imply that trade flows stimulate interregional inequalities in low- and middle-income countries more than the high-income ones (Rodríguez-Pose, 2012; Chyi and Su, 2019). Similarly, the role of globalisation in contributing towards interregional inequality is found to be higher for low- and middle-income countries than high-income countries (Ezcurra and Rodríguez-Pose, 2013). Thus, the stages of development of individual countries matter in terms of being influenced by the determinants of growth.

Controversy

The controversial nature of the impact of exports on economic growth makes it difficult to conclude whether it is important for an economy. In this regard, the empirical findings have been mixed and inconclusive (Awokuse, 2003; Awokuse, 2008; Bahmani-Oskooee and Alse, 1993). Many studies have explored the causal link between exports and economic growth in some developing countries and found strong bidirectional causality (Chow, 1987; Wacziarg, 1999; Esfahani, 1991; Dodaro, 1993; Kokko et al., 1991). On the other hand, many studies have shown one-way causality or no causality at all for some countries (Bahmani-Oskooee et al., 1991; Giles and Williams, 2000; Shirazi and Manap, 2005; Vohra, 2001; Fatemah and Qayyum, 2018). In order to show a positive impact of exports on growth, Harrison and Rodríguez-Clare (2010) highlighted that the impact of restricting exports through policies have a negative impact on developing countries. Therefore, it is emphasised that exports could lead to faster growth in developing countries and enable their catch-up with advanced countries.

Palley (2011) argued that the export-led growth paradigm has lost its relevance in the changing environment of emerging markets and developed economies after the global recession of 2007/08. The crisis has led to shortages in demand and hence economic growth stagnation in industrial economies. Some of the developed industrialised economies suffered from de-industrialisation due to international financial imbalances, unemployment, output gaps, and productivity losses immediately after the global crisis. For instance, the UK's manufacturing production lost eight percent jobs which are double compared to the financial and business services job loss which was four percent (Pike et al., 2013.) Meanwhile, many studies have advocated the reliance on domestic demand-led growth instead of export-led growth due to its impact on unbalanced growth (Palley, 2002; Babatunde and Busari, 2009). In addition, some studies have shown the existence of both domestic demand-led and export-led growth to be important for the growth of a country in the short run

(Tsen, 2010; Yew Wah, 2004; Tsen, 2007; Jarra, 2013). In terms of the significance of trade for developing countries, Bilman and Turkeli (2013) have shown that appropriate trade policies were more highly significant for developing countries than they were for developed ones for stimulating economic growth.

In summary, the relationship between export/trade and convergence is researched by many studies (Kaitila, 2013; Jayanthakumaran and Lee, 2013; Baddeley, 2006). This debate on the effects of regional trade and investment reforms on regional convergence and income inequality in emerging markets is highlighted by Jayanthakumaran and Lee (2013). The findings suggest that convergence is present for ASEAN countries but not for SAARC countries. In addition, the effects of export on regional inequality are based on the stage of development of the country. Some studies highlight that the effect is more acute in the low- and middle-income countries than the high-income countries (Rodríguez-Pose, 2012; Chyi and Su, 2019). The controversies on the effect of trade and export on regional convergence and inequality contribute to the inconclusive findings of patterns of convergence. Trade is an important factor that stimulates interaction between regions and their rank order positions change with respect to one another which is highlighted as “churning/mobility” in the literature (detail in 2.24). Trade is an important mechanism for interactions between economies that change the rank order positions of regions. Therefore, export plays an important role for both developed and developing regions in the assessment of a conclusive convergence trend.

Table 2.1: Summary review of different theoretical perspectives

Approaches	Assumptions	Features	Strengths	Weaknesses
Neoclassical growth models	Diminishing marginal returns, labour augmenting technology, publicly available technology, etc.	Accumulation of physical and human capital, exogenous technology, supply-side factors, etc.	Assesses the determinants of growth, provides reasons for convergence, etc.	Omitted variable bias, disconnect between theory and empirical evidence, etc.
New growth models	Increasing marginal returns, endogenous technology, positive externalities, etc.	Agglomeration effects, cumulative causation, technology diffusion, etc.	Focuses on regional performance and competition, provides reasons for divergence, etc.	Biased towards agglomeration effects against dispersion/ spreading effects, use of complex mathematical tools, etc.
Demand led models	Export as an engine of growth	Product specialisation, focus on resource-rich regions, government intervention, etc.	Perceived to be a short-term driver of growth, considers dynamic effects of technology transfer, etc.	Inconclusive nature of the impact of exports on regional growth and convergence, recently receiving lower levels of attention which may be partly due to the presence of deindustrialisation etc.

Source: Author's own work

2.4 Gaps in the Literature

The topic of regional income convergence is a widely studied subject. Researchers have scrutinised the process of convergence from different perspectives. This section throws light on various mechanisms of convergence that are predicted from different growth theories. The perspectives of neoclassical and endogenous growth models are commonly studied and later scrutinised by the proponents of distribution dynamics. The neoclassical hypothesis predicts the catch-up of capital poor economies through the mechanism of faster growth of these economies compared to the richer ones. The assumption of diminishing marginal returns on capital applicable to the richer economies and labour augmenting technologies in capital poor economies facilitated a faster growth rate for poor economies. According to the neoclassical viewpoint, the poor economies would grow faster and gradually become similar to the richer ones. However, the question raised on this perspective is that whether it is possible in a real world that all developing countries become developed at one point of time in future with little or no difference between the developed and developing world.

Scrutinising the above-mentioned question, the new growth theorists (including new economic geography) proposed a mechanism for the divergence of growth paths among economies. Their viewpoint supported the fact that the rich economies grow faster due to increasing returns on factors that help them grow faster and diverge away from the rest. The increasing returns could be the result of agglomeration economies, spillover effects, positive externalities, etc. Studies scrutinised the mechanism of increasing returns or determinants of growth yielding increasing returns (Martin and Sunley, 1998). Some researchers have expressed their dissatisfaction on why the determinants/factors of growth for richer economies are not considered to have a possibility of yielding diminishing returns. For instance, the new growth theories do not discuss the possibility of a negative effect of endogenous factors such as technology overpowering the positive effects (Martin and Sunley, 1998; Giuliani, 2005). Therefore, the two stances of growth theorists on the mechanisms of convergence and divergence have been closely inspected by many studies.

With regards to the assessment of overall convergence experience, the extent of convergence of growth paths between the two economies could be considered as the net effect of divergence experienced by the rich economy and convergence experienced by the poor economy. In this case, heterogeneities among regions play important role in determining the overall experience of convergence and divergence. A sample consisting of a higher number of rich or advanced nations would demonstrate a higher extent of divergence than convergence in that sample. To address the issues, the significance of grouping regions based on similar characteristics has been promoted by researchers (Galor, 1998: Canova and Marcet, 1995; Durlauf and Quah, 1999; Webber et al., 2014; Bartkowska and Riedl, 2012). The evidence of convergence within groups and divergence or no convergence between groups is supported by many studies (Martin, 2001). Building on the advantages of the identification of groups of identical regions to combat the problem of identifying a dominant convergence trend, the thesis is going to identify groups of regions based on their growth trajectories.

The literature on regional convergence has an important implication on regional inequality. The convergence of growth paths of regions promotes equality while divergence promotes inequality among regions. In order to understand the inequality among regions, it is important to understand the process of convergence and divergence between economies. With regards to regional inequality, the literature on distribution dynamics emphasises the need to assess the shape of the cross-county income per capita distribution (Quah, 1997; Durlauf and Quah, 1999). The changing behaviour of economies through constant interactions between economies in terms of trade, capital investment, and labour flows are considered important to determine the evolving cross-country distribution dynamics. The narrowing and broadening of the distribution reveal the lowering and increasing dispersion of the distribution. If the dispersion is lower, then the inequality is lower, vice-versa. In other words, the sample countries will become similar or identical to each other with lower dispersion.

Furthermore, the shape of cross-country income distribution throws light on the polarisation of countries. If countries are stratified into groups there will be the existence of more than one peak. The identification of more than one peak is a contradiction to the assumption of a single steady state growth path at which all countries strive to settle down as predicted by the standard convergence hypothesis (Kremer et al., 2001). The polarisation of countries laid a foundation for multiple-equilibria steady states for different clubs/groups of economies which were widely studied as a part of club convergence. Clubs of economies with identical characteristics converged their growth paths towards each other and disparity between them declined.

The literature on convergence, among many other ideas, brings into attention three important issues/gaps that are acknowledged by many researchers (Chen et al., 2014; Korotayev and Zinkina, 2014) but not studied in detail. The thesis will take these three issues as a foundation to address the gap in the existing knowledge of regional convergence and inequality. The first problem is about inconsistent findings on convergence and divergence trends. Researchers have highlighted the problem of inconclusive findings on the convergence trend (Martin, 2001; Awokuse, 2003; Awokuse, 2008; Bahmani-Oskooee and Alse, 1993). There are a lot of factors responsible for mixed findings such as different conceptual underpinnings of convergence measures such as beta, sigma, and gamma convergence, mix of heterogeneous regions in a sample, selected geographical scales considered, and selected time frame considered in the studies, among others. The debate on inconsistent findings owing to differences in methodology and selection of scale and scope of studies is discussed in detail in the next chapter.

The second problem is about the dynamic nature of steady-state equilibrium at different times. As highlighted by Chen et al. (2014), the interactions between technology and accumulation of capital and labour are ongoing phenomena and do not occur only in the current period and hence the model should consider the dynamic behaviour of economies. The study found that the dynamic convergence to the moving steady-state equilibria exists in economic growth. With the help of US data from 1951 to 2000, the study supported the hypothesis of dynamic convergence in the Solow model. This emphasises the need to take account of changing regional dynamics of convergence.

The third issue is the dearth of studies on regional convergence and inequality between countries using data since the mid-2000s. Korotayev and Zinkina (2014) underlined that the global trends changed from the mid-2000s and hence changed the regional dynamics of growth and convergence. The study highlighted that the "most respective" journal papers have examined the data until the early or mid-2000s. As a result, the study called for a revision of the convergence issues. Likewise, a press release by UN/DESA (2017) emphasised that the early years of the 2000s have seen several developing countries experiencing significant convergence towards the advanced countries in terms of living standards, however, countries in Africa have been lagging behind.

The uneven economic growth within economies led to differential findings during the 2000s. In order to find the impact of increasing openness to growth, Morrisson and Murtin (2011) used household surveys for income distribution from 1992 to 2008 and separated the countries into groups—transition countries (e.g., China, Hungary, Poland, Russi, Czech Republic), emerging countries (e.g., Brazil, Chile, Colombia), developing countries (e.g., South Africa, Bangladesh, Egypt, India), and developed countries (e.g., Germany, Australia, US, UK, Japan). The study found different findings within the groups depending on the country policies. The emerging countries reaped the benefits of globalisation with stable inequality within countries, while transition economies experienced increased inequality (except Hungary) within countries. The differences in country-specific characteristics lead to differential findings in inequality. Therefore, the heterogeneous economic behaviour calls for a detailed study on convergence and inequality between- and within-country, particularly after the 2000s.

The three gaps, thus, draw attention towards three issues—inconclusive/mixed findings on convergence trend, dynamic change in the convergence process, and limited recent studies in the domain. To address these issues, a detailed/comprehensive study on dynamic convergence patterns for regions post-2000 should be employed which could help identify a conclusive convergence trend. In order to address the three issues, the thesis is going to compare the changing behaviour of convergence across regions and time periods using the relative ratios technique for the required time period.

The first issue is about the disproportionate share of incomes across the countries around the world. This is because of the heterogeneity of income per capita between and within countries. Some studies have highlighted that the problem of size differences among individual regions are ignored in convergence literature (Topaloglou et al., 2005; Petrakos and Artelaris, 2009; Novotný, 2008). Within a sample, two regions with a massive difference in their income per capita make it difficult to come to a conclusion when absolute differences in income are compared (Novotný, 2008). The two regions could be outliers and affect the assessment of the overall trend for a sample of regions. The absolute gap comparison is useful when the sample contains regions with similar income per capita so that they easily converge towards each other. However, it is a problem when there is a huge difference between the two regions' income per capita. In this regard, Piketty et al. (2019) emphasised that constructing a comparable data series is important to monitor and compare the diversity of economic performance across countries over time.

However, when there is a huge difference between the two regions' incomes per capita then the comparison of absolute difference in their incomes provide a limited understanding of regional convergence and inequality. In that case, comparison in terms of ratios or proportions become more appropriate. The ratios of income differences of two regions in two time periods provide the proportionate change in income which could be easy to interpret and compare with others. Consequently, pairwise ratios make it easy to interpret the findings, at the same time, they are easy to compare the change across regions. Therefore, comparing regions in pairwise settings in relative ratios will be provided in the thesis for the detailed assessment of the overall convergence trend which could help in identifying a conclusive trend.

The second issue on considering the dynamic change in the convergence behaviour of regions is related to interactions between regions through trade, labour flows, and capital investment, among others. The interactions and continuous change in convergence behaviour between regions alter the rank positions of one region relative to another within the income distribution. The changing rank positions draw attention to regions that are overtaking, lagging behind, and stagnating with respect to others. Based on the evidence from The World Bank (2019), the lower middle-income countries share of global GDP has doubled from 4 percent in 2002 to 8 percent in 2017 and upper middle-income countries have increased from 13 to 27 percent during the same period. On the other hand, high-income countries share has fallen from 83 to 64 percent. The evidence alludes the possibility of regions overtaking, lagging behind, and stagnating relative to each other. Thus the feature of relative behaviour assessment becomes important in the examination of mobility dynamics across regions.

The distribution dynamics proponents had already underlined the significance of churning/mobility behaviour of regions within the income distribution during the 1990s (Quah, 1993a, 1993b, 1996a, 1996b, 1997; Webber et al. 2005; Kremer et al., 2001). They advocated the presence of increasing inequality and emerging stratification or polarisation through twin peaks dynamics (Quah, 1996b). The twin peaks dynamics observed the transition of countries in poor category to rich and rich to poor, at the same time, middle-class countries disappearing. In addition, the twin peaks dynamics suggested convergence within the two categories/classes of countries and divergence between them. Thus, the evidence of churning or mobility of economies has been explicit in the literature which makes the requirement of assessment of mobility dynamics important. Simultaneous assessment of regional mobility and convergence dynamics play an important role in assessing the regional disparity patterns. Therefore, the thesis is going to provide evidence on changing regional inequality by investigating the dynamics of convergence and mobility together.

The third issue is on the lack of studies using data from the mid-2000s—the period which has experienced changes in global convergence and inequality trends. With regards to global trends change, Villaverde and Maza (2011) emphasised that globalisation play an important role in influencing the economic growth of a country and hence its convergence behaviour with others. Likewise, Grinin and Korotayev (2014) showed that due to globalisation many developing countries are growing faster than the developed countries indicating convergence between them, however, there is a presence of divergence between major developing countries and a group of poor countries which is increasing the gap between the developed and lagging countries.

Apart from globalisation, the period has experienced a global recession in 2007/2008. The recession has changed a lot of dynamics between countries/regions globally which has affected the convergence and divergence pattern. For instance, some previously high-income regions in the US and the UK were struggling to revive from the recession and showed stagnation in income and gradually diverged away from their peers. Research has highlighted that the impact of shocks has been heterogeneous and inconsistent on economies (Noy and Nualsri, 2007; Kilian, 2008; Cardia, 1991). The explanation for the inconsistency is provided by growth theorists.

According to the neoclassical growth models, the exogenous shocks drive countries away from their balanced growth paths and, consequently, the countries strive to get back to their balanced growth paths fast and recover from the shock quickly (Noy and Nualsri, 2007). On the other hand, new growth theories observe the long-term impact on the economic growth of countries if the intensity of shocks is beyond a threshold value or at least a temporary decline in income growth rate (Noy and Nualsri, 2007). The evidence of changes that happened during the 2000s recommends a detailed study of convergence patterns across the world. Therefore, the thesis is going to investigate any noticeable change in the convergence patterns during the 2000s.

The three research gaps highlighted above call for a comprehensive study on convergence/divergence behaviour between regions. In order to address the gaps, the thesis will conduct a detailed analysis of changes in ratios of income per capita of one region with respect to another between two periods. The study will be assessing the convergence or divergence between the two regions between two time periods based on the notion of concordance and discordance. The concordant pairs will be treated as converging pairs and discordant pairs will be treated as diverging pairs. The pairwise analysis of change in income also helps understand the relative mobility behaviour of regions. The comparison will help easy interpretation of regions overtaking, lagging behind, or stagnating with respect to each other. A comparison of mobility behaviour between high- and low-income group of regions divulge about the persistence or non-persistence of income groups. Therefore, pairwise ratio analysis of change in regional income behaviour reveals a lot of features that are not identified by the standard measures of convergence.

The simultaneous assessment of regional convergence and mobility behaviour is important to understand the intricacies of regional income disparity patterns (Quah, 1997; Boyle and McCarthy, 1997, 1999;

Beenstock and Felsenstein, 2008). In this regard, the two research questions that are addressed in the thesis are:

RQ1. How have the regional dynamics of convergence evolved across the world and in China, the US, and the EU at the national and subnational levels over the last 20-25 years?

RQ2. How mobile were regions within- and between-groups of similar regions in these geographical locations?

2.5 Conclusion

This chapter provides an overview of different theoretical underpinnings that explain convergence and inequality between economies. The growth theories and demand-led growth provide many insights into the mechanisms of convergence and divergence between economies. The chapter highlights the debate on the disconnect between theory and evidence that has been underlined by researchers following different schools of thought. Three gaps are highlighted in the chapter—the issue of inconsistent findings in the literature of dominant convergence trend, the dynamic behaviour of convergence between economies which has been explored by very limited research, and the dearth of studies exploring the recent convergence patterns, particularly after the 2000s. The thesis will address these gaps in the subsequent empirical chapters. The literature asserts that the findings of the dominant patterns of convergence are controversial due to the application of differential techniques to measure convergence. In this regard, the next chapter will discuss the techniques that have been widely used in the literature and emphasise the importance of assessing a comprehensive convergence behaviour to understand the intricacies of economic disparity.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

Chapter two illustrated the hypothesis of convergence as predicted by growth theories and the mechanisms behind the process. Growth theories illustrate different opinions on the process of convergence and divergence among economies. The neoclassical theory considers convergence as a rule and divergence as only a temporary phenomenon (Soukiazis and Castro, 2005). New growth theories emphasise that the divergence of income is a predominant phenomenon among economies (Baldwin et al. 2001). This implies that convergence of incomes is facilitated by higher rates of growth experienced by low-income economies, while divergence takes place owing to the higher growth rates experienced by high-income regions.

The empirical findings in the domain of convergence offer a wide range of conclusions regarding income per capita. One strand of the literature predicts successful catching-up of the developing countries with developed ones, while another strand predicts that developed countries grow faster than developing countries (Dufrénot et al., 2009; Dobrinsky and Havlik, 2014; Stengos and Yazgan, 2014). There is evidence of conditional convergence that goes beyond the fundamental assumption of initial income as a major contributor towards convergence and also includes factors, such as human capital, technological advancement, and innovation (Galor, 1996). The evidence of convergence clubs highlights that countries with similar initial incomes and structures such as savings propensities and government policies can form a group and converge towards each other (McQuinn and Whelan, 2007; Bloom et al., 2002; Berthélemy, 2006; Ben-David, 1994; Li et al., 2018). Hence, the literature on convergence is inconclusive about the dominant trends towards convergence. Finding a conclusive dominant trend is necessary to feed the curiosity of scholars and policymakers and it also helps to know what is actually happening across the developing and developed countries. Moreover, finding a dominant trend in convergence could help assess the successfulness of regional growth policies.

Delving deeper into the literature shows that there are many indicators that are used to find convergence among economies, such as the absolute beta coefficient, conditional beta coefficient, sigma indicator, Theil index, Gini coefficient, and rank concordance (Friedman, 1992; Martin and Sunley, 1998, Sala-i-Martin, 1996; Liddle, 2010; Dobson and Ramlogan, 2002; Marques and Soukiazis, 1998). The inference obtained using these indicators and their conceptual underpinnings might be different. For instance, convergence is observed by catching up economies, narrowing down of income distribution, declining percentage point difference, etc. (Te Velde, 2011; Quah, 1997; Dvoroková, 2014). All the different definitions and interpretations of convergence are important but it cannot be denied that they give rise to mixed outcomes on convergence. These indicators are, very often, scrutinised by researchers for varied levels of explanatory power owing to neglecting things like interactions between economies, change in rank order and so on (Martin and Sunley, 1998; Quah 1993a). As a result, researchers highlight the need for a coherent indicator that incorporates important conceptual underpinnings and could be easily compared across economies (Novotný, 2011).

Other problems that give rise to mixed findings on convergence trends are scale, scope and spatial effects. Evidence suggests different findings when the unit of geographical analysis changes from the country to the regional level, the outcome variable changes from income per capita to productivity levels, different time periods are considered, different convergence indicators are used, and spatial interaction effects are incorporated in standard growth models, etc. (Margini, 2004; Monastiriotis, 2014; Ramajo et al., 2008; Butkus et al., 2018). The validation of findings across different regional scales, scope, and spatial dimensions in this domain is important to find a conclusive convergence outcome.

This chapter demonstrates techniques that can be used to address the problem of contradictory findings. First, by underlining a need to measure beyond standard traditional measures of convergence (beta, sigma, and gamma indicators) and revealing the nuances of convergence and disparity among regions. A pairwise technique was proposed by Webber and White (2003, 2009) to measure convergence by quantifying the growth mobility dynamics of regions. The chapter is going to describe the benefits of X-convergence that will be validated in the subsequent empirical chapters. Secondly, this chapter describes a grouping technique, based on regions' growth trajectories to define the scope of the study. There are many techniques used in the literature to group regions such as the log-t test. The group-based trajectory modelling is suitable for empirical studies that are based on how a group's growth trajectory evolves. This is beneficial for the understanding of growth dynamics within- and between-groups, which is one of the objectives of the study. Therefore, this chapter provides insights on techniques that are going to be used in subsequent empirical chapters to understand the subtleties of regional convergence and disparity.

Consequently, the aim of the PhD study is to examine the evolution of regional dynamics of convergence, disparity, mobility, and persistence in selected geographical locations. To achieve the aim of the research, certain objectives are laid out as below:

1. To provide evidence of how differential outcomes employing different convergence measures contribute to the inconclusive nature of findings on convergence patterns. (RO1)
2. To assess the mobility of regions within– and between-groups of similar regions to identify the presence of persistence in regional income groups. (RO2)
3. To identify regions that stagnate or lag behind which may need government assistance. (RO3)
4. To assess the role of the 2008 global crisis on regional convergence and disparity. (RO4)

The chapter is organised in the following way: section 3.2 highlights the shortcomings of three traditional standard measures of convergence—beta, sigma, and gamma convergence; section 3.3 emphasises the importance of understanding scale, scope, and spatial properties in any study of convergence trend; section 3.4 describes how grouping similar regions are important for outlining the scope of the study; Section 3.5 describes and underlines the advantages of the X-convergence technique; section 3.6 outlines the research design of subsequent empirical chapters and section 3.7 concludes the chapter.

3.2 Critique of Standard Measures of Convergence

This section reviews the standard measures of convergence—beta, sigma, and gamma that have been used in the studies in this domain. This section and subsequent chapters highlight the low levels of explanatory power that these techniques have when the aim is to go beyond the underlying assumptions of linear-growth paths. Growth paths are not always linear as is proven by the club convergence literature. The evidence of polarisation, groupings, and clustering reveals the existence of non-linear or multiple-equilibria across a set of economies, which could give rise to economic dynamics via regional interactions. Hence, standard traditional measures of convergence fail to help us understand the economic reality of a situation in a world where regions are constantly moving up or down with respect to one another. The next section questions the applicability of these measures to a group of economies following very distinct growth paths.

3.21 Beta (β) Convergence

One of the most commonly used indicators of long-term convergence in per capita incomes and output between economies is beta (β) convergence. β convergence measures use growth regression equations to capture cross-country convergence mechanisms (Barro and Sala-i-Martin, 1992). Catching-up occurs when there is a negative correlation between the initial income level (independent variable) and the subsequent growth rate (dependent variable) of per capita incomes, as shown in equation (1) with a negative β coefficient. The interpretation of the beta coefficient in equation (1) is simply that if the coefficient has a negative sign, then it indicates the presence of convergence of low-income with high-income economies. The value of β gives the rate of convergence that economies converge to a group average growth path.

Equation (1) yields absolute and unconditional beta convergence if the β coefficient has a negative sign (Barro and Sala-i-Martin, 1992).

$$(1/T)\log\left(\frac{y_{it+T}}{y_{it}}\right) = \alpha + (-\beta)\log(y_{it}) + \epsilon_{it} \qquad (1)$$

Where,

$y_{it} = (Y_{it}/Y_t)$ is per capita GDP in the i^{th} country relative to the average per capita GDP for the whole sample of countries.

$(1/T)\log(y_{it+T}/y_i)$ is the annual rate of growth of relative per capita GDP in the i^{th} country over the period of the study from t to $t+T$

$\log(y_{it})$ is the logarithm of per capita GDP of country i in the base year t.

If $\beta < 0$, then the data set is said to exhibit "absolute" beta convergence, i.e., there is a long term tendency for per capita GDP to equalise across countries.

If $\beta > 0$, then there is a possibility of divergence across countries.

If $\beta = 0$, then this depicts that there is no convergence. However, if other independent variables, such as human capital and innovation, were considered in the model for the assessment of "conditional" convergence, then those variables would measure differences in the steady-state growth rates across countries.

The interpretation of the initial income levels variable was taken as a proxy for 'relative income' that would capture different levels of technological progress (Sala-i-Martin, 1994). Following the neoclassical hypothesis of convergence, convergence happens because low-income economies grow at a faster rate than high-income economies. This result is based on the assumption of diminishing marginal returns applied to capital-rich economies and the effect of exogenous technical progress. Consequently, given there are no barriers to operations in the market, regional attributes will self-correct differences in prices, wages, capital, and labour to help economies converge towards each other (Martin and Sunley, 1998). Eventually, it results in the equalisation of income per capita across economies and if we follow the theories of convergence so then the income inequality for the entire set of economies will be equal to zero (Glushchenko, 2012).

Myrdal (1957) and Kaldor (1970) hold an endogenous perspective view and emphasise that there is no reason for economic growth and income to converge in short- or long-run. This is because economies of scale and agglomeration forces lead to cumulative concentrations of capital, labour, and output in a few places at the expense of other places that then stimulate self-reinforcing tendencies and result in uneven regional development. In this line of research, many empirical studies found the prevalence of divergence among economies (Baldwin et la., 2001; Pedroni and Yao, 2006; D'Elia and De Santis, 2019; Bishop et al., 1994; Fagerberg and Verspagen, 1996). The findings of these studies imply that when economic growth enhancing factors, like human capital and R&D expenditure, are included and treated as endogenous in the growth equation, the significance level of parameters increases and the speed of convergence accelerates for a few places. Therefore, convergence is not the rule as predicted by the neo-classical theory but it is based on many types of technical progress that poor economies are able to adopt, which thereby improves capital efficiency and innovation capacity (Soukiazis, 2000).

The differential empirical findings on convergence stimulated a lot of debate on the effectiveness of the beta convergence approach to the measurement of convergence among economies. Beta convergence is an indication of the behaviour of economies within a group that converges to a representative economy (Margini, 2004). The problem of relying on a representative economy is that it may not be a representative economy for the entire period of analysis (Beylunioğlu et al., 2015). Realising this fact, one of the aspects of the beta convergence debate is that economies are assumed to converge to the same group average steady-state path. The idea is that all economies converge to the same level of advancement or economic output for the whole period of analysis (Dvoroková, 2014). In other words, an examination of cross-country growth regressions using the beta coefficient assumes that the major contributor to economic growth (e.g., technology growth) exerts the same effect on growth across countries and across time and assumes a linear or log-linear relationship (Barro, 1991; Barro and Sala-i-Martin, 1995). The assumption of a linear relationship implies that explanatory variables have similar causal effects on the dependent variable across economies.

However, an array of studies accept the presence of non-linearity in the model and allowed for multiple regimes of growth patterns among different economies instead of a single unique steady-state position for all economies (Durlauf and Johnson, 1995; Galor, 1996; Quah, 1993a; Canova and Marcet, 1995; Durlauf and Quah, 1999; Webber et al., 2014; Bartkowska and Riedl, 2012). Non-linear growth models are consistent with the presence of multiple steady-state equilibria that categorise economies into different groups with different convergence characteristics (Maasoumi et al., 2007). The non-linear behaviour of economies makes the inference of beta convergence doubtful and this may contribute towards the mixed findings in this domain.

3.22 Sigma (σ) Convergence

Many studies (Quah, 1993a, 1996b; Friedman, 1992) have started questioning the approach of growth regression for finding a beta coefficient because the approach was unable to provide any information on the evolution of the income distribution. Studies argue that the regression approach was fine to increase understanding of the behaviour of a 'typical' country, but it would not say anything about how and why the income distribution has changed for a sample of economies. Quah (1993a, 1996b) emphasised that distribution dynamics is important for a deeper understanding of the behaviour of one economy with respect to another. Regarding the negative sign of the initial levels regression coefficient (negative β), Quah (1993a, 1996a, 1996b) and Friedman (1992) emphasised that negative beta does not necessarily imply a reduction in the dispersion of income levels. It could be the case that the growth regression gives a negative coefficient on initial levels even when there is no change in the cross-section distribution over time. They argue that negative beta could arise for a number of reasons unrelated to convergence, like political instability or recession, and hence the evidence of negative beta convergence is simply a "statistical fallacy."

Friedman (1992) advocated the assessment of trend using the coefficient of variation (known as sigma convergence) of per capita GDP to provide unbiased estimates of convergence. Similarly, Lichtenberg (1994) asserted that studies have overestimated the rate of convergence when measuring beta convergence. The findings suggest that research should focus on sigma convergence as convergence should be equivalent to a decline in variance of productivity across countries over time.

Theoretically, σ-convergence is said to exist when the dispersion (variance) of relative per capita GDP levels tend to decline across economies over time. In other words, the sigma-convergence value at time *t*+*T* should be less than at time *t* if the conclusion needs to be that a group of economies have converged towards each other, i.e.,

$\sigma_{t+T} < \sigma_t$

where σ_t is the variance of log(yi,t) across a set of economies i.

The ratio of variance statistic can be expressed as:

$$\sigma = \frac{Variance\ (GDP_T)/Mean(GDP_T)}{Variance(GDP_t)/Mean(GDP_t)} \qquad (2)$$

Between periods t and T and where the variance (GDP) refers to the variance of the absolute level of per capita GDP for each cross-country distribution.

Research in the area of distribution dynamics has used a number of measures such as Gini coefficient, Theil index, and the Atkinson index to understand the movement in interregional inequalities (Chen et al., 2010; Xie and Zhou, 2014; Kanbur and Zhang, 1999). Gluschenko (2012) argued that these income inequality indicators are statistics of income distribution density and measure its width in one way or another and hence these indices provide similar information as the sigma indicator.

Another limitation with these measures is that they are not able to shed light on the polarisation dynamics of regions (Gluschenko, 2012). To address this issue kernel density estimates and transition tables are used to assess the polarisation of economies. However, another problem while using these measures is that they do not provide insights on group dynamics or what is going on within the groups with respect to overtaking, lagging behind, and switching places between economies. To an extent, transition tables help to address this issue by providing information on what percentage of economies have moved between discrete ranges of groups but they do not allow for detailed comparisons between economies (Novotný, 2011).

Glushchenko (2012) argued that sigma convergence is irrelevant if we want to know whether a single economy has converged to a steady state equilibrium path. Sigma shows how the entire distribution of income per capita across a group of countries has evolved. Thus, like beta convergence, sigma convergence also provides information on the aggregate behaviour of a set of economies.

The problem with identifying an aggregate behaviour of a set of economies is that it does not provide any information if we want to know how economies are behaving individually relative to one another. Every economy/region is assumed to behave in a similar fashion. This may not be true if economies are at different stages of economic development or if their behaviours differ at different time periods. This is particularly important for any economy that is an outlier in a group. The outlier region may be a high-income or low-income economy, which is supposed to behave in a certain way, but the process of finding the aggregate behaviour is neglecting individuality. Another problem of using beta and sigma convergence is that it is difficult to know whether convergence is happening because of slow growth/stagnation of rich economies (from the top) or fast growth of poor economies (from the bottom). Beta convergence assumes that low-income regions grow at a faster rate and converge with their counterparts, however, it could be the case that high-income regions are growing at a slower rate and converging towards the group average. Thus, there are many insights that are ignored by using these two indicators of convergence.

Another problem arises when exploring the relationship between β and σ convergence. It has been argued that β-convergence is a necessary but not a sufficient condition for σ-convergence (Friedman, 1992;

Martin and Sunley, 1998; Sala-i-Martin, 1996; Liddle, 2010; Dobson and Ramlogan, 2002; Marques and Soukiazis, 1998). Figure 3.1 shows per capita GDP for economies A and B. Suppose economy A is richer than economy B. Panel I shows that the growth rate of A is less than B or B is growing faster than economy A between *t* and *t+T,* implying the existence of β-convergence. In addition, dispersion at *t+T* is smaller than at *t*, it can be said that there is the presence of σ-convergence too. In this case, it is impossible to have σ-convergence without β-convergence because economy B (poor) needs to grow faster than A. Hence, the existence of β-convergence is a necessary condition for the existence of σ-convergence. It can be seen in Panel II that the lack of β-convergence (economy A growing faster than B) leads to the lack of σ-convergence (distance between the two economies increases over time). Panel III shows that economy B grows at such a fast rate that at time *t+T* it becomes richer than economy A (switching). If a poor economy grows faster than richer ones, then there is assumed to be the existence of β-convergence, but at time *t+T* the distance between the two economies is the same as it was at time *t.* in other words, the dispersion between the economies has not increased or decreased, i.e., there has been no σ-convergence. It seems that although β-convergence is a necessary condition for σ-convergence, it is not a sufficient condition for σ-convergence. Therefore, it is evident that the presence of β convergence does not necessarily mean the presence of convergence. One of the major implications of this relationship is that the presence of β convergence is not always accompanied by the presence of σ convergence, and rather in some instances, it is σ divergence that is predominant (Young et al., 2008).

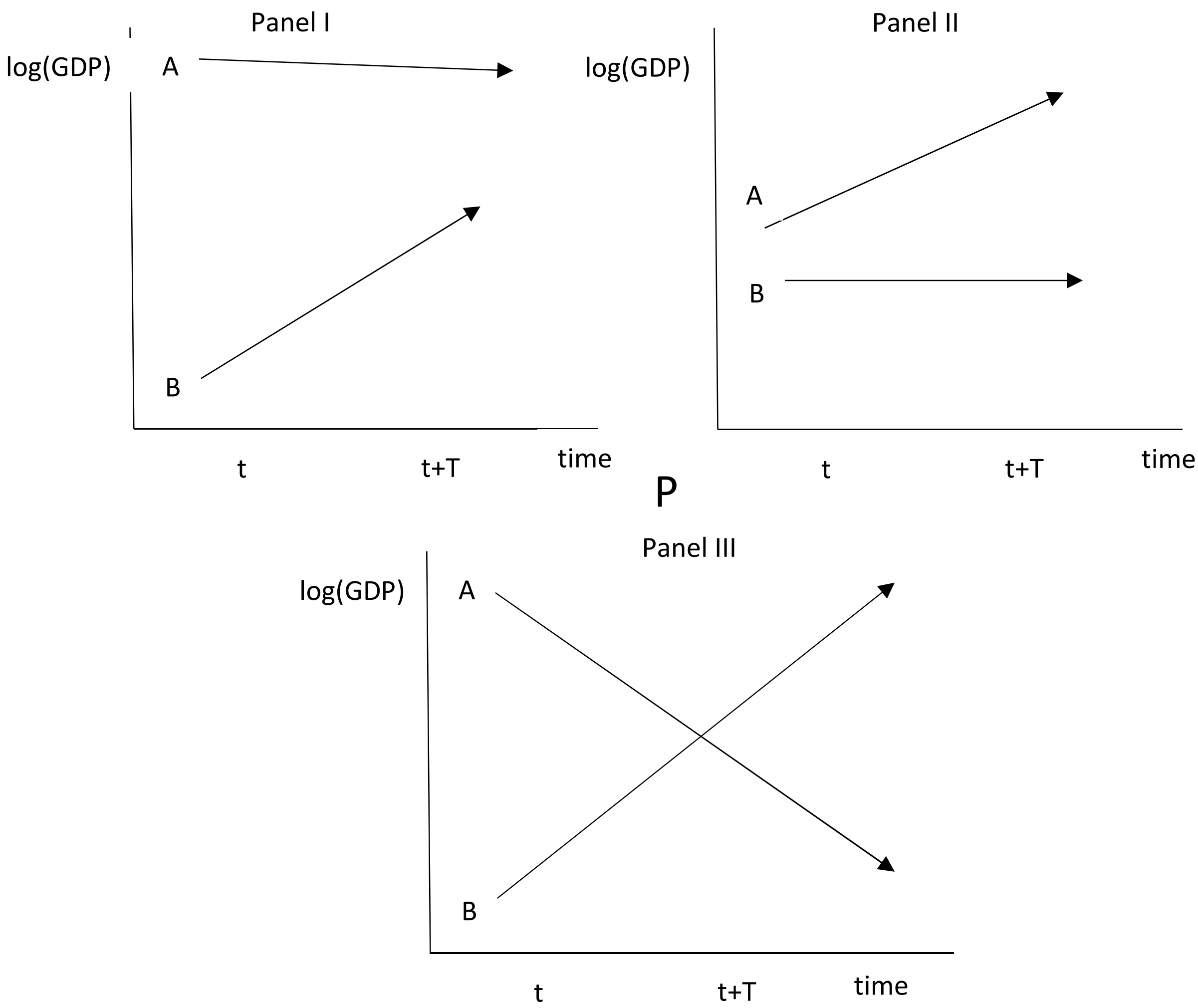


Figure 3. 1: Relationships between β and σ-convergence

Source: Sala-i-Martin (1996; pp 1021)

Panel III shows that when countries criss-cross their growth paths β and σ estimates fail to assess the convergence dynamics. It is illustrated as follows: let's say countries A and B are approaching each other at β convergence rate until point P. After point P, countries may be converging to their own steady states (β convergence) but they are not converging to each other (σ divergence). This is analogous to beta convergence being a necessary but not a sufficient condition for sigma convergence. In addition, the finding of convergence after point P would be misleading if both β and σ convergence indicators are considered. That is, if a set of economies has evidence of a lot of rank switching economies, then beta and sigma convergence estimates may result in misleading outcomes.

3.23 Gamma (γ) Convergence

The failure of beta and sigma convergence in certain cases motivated Boyle and McCarthy (1997, 1999) to devise a method called gamma convergence. The studies by Boyle and McCarthy (1997, 1999) highlighted that employing σ convergence was flawed in a situation where σ-convergence could be constant for certain distributions of per capita income. In the case of constant σ convergence, the economies may be moving within the distribution but the overall effect would might be ignored. Thus, the quantification of within distribution mobility becomes important.

Boyle and McCarthy (1997, 1999) further proposed a technique of estimating variation in the rank concordance of a group of economies. This technique is particularly important in the case of low-income countries/economies that are switching in rank within a group. It was also emphasised that gamma convergence should be used in conjunction with σ convergence to test for the presence of β convergence for that group.

In other words, Boyle and McCarthy (1997, 1999) highlighted that in a situation where σ-convergence is constant, the use of the proposed measure of gamma convergence would ascertain whether β-convergence exists. Gamma convergence would provide a mobility indicator for σ-convergence in an evolving distribution. The study calculated gamma-convergence by investigating the change in position or rank of economies over time.

$$\gamma = \frac{Variance(RGDP_T + RGD\ \ _t)}{Variance(RGDP_t\ X\ 2)} \qquad (3)$$

Where,

variance (RGDP) is the corresponding variance of the ranks of per capita GDP. The rank of per capita GDP in each year (from t…to T) is compared with the rank in base time *t.* A gamma convergence (γ) value close to 0 would depict high mobility and a value close to 1 would depict low mobility within the income distribution.

The Gamma convergence indicator tests whether the rankings of countries within a group have changed over time. In the context of testing for the presence of β convergence with the help of equation (4), Kendall's index of rank concordance was used to capture the change in rankings. The denominator of the index is the maximum sum of ranks, which would be obtained if there were no change in rankings over time (Kerem et al., 2008). The closer the index value is to zero, the greater the extent of mobility within the distribution. Whereas the index value closer to one would indicate a loss of mobility among the group of economies. One of the shortcomings of gamma convergence approach is that like beta and sigma convergence, it provides information for a group of economies in an aggregate form and fails to provide any details on the behaviour of individual economies.

Another way to demonstrate the problem of finding aggregate behaviour is illustrated by the following example. The literature reveals that the majority of studies using standard measures of convergence use levels of income per capita growth to assess convergence (Barro and Sala-i-Martin, 1992; MRW, 1992; Sala-i-Martin 1996). This reflects that the convergence process is dependent on the absolute difference in the levels of income per capita. The assessment of whether convergence is occurring is based on declining absolute differences in levels of incomes per capita, which would be ideal for a group containing very similar economies. Similar economies might converge to their group average with ease. However, the very unequal share of world income provides an acute problem for the comparison of various economies' income/output in absolute terms and makes it more relevant to compare these values in relative terms.

Not all economies across the world are at the same level of development and the spatial concentration of income is high, and hence comparisons based on relative terms (pairwise ratio differences) becomes important rather than absolute terms (magnitude differences). For instance, when the US is compared with a small African country such as Burundi, then it may provide distinctly different results for absolute differences in per capita GDP than it would be for relative differences in their per capita GDP. Both absolute and relative figures could vary in terms of magnitude or the direction of change to provide fundamentally different conclusions. For example, economies could be converging in absolute terms but diverging in relative terms.

Intuitively, consider two economies, A and B, with starting levels of per capita GDP at 100 units and 10 units (an absolute gap of 90 units) and GDP growth rate of 15 percent and 50 percent for them, respectively. This implies that in subsequent time periods country A will have 115 units per capital GDP and B will have 15 units. The absolute gap increased from 90 (100-10) to 100 (115-15) units showing signs of divergence. In terms of ratios, in period 1 country B's income relative to A is 0.1 (10/100), while in period 2 it is 0.13 (15/115), the ratios indicate that the two economies are converging as (poor) country B's income growth is increasing relative to country A in period 2. In other words, in period 2 the proportion of income increase was more that the proportion of income increase in period 1 for both the countries suggesting the poor economy has shown improvement in growth rate (because it is in the numerator) and getting closer to the rich economy. It is evident that, ceteris paribus, the two measures yield different results—divergence in terms of absolute and convergence in terms of relative figures. Therefore, the question arises that whether the reduction in the absolute gap between economies' per capita GDP is sufficient to understand the phenomenon of convergence or we need a proportionate (relative) indicator to understand the true meaning of the convergence process. Novotný (2008) showed that both absolute gaps and relative ratios techniques could yield different outcomes for the same sample and same time period considered.

Moreover, as underlined by Boyle and McCarthy (1996, 1999), the possibility of the crisscrossing of growth paths of economies by exchanging rank positions with others could provide important insights on intra-distributional properties of per capita income distribution. To understand the dynamic nature of intra-distributional properties, Quah (1997) highlighted the various possibilities of income distribution dynamics such as persistence, stratification, and polarisation rather than only convergence or divergence. In this regard, Webber and White (2003, 2009) proposed a method to identify distribution dynamics that was easy to use and interpret and assess the regional dynamics of convergence, divergence, persistence, mobility, all at once. The use of pairwise analysis was used by the study to understand the relative behaviour of regions. For the pairwise comparison, *n(n-1)/2* pairs of economies are compared in ratios in the study. The pairwise analysis in relative ratio scales provides an opportunity to perform a comprehensive convergence behaviour analysis. Webber and White (2009) proposed this method as an alternative test to check for the convergence findings in the literature.

To conclude, the purpose of this section was to highlight two things: first, all the three above-mentioned techniques provide the assessment of the convergence of economies to their group average or a benchmark economy. If we want to know how an individual economy is performing, these measures fail to do so. Secondly, the different conceptual underpinnings of the three techniques generate outcomes of dominant trends of convergence or divergence. All these measures have the potential to yield different results based on their different definitions of convergence. Therefore, there is a need to have a measure that addresses the shortcomings highlighted regarding the traditional standard measures of convergence without ignoring their significant conceptual underpinnings if we want to find a conclusive dominant convergence trend across economies. In this regard, the thesis will highlight the importance of examining pairwise economies' mobility dynamics (overtaking/lagging behind/stagnating) within the income distribution in subsequent sections.

3.3 Scale, Scope and Spatiality

An important under-appreciated set of factors behind the mixed results on income convergence across economies belong to the scale, scope and spatial characteristics of the studies. The scale factor involves geographical analysis of various units of regions such as country, metro, or county-level data. The scope of the study determines specific parameters or boundaries of research in terms of the time period, geographical location, factors/variables, and so on. Spatial characteristics deal with any location-based attributes, such as the labour market and neighbourhood that are distinct to a particular location. The mixed findings owing to the outline of scale and scope are illustrated in Table 3.1 below which shows varied findings on convergence trends between1980 and 2015 for European regions.

Table 3. 1: Varied findings on EU convergence/divergence patterns between 1980 and 2015   Source: Author's own work

Source	Method/indicator/ source of data	Period	Region	Findings
Petrakos et al., (2011)	Beta convergence/GDP per capita/ Cambridge Econometrics European Regional database	1990-2003	249 NUTS 2 regions	Regional divergence factors dominate
Geppert and Stephan (2008)	Markov chain analysis and dynamic panel estimation/GDP per capita/	1980-2000	EU15's 207 NUTS 2 regions	Stronger regional convergence in 1990s

	EUROSTAT REGIO			
Monastiriotis, (2014)	Sigma convergence using coefficient of variation, regression analysis, Kuznets curve/ gross value-added per employee, GDP, GDP per capita/ Cambridge Econometrics European Regional Database	1990-2008	1,276 NUTS 3 regions out of which 190 are CEE regions	Non-linear convergence at national level for both EU15 and CEE, and weaker convergence for CEE regions
Ramajo et al. (2008)	Spatial econometric technique/ GDP per capita/ EUROSTAT REGIO	1981–1996	163 NUTS 2 regions of 12 EU countries	EU cohesion-fund countries (Ireland, Greece, Portugal and Spain) are converging separately from the rest. They are converging faster at 5.3 percent than the rest at 3.3 percent
Fingleton and López-Bazo (2006)	Spatial dependence/ GDP per worker/ EUROSTAT REGIO	1980-1996	108 EU NUTS 2 regions	Externalities hold importance across regional production process
Badinger (2004)	GMM estimators	1985-1999	196 NUTS 2 regions	The speed of convergence amounts to some 7 percent

Cuadrado-Roura (2001)	Beta convergence/GDP per capita	1977-1994	109 EU regions	Process of convergence lost speed and disparities stabilised
Butkus et al. (2018)	Theil index/ GDP per capita/ European System of Accounts (ESA) 2010	1995–2014	NUTS 1,2,3	Disparities decreased at the country level but not at the regional level, and the speed of convergence varies over time
Borsi and Metiu (2015)	Phillips and Sul (2007, 2009) commonly known as *logt* test/ GDP per capita/ PennWorld Tables	1970-2010 for 21 EU states 1995-2010 for 27 EU states	27 EU countries	Overall income convergence in the EU and existence of convergence clubs South-East vs. North-West division of European economies by the mid-nineties.
Cheshire and Magrini (2000)	Markov chain estimates/ GDP per capita/ Eurostat	1978-94	122 Functional Urban Regions (FUR) in western Europe	Existence of a divergence process in patterns of regional growth.
Cuaresma (2014)	Bayesian Model Averaging (BMA)/ 50 possible growth determinants	1995-2005	255 NUTS 2 regions	Convergence driven by the catching up process of CEE countries

Paci (1997)	Sigma convergence or various measures of dispersion/ GDP, population, value added and employees	1980-1990	109 EU regions	Labour productivity disparity is declining but disparities in per capita income not diminishing.

Although not explicitly discussed in the literature, from Table 3.1 it is evident that outlining different scale, scope, and spatial attributes within studies has the potential to reveal inconclusive findings on convergence trends. Deciding on the geographical scale of the study can make the definition of regions very important. The role of regional governments has been expanding and many studies use the region as a spatial unit (Rey, 2004; Fotheringham and Brunsdon, 1999; Anselin, 2010). The challenge of defining a region has been emphasised by many studies (Capello, 2009; Magrini, 2004; Harris, 2011). For instance, Functional Economic Market Areas (FEMA) has been developed to define patterns of economic activity and demand for local economies in England (Morphet, 2018). These areas extend beyond the administrative boundaries to understand the needs of local enterprises. There is no standard approach to define a FEMA, as the trends of economic flow seem to differ depending on the market areas being assessed. In this regard, defining a regional system is a very complicated idea and is based on many factors such as the availability of data (administrative or otherwise), purpose of study, interaction between regions, and conceptual framework, among others (Behrens and Thisse, 2007). These factors make spatial scale analysis in applied research very problematic and can lead to different and unconvincing conclusions (Magrini, 2004).

When defining a region, the basic areal units are taken in the form of pixels or grid cells that are regarded as spatially discrete units (Openshaw and Rao, 1995). The edges of the pixels or cells are located in arbitrary fashion and by slightly shifting the grid system over space a new dataset could be created. Numerous datasets can be created which yield different results when analysed. Even though some basic data are available at a disaggregated geographical level or in the form of a discrete set of points, various other data are still available at the aggregate spatial level (Behrens and Thisse, 2007). Aggregation is based on the geographical level and sometimes at two or more spatial scales. In other words, data would be available for smaller units that are nested within the larger ones and households are uniquely assigned to specific small units and larger units (Flowerdew, 2011).

The spatial aggregation crucially influences the findings on designating the optimal location of new regional units. Burger et al. (2008) emphasised that analyses of agglomeration economies pay little attention to the spatial configuration of regions and geographical benefit of the scale of agglomeration. The outcome of the spatial analysis may not be independent of the scale at which the analysis is done (Flowerdew, 2011). For example, the correlation between two variables may be at very different NUTS 1 and 2 levels. It could be realistic to consider the dynamics of economic growth that take place at smaller spatial scales, as potential heterogeneity across local areas may not be correctly quantified at the aggregated geographical scale (Dapena et al., 2016). This issue of aggregation was first identified by Gehlke and Biehl (1934) and later on emphasised by Openshaw (1984) and is termed as the modifiable areal unit problem (MAUP). As the level of aggregation grows, the severity of MAUP also increases (Duranton et al., 2015; Carlino and Kerr, 2015). MAUP is also referred to as border effects because they depend on the boundaries used to demarcate regions.

MAUP has two forms of effect: scale effect and zone effect. Collecting and analysing data at different scales or levels lead to the problem related to scale effect as discussed above. The zone effect problem becomes prominent when each region is considered as an exclusive zone and the closeness of regions in terms of activity spilling across them is totally ignored (Duranton et al., 2015). Due to zone effect problem, the impact of concentration or agglomeration or spillover is underestimated.

In response to these problems, studies eradicate spatial units altogether by using a continuous-distance metric or range of scales in continuous space to measure the spatial concentration of innovation activity rather than predefined and fixed boundaries (Murata et al., 2014; Kerr and Kominers, 2015; Buzard et al., 2016; Carlino and Kerr, 2015; Menon, 2012). For instance, the continuous distance metric approach considers the agglomeration of R&D labs and measures how rapidly the clustering of labs weakens with increasing distance. The studies that employ continuous methods to measure concentration are still evolving and need to be deployed to measure the concentration led by complementary industries that cause agglomeration and spillovers. This gap once addressed would provide a wider perspective while dealing with sectorial data such as industry data analysis.

Menon (2012) highlighted that given the difficulty to get rid of the MAUP issues, recently MAUP has become a part of the subconscious mind of spatial economists and may not be taken care of in the research analysis. It implies that the MAUP issue is subconsciously accepted in regional studies. The dataset of spatial units which is geographically meaningful is highly rare to obtain. Nevertheless, researchers in quantitative geography have tried to develop concepts such as ‘optimal zoning’ to minimise MAUP (Openshaw and Rao, 1995).

Apart from defining a region, assessing spatial dependence and heterogeneity have been continuously influencing the convergence outcome. Magrini (2004), however, highlighted that methods of analysis cannot be readily applied to both—countries and regions. Regions are more similar to each other within a country due to the similarity of economic conditions, political conditions, regulations, etc.

So spatial dependence should not be ignored in a regional data analysis. Janikas and Rey (2005) highlights that regions, as observational units to understand changes in the dispersion of incomes, are used often but the role played by the spatial scale and clustering is ignored.

Distinguishing between absolute and relative location-based studies, Breu et al. (2004) emphasise that absolute location studies consider the location of a particular region in space as important and parameters in growth models vary depending on their relative location (known as spatial heterogeneity). Relative location-based studies consider situations when observations at one location depend on the values of observations at other locations (known as spatial dependence). Spatial econometrics literature stresses the relative location model, while non-spatial literature focuses on models of absolute location.

Moreover, empirical studies emphasising the need to incorporate spatial dependence seem to be weakly linked to theory but employ sophisticated econometric tools to assess spatial effects (Breu et al., 2004). For instance, spatial clustering has been used in tandem with many theories, such as knowledge based clustering, labour pooling, and firms' competitiveness (Malmberg and Maskell, 2002; Malmberg et al., 1996; Combes and Duranton, 2006). In terms of techniques, the use of spatial lag and spatial error methods are commonly used to incorporate spatial spillover effects in the growth regression equation. However, at the same time, it has been highlighted that the interpretation of using spatial techniques are not very clear (Malmberg and Maskell, 2002). The inference drawn from the spatial clustering technique is not that easy as regional variables are so closely linked together that it becomes difficult to understand their causal effects on each other (Breinlich et al., 2013; Anselin, 2013).

With regards to the absolute location model, the uneven region-specific characteristics give rise to spatial heterogeneity that is primarily dependent on dissimilar regional capacities to exploit sources of growth (Kang and Dall'erba, 2016). For instance, the uneven concentration of industries or investment could have differential effects on the ability to exploit the sources of growth leading to different incomes generated by regions. In this regard, it is evident why the capital cities of Bulgaria and Romania are high-income regions compared to the other cities within the two countries. Thus, spatial heterogeneity could have different impacts on the findings of convergence.

Spatial heterogeneity emphasised the need to evaluate the internal income distribution, and as a result, many researchers diverted the research focus on within-country income inequality analysis from between-country (Salvati, 2016; Alvaredo et al., 2018). Hong et al. (2020) find that within-country inequality increased during the 1990s and 2000s even though the world income inequality between countries declined during the 2000s. It is highlighted that within-country inequality trajectories have a large impact on global inequality and hold importance for poverty eradication and hence have policy concerns (Alvaredo et al., 2018; Modalsli, 2017). The decomposition of inequality within and between countries pose a limitation on traditional measures of convergence. This underlined the importance of how convergence and inequality are measured rather than the way they are measured. Consequently, instead of the traditional measures, the Gini coefficient measure has been used widely by researchers. For instance, Morrisson and Murtin (2011) using Gini Coefficient find that disposable income distribution within countries is increasingly becoming unequal. The reason highlighted was that within a country only a few selected regions became the engine of growth and gains were heavily concentrated (Liberati, 2015).

In light of the concentration of economies, it is highlighted that the development of high-tech industries increase inter-regional inequality and hence enhances social polarisation. Hansen (2020) in LSE Blog has highlighted the ambiguity on the sustainability of innovative regions. Innovative regions tend to grow fast in a short period and diverge away from the low-income regions to increase regional income inequality. In this regard, Shaheen (2014) simply defined inequality as income differences and underlined that unequal regions may grow slow and hence are less successful in sustaining growth in the long run. Therefore, reducing inequality promotes stable economic growth.

While scrutinising the regional growth and convergence literature, it is underlined that the choice of parameters outlining the scope of the study also contributes to the inconclusive nature of findings on convergence, and they include the mix of countries/regions analysed, the techniques employed, the parameters outlined in the study, etc. Furthermore, the choice of the start and end date in assessing convergence also play an important role in determining a convergence trend. For instance, if a recession hits different regions at different periods, so the findings on regional convergence could be impacted. Similarly, the location choices and variables analysed are important to consider while outlining the scope of the study. Mostly, studies in the domain are driven by the availability of data and the purpose of the study. Sometimes, the data at the local level is not easily available and if available then it may not be consistent across the sample. Thus, it is important to consider data that could be compared across the sample economies and could meet the purpose of the study to generate a conclusive outcome.

To conclude, there are a lot of factors, other than the use of convergence indicators that could reveal contradictory findings on dominant convergence trends. These are related to the scale and scope of the study that analyses convergence at different geographical locations, by using different time periods, different income/output variables, and analysing data at different regional hierarchical levels. When these factors are taken into account they yield different outcomes. Thus, the study is going to examine the outcome of analysing data at different scales and scope in subsequent empirical chapters to prove their contributions towards mixed findings. In terms of spatial techniques, the study is not employing spatial econometric techniques because it attempts to provide insights on understanding whether the convergence trend is evolving in line with the economic theories and empirical evidence. This will help to contribute to the debate around regional convergence and divergence. The use of spatial econometric techniques will be explored in future studies.

3.4 Making Sense of 'Scope' Through Grouping Regions Based on Growth Trajectory

Defining the scope of the study is a problem that commonly arises from the mix of economies based on their per capita incomes. Some high-income economies may not follow the same growth path as low-income ones and they may diverge. The problem of categorising economies following almost the same growth trajectory has been taken into account by the convergence clubs literature. The evidence of polarisation across the world economy has been demonstrated in distribution dynamics studies and they typically found bimodal distributions suggesting that the world economies were clustering into high-income or low-income groups (Bulli, 2001; Kharas and Kohli, 2011; Flaaen, 2013; Paap et al., 2005; Acemoglu and Ventura, 2002; Kerekes, 2012). Many studies reveal the formation of convergence clubs among regions based on various principles of clustering, such as initial incomes, political regimes, literacy rates, etc. (Baumol, 1986; Chatterji, 1992; Durlauf and Johnson, 1995). Therefore, to understand the subtleties of convergence and income inequality there is a need to group regions based on certain characteristics.

The thesis is going to deal with the problem of defining the scope of the study by grouping regions based on evolutionary growth trajectories. The group based trajectory model captures the evolution of regional economic trajectories. Nagin's (1999) group based trajectory approach is used to identify distinct groups of regions following similar growth trajectories to assess whether regions within- and between-groups experience convergence or divergence. This is important to examine from the regional disparity perspective because it gives an indication of whether there are groups of regions that experience similar economic convergence outcomes.

The group based trajectory method (GBTM) is a non-parametric technique to group regions based on the degree of similarity of growth trajectories over time. The approach allows the identification of groups of regions with distinctive growth trajectories that are not defined based on any priori assumption. This is an inductive approach that permits the identification of patterns and trends of growth evolution. In this approach, individual economies do not actually belong to the same trajectory groups, rather they are assigned a probability of membership in the respective group. Hence, the method is also referred to as latent class growth analysis (LCGA) developed by Nagin and Land (1993) and Nagin (1999); and later used in many different contexts by these authors. The method is a type of growth mixture model (GMM) that has been highly recognised for identifying groups of homogenous individuals or regions within a larger heterogeneous population (Jung and Wickrama, 2008).

The variance and covariance estimates of the growth variables used to classify groups are assumed to be fixed or zero within each group. Because of this assumption, all individual growth trajectories within a group are homogenous. The model described below is adapted from Webber et al. (2018).

An unobserved group membership, Z_{jg}, is coded 1 if region *j* is in group *g* and 0 otherwise. The probability that region j belongs to group g is denoted by

$$\pi_j^{(g)} = \Pr(Z_j = g)$$

Where,

g =1,…..G, and where G indicates the total number of groups,

Y_{ij} is the output measure or per capita income for region j in year i which depends on a set of time variables, T_{ij}

This model is appropriate when the expected value of Y changes smoothly as a function of a polynomial of time. The specification of the order of the polynomial equation represents the shape of groups' trajectories. A growth trajectory model with a fifth order polynomial of time can be written as:

$$\begin{aligned}
&y_{ij}^{(g)} = \beta_{0j}^{(g)} Z_{jg} + \beta_1^{(g)} T_{ij} Z_{jg} + \beta_2^{(g)} T_{ij}^2 Z_{jg} + \beta_3^{(g)} T_{ij}^3 Z_{jg} + \beta_4^{(g)} T_{ij}^4 Z_{jg} + \beta_5^{(g)} T_{ij}^5 Z_{jg} + e_{ij} \\
&\beta_{0j}^{(g)} = \beta_0^{(g)} + u_j^{(g)} \\
&u_j^{(g)} \sim N(0, \sigma_u^{2(g)}) \\
&e_{ij} \sim N(0, \sigma_e^2)
\end{aligned} \tag{4}$$

The βs in this model are regression coefficients that give the linear, quadratic, or cubic relations between time and income per capita. Each group has potentially different sets of estimated β terms and hence has a distinctive trend. The random terms in the equation summarise the unexplained variation after the trends have been estimated.

Procedures to fit this model in statistical software like Stata have been implemented by Jones and Nagin (2012) in their *PROC TRAJ* procedure. After the installation of Traj, it becomes easier to use Stata commands to implement GBTM. One restriction of using group based trajectory models in Stata is the determination of the optimal number of groups within the population (Nagin, 1999). One of the shortcomings of using this technique in Stata is that the number of groups and polynomial orders must be specified or guessed in advance. It seems that software packages like SAS and Mplus provide some indication of starting values of numbers of groups but in Stata the analyst has to rely on a trial and error technique to estimate the starting and end values of a number of groups. Similarly, for polynomial order selection processes in Stata, starting values are estimated using the trial and error method at first and then diagnostic tests can be used to identify the optimum number of groups and order of polynomials.

The Bayesian Information Criterion (BIC) is used as one of the diagnostic tests for model selection. The maximum value of BIC is recommended to select an appropriate model. It is noted that BIC in this case is always negative and the maximum BIC will be the least negative value (Nagin, 1999). Subsequent empirical chapters will use the GBTM to identify groups within each geographical location and then explore the patterns of convergence within- and between- groups. The group dynamics assessment has the potential to reveal the behaviour of economies that may be significant but could go unnoticed if not analysed in detail. If, for instance, within group members exhibit divergence among themselves, then it signifies that the relatively poor economies in the group are either stagnating or lagging behind. Unpicking these nuances would call for a very comprehensive and detailed study of the economic/growth mobility of economies within- and between-groups. Studies by Quah (1993a, 1996a, 1996b, 1997) and other proponents of distribution dynamics have emphasised the need to quantify the mobility of economies within their income distribution and consequently, Boyle and McCarthy (1997, 1999) proposed a mobility indicator (gamma convergence) based on the variation in rank order positions of economies. Although some indicators provide insights on the mobility of economies between groups, comparisons of findings of one economy with another are not easy (Novotný, 2011). The next section addresses the gap in quantifying the mobility behaviour of economies using the X-convergence technique.

3.5 The X-Convergence Technique

Given the critique on standard measures of convergence in section 3.1 and my interest in convergence, the purpose of this section is to outline a method of measuring convergence that can provide useful insights that can build on and complement beta, sigma, and gamma convergence. The thesis will argue that convergence as a relative measure is better than as an aggregate measure. That is, measuring convergence between two regions in a pairwise setting provides more details when examining convergence patterns between regions. Aggregate trends provided by beta and sigma convergence only provide detail on a representative economy's growth path that every other economy within the sample is assumed to be converging towards. Moreover, there is very little scope of quantifying the actual movement of economies in terms of identifying which economy is overtaking, stagnating, or lagging behind with respect to another. As shown in earlier sections, when quantifying the growth mobility of economies, it is important to understand whether convergence is happening from top down or below up or which economy is stagnating or lagging behind. This will help policymakers to appropriately focus resources.

Even after recognition of the importance of mobility dynamics to investigate growth and inequality among economies, there remain a lack of sufficient measures to investigate distributional dynamics issues (Novotný, 2011; Castro, 2003; Gluschenko, 2012; Monfort, 2008). Literature has highlighted that some measures like the Gini coefficient, Theil index, and Atkinson inequality measures employed for inequality decomposition by population groups or income sources are not easy to interpret (Novotný, 2011). Similarly, approaches to assess mobility within the distribution have been applied, however, at the same time, the complications of measuring and comparing mobility across regions are realised by researchers (Chan et al., 2019; Gluschenko, 2012; Monfort, 2008). The X-convergence estimates help in his case as they are easy to interpret in a pairwise setting. The examination of within and between countries income inequality is assessed with the help of mobility dynamics in terms of overtaking, stagnating and lagging regions for two economies.

To fill this gap, Webber and White (2003, 2009) and Webber et al. (2005) have proposed a method based on concordance and discordance estimates that examines important regional dynamics of convergence, divergence, switching, persistence, polarisation, and mobility of economies, all at the same time. The simultaneous assessment of major regional dynamics is a feature that makes Webber and White (2003, 2009) measure distinct from other measures of inequality. The technique helps to precisely quantify and compare the mobility of economies within a distribution.

Another distinctive feature of Webber and White's (2003, 2009) method is that it facilitates an in-depth study of two regions between two time periods to assess the exact frequency of convergence or switching. This allows the researchers to take account of the repercussions of any small change that happens during a particular time period. The method has been named X-convergence and has been employed to understand various forms of inequalities in a number of subsequent studies—the living standard inequality dynamics by Novotný (2011); convergence of household consumption expenditure by Liobikiene and Juknys (2013); changes in household consumption expenditure regarding environmental impact by Liobikienė and Mandravickaitė (2013); and convergence of public expenditure by Ferreiro et al. (2014), among others. It is evident that the X-convergence technique has been used by researchers to get insights on the convergence of different variables. The X-convergence indicator could provide important insights for understanding the inter-regional growth convergence and inequality.

Webber and White (2003, 2009) developed the X-convergence technique for examining concordant and discordant pairs to understand the dynamics of change in relative positions of pairs of economies. If the countries are ranked in two time periods based on their GDP per capita, then the concordant pairs of economies will be equally ranked higher in both the periods. And the discordant pairs will be ranked in opposite directions in the two periods. Hence concordance and discordance in the context of measuring economic convergence/divergence can be explained as follows:

Assume x1 is per capita GDP of country 1 in period t; and y1 is per capita GDP of country 2 in period t.

Let x2 be per capita GDP of country 1 in period t+T; and y2 is per capita GDP of country 2 in period t+T.

In general, for a pair of countries (country 1 and country 2), the two observations (x1 and y1 or x2 and y2) of continuous random variables (per capita GDP) are concordant if x1 < x2 and y1 < y2 or x1 > x2 and y1 > y2. In other words, if the direction of increase or decrease of random variable is same for two countries in two time periods, then the countries are concordant pairs (e.g., country 1’s per capita greater in period t+T than t, also country 2’s per capita GDP greater in period t+T than t or in the final period both the countries have higher GDP per capita than the initial period).

Similarly, two observations are discordant if x1 < x2 and y1 > y2 or x1 > x2 and y1 < y2.

Figure 3.2 shows that economies A and B are concordant (converging) pairs as A and B both have higher GDP per capita in the final period. While economies C and D are discordant (diverging) pairs because D has higher income in period t but lower in period t+T and C has lower income in period t and higher in period t+T.

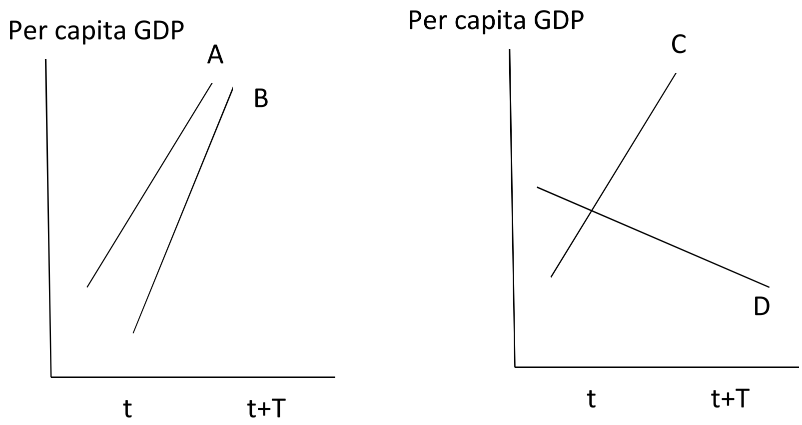


Figure 3. 2: *Economies A and B are concordant pairs while C and D are discordant pairs*

Source: Author's own work

Typologies

The X-convergence statistic calculates concordance and discordance indicators in terms of relative ratios of differences in per capita income of two economies between two time periods. Averaging the estimated frequencies of per capita income differentials for each pair provides a measure of concordance or converging pairs and discordance or diverging pairs of economies. The method of concordance and discordance is much more comprehensive than the earlier cited indicators of convergence and divergence because this method interprets outcomes based on every pair of economies. If the comparison is based on 'n' economies, total indicators of n(n-1)/2 pairs are investigated. This provides an overview of differentials in per capita GDP in relative ratios terms.

Inspired by the neoclassical growth predictions of convergence that a poor economy grows at a higher speed to catch up with a rich economy, Webber and White's (2003, 2009) model outlines that convergence could be referred to a gradual decrease in the magnitude of difference between rich country (*i*) and poor country's (*j*) output per capita (s_i and s_j) between periods t and t+T.

That is, if $s_{i,t} > s_{j,t}$ and $(s_{i,t} – s_{j,t}) > (s_{i,t+T} – s_{j,t+T})$, then this is 'convergence without switching'. Note that rich country *i*'s growth rate will be lower than the poor country *j*'s growth rate in *t+T*. In other words, convergence without switching based on ratios of per capita GDP happens when $(s_{i,t}/ s_{j,t}) > (s_{i,t+T}/ s_{j,t+T}) > 1$.

Following Webber and White (2009):

$$(s_{i,t}/ s_{j,t})^{X_{i,j}} = (s_{i,t+T}/ s_{j,t+T}) \qquad (5)$$

$s_i > s_j > 0$

By defining X_{ij} as a solution for (6) and taking logarithms on both sides gives:

$$X_{i,j} = \frac{\log(s_{i,t+T}) - \log(s_{j,t+T})}{\log(s_{i,t}) - \log(s_{j,t})} \qquad (6)$$

If, $X_{i,j} > 1$ then countries i and j exhibit divergence in ratios without switching,

Type I, where a relatively high-income region (A) grows at a faster rate rather than a low-income region (B) as shown below in Figure 3.3:

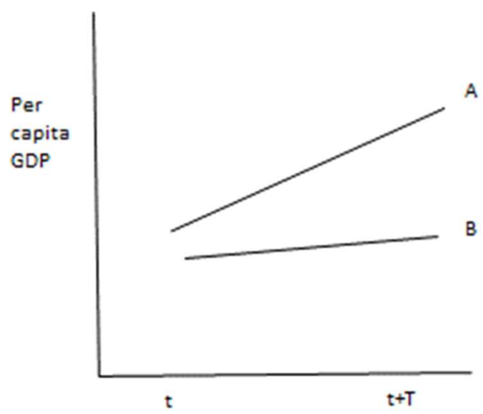


Figure 3. 3: Type I behaviour

Source: Author's own work

If $0 < X_{i,j} < 1$ then countries i and j exhibit convergence in ratios without switching which is called Type II and where a relatively low-income region (B) grows faster rate than the relatively high-income region (A) which stagnate as shown below in Figure 3.4:

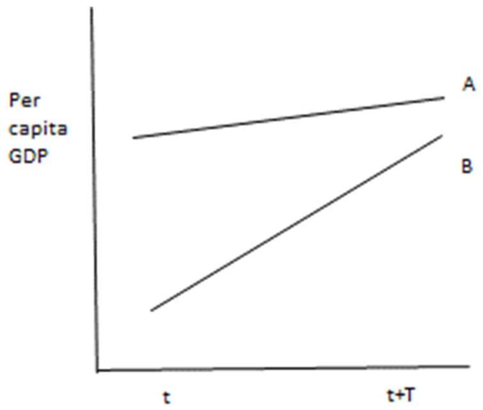


Figure 3. 4: Type II behaviour

Source: Author's own work

When -1 < $X_{i,j}$ < 0 occurs then countries i and j exhibit convergence in ratios with switching, which is called Type III and where a relatively high-income region (A) lags behind the relatively low-income region in terms of growth, as shown below in Figure 3.5

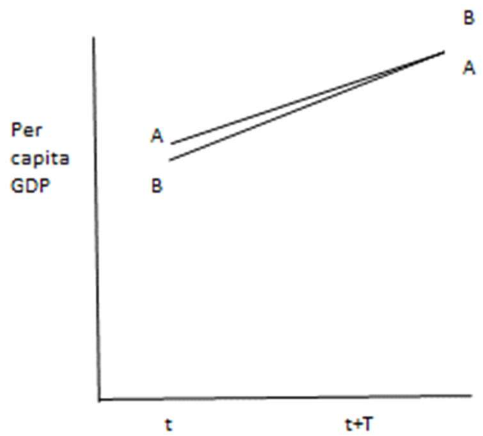


Figure 3. 5: Type III behaviour

Source: Author's own work

When -1 > $X_{i,j}$ then countries i and j exhibit divergence in ratios with switching, which is called Type IV and where a relatively low-income region (B) overtakes high-income region (A), as shown in Figure 3.6.

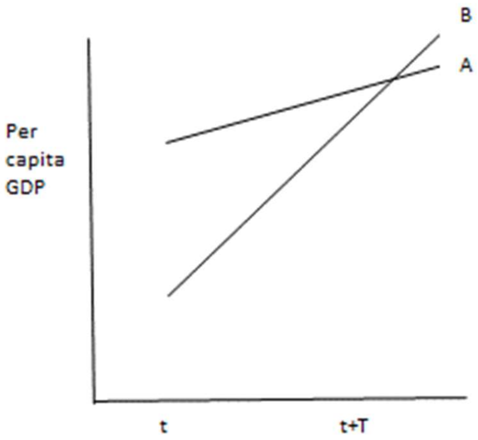


Figure 3. 6: Type IV behaviour

Source: Author's own work

When $X_{i,j}$ = 0 then the countries have already merged and there cannot be any further convergence, which is called Type V, as shown in Figure 3.7.

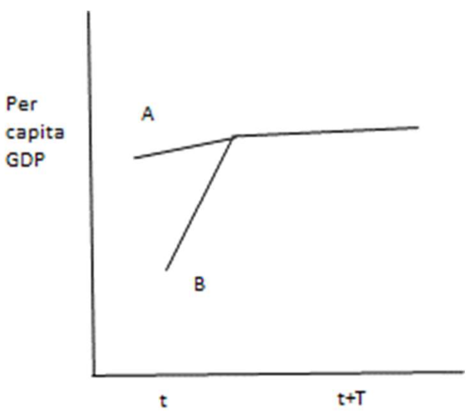


Figure 3. 7: Type V behaviour

Source: Author's own work

The typologies are based on the corollary of the neoclassical hypothesis of convergence, i.e., where poor regions grow at a faster rate to converge with the richer ones. The total convergence among regions is determined by adding Type II and Type III percentages and the total amount of divergence is determined by adding together Type I + Type IV. Type V instances of full convergence were not noted in the analysis, and that is why it is omitted from the analysis. Moreover, pairs of economies exhibiting Type III and Type IV behaviours have low percentages. Type III behaviour implies the lagging behind characteristics of relatively high-income regions and Type IV behaviour implies overtaking behaviour of relatively low-income regions. Hence, even though the two types of behaviours are in less proportion, they have high significance for regional mobility dynamics. Assessing these behaviours provide added insights on income inequality over the traditional measures of convergence.

Advantages

Standard measures of convergence explained in section 3.2 depend on the magnitude of data/observations. As a result, the findings of these indicators could be highly sensitive to extreme values and may not detect empirically any small but significant change. The X-convergence technique provides a magnitude free measure based on pairwise comparisons of economies. When comparing two regions the X-convergence estimate does not depend on the actual values of the regions' GDP per capita. Instead, it depends on the direction of GDP per capita change for the two regions in question. It considers the ratio of the changes in per capita incomes between two time periods for comparison. This process continues for all other economies and then percentages of converging/diverging pairs are taken into consideration. Therefore, the X-convergence statistic gives an estimate that is magnitude free and is capable of detecting small but significant changes during a particular period of time.

As highlighted by proponents of distribution dynamics, the study of the evolution of an entire distribution of income in time is important. If one wants to assess the impact of an event or small change on the convergence process then a temporal assessment becomes important. Since standard tools of measuring convergence give group averages during the whole period of time, small but significant changes between two time periods could go unnoticed if structural breaks are not considered. One of the benefits of using X-convergence is that it could be analysed between any two time periods, e.g., five-yearly, monthly, annually, etc. The change in convergence dynamics could be understood in accordance with the event. As a result, the X-convergence technique has the potential to test structural breaks in the series as well.

The X-convergence technique provides a detailed outcome on the behaviour of one economy compared to another. The specific behaviour between two regions can be easily examined with the help of this method. The method helps identify the behaviour of individual regions instead of the average group behaviour identified by the traditional convergence measures. This has important implications on the identification of economies for policy implementation and understanding the effectiveness of policies for particular economies that require growth stimulation. For instance, if a particular economy is relatively low-income and is diverging away from the rest of the regions (Type I behaviour) within a group of identical economies, then the economy needs policy attention and further analysis on factors affecting growth could help in implementing policies for growth stimulation. Furthermore, the evaluation of the effectiveness of the policy measures can be made after a lag period of implementing the policy. That is, the comparison of convergence behaviour pre-and post-policy implementation could help understand the effectiveness of policy measures. Thus, the pairwise comparison help in the easy assessment of the convergence behaviour of a particular economy for, first, identification of economies that need policy attention and second, assessment of the effectiveness of policies.

In addition, this technique helps to address the problem of quantifying the relative mobility of economies which is considered important for examining inter-regional growth disparities. In this context, Webber and White's (2003) framework would help understand the intra-distribution dynamics by emphasising the study of dynamics of switching and persistence of economies. They illustrated convergence with an example of the mechanism of factor price equalisation—switching indicates that the increase in demand for labour in a specific region is high/low relative to other regions, hence the productivity of the region increasing/declining compared to another region and accordingly the region changes rank or move together. Similarly, persistence could imply that there is no change in the rate of demand for labour and, therefore, the region is stagnated at the same position over time.

The churning of economies (changing rank order positions) within the cross-sectional income distribution helps to identify regions that are switching places. In this regard, the mobility of economies is investigated through overtaking, stagnating, and lagging behind economies. The five types of behaviours demonstrated by economies using X-convergence provide insights into the economies that are overtaking, stagnating or lagging behind. Moreover, the mobility dynamics help understand the disparity patterns of regions within and between groups. For instance, if a relatively low-income region is demonstrating Type II behaviour, then it indicates that the low-income region is converging with the relatively high income region. Similarly, if a relatively high-income region is exhibiting Type I behaviour, then that region is growing very fast compared to the relatively low-income region, and this increases the disparity between them. Low values of Type III and IV help to understand the persistence of relatively high- and low-income regions in the same category during the analysis period. The X-convergence technique has the potential to examine major regional dynamics of convergence, divergence, mobility, persistence, etc. all at once. Thus, assessing mobility dynamics with the help of the X-convergence technique provides better insights into conclusive convergence trends and disparity patterns.

The thesis is going to assess the convergence dynamics with the help of growth differentials measured in relative ratios because it has very limited evidence in the literature (Novotný, 2011). Few studies have employed this technique to understand the convergence pattern among economies. For instance, Webber and White (2009) found evidence of divergence between 97 countries over 1960-2000 as the dominant phenomenon but the presence of convergence and switching was also present. Webber et al. (2005) analysed 48 US states between 1929 and 2002 to find that states are converging with each other at different rates. Webber et al. (2004) studied 52 Spanish provinces over 1955-1997 to suggest that convergence is prevalent for the entire sample with swings in convergence and divergence. Similarly, Novotný (2011) examined 264 EU27 regions over 1992-2006 and showed ambiguous results on living standard convergence and divergence—coexistence of regional convergence in relative ratios and divergence in absolute terms.

Thus, Webber and White have reportedly used the technique of concordance and discordance in a number of studies to understand the convergence/ divergence trends. Recently, a limited number of studies have employed the X-convergence technique to understand the impact of the convergence of consumption expenditure and public finance (Novotný, 2011; Liobikiene and Juknys, 2013; Liobikienė and Mandravickaitė, 2013; Ferreiro et al., 2014). The popularity of X-convergence is gaining ground and therefore, its potential to reveal insightful inferences about growth disparities will be investigated in the thesis.

Disadvantages

Although the technique has an edge over others (like beta and sigma statistics), there are a few limitations associated with this technique. One of the disadvantages of this technique is that it offers a massive amount of data to deal with. Pairwise analysis of countries makes it a computationally intensive procedure for researchers. Another limitation of this technique is that it could provide biased inference if the majority of countries in the sample share the same characteristics in terms of development or technological advancement. For instance, if there is a large number of developing countries in the sample, the convergence trend would dominate if they are successful in catching up with the relatively developed countries. In this case, the grouping technique could be used to identify groups of regions based on certain characteristics and then the X-convergence technique could be used to assess patterns within-and between-groups. A third limitation is that this technique is fully based on the factor/variable that the researcher is considering and does not give any weightage to the spillover or agglomeration effects from neighbouring regions. This problem could be addressed by employing spatially weighted variables to gain insights.

To conclude, the significance of interactions of economies within a distribution was established but a lack of sufficient measure to fully investigate the issues drew the attention of researchers. To fill this gap, Webber and White (2003, 2009) proposed the X-convergence method based on differences between per capita incomes of two economies at two periods. The estimates have the potential to examine important regional dynamics of convergence, divergence, switching, persistence, polarisation, and mobility of economies, all at the same time. The simultaneous assessment of major regional dynamics is a feature that makes Webber and White (2003, 2005) measure distinct from many other measures of inequality. Another distinctive feature of Webber and White’s (2003, 2005) method is that it allows an in-depth comparison of two regions on a yearly basis to assess the exact frequency of convergence with any region. Furthermore, it facilitates a comparison between small periods (monthly/annually), which helps to detect small but significant changes during that time period. The technique does not get affected by the extreme values unlike other measures of convergence. The measure has been employed to understand the convergence of household consumption expenditure but not many studies have explored the regional convergence and disparity issues using this technique. The immense potential of examining pairs of regions to understand the subtleties of regional convergence and disparity inspired the study to use the X-convergence technique.

3.6 Research Design: Empirical Investigation of Convergence

This section will provide an outline of four empirical chapters that are to follow. Each chapter will follow four steps: first, there will be an investigation of the three standard measures of convergence (beta, sigma, and gamma) to ascertain the controversy of mixed finding. Second, assess the X-convergence technique of convergence to validate the findings of the standard measures of convergence. Third, to find evidence of polarisation of regions and group them according to the group based trajectory modelling approach. Fourth, use the X-convergence method to examine within-and between-groups and compare the findings and provide insights on mobility dynamics.

The first empirical chapter provided an assessment of the convergence trend for 109 countries using standard traditional measures of convergence (beta, sigma, and gamma) and then compare the outcomes with the estimates obtained from the X-convergence technique. The purpose of this chapter is to show how differential outcomes obtained from different techniques contribute to the inconclusive nature of findings on convergence trends and economic disparities. The data is obtained from the World Bank database from 1970 to 2015.

The second empirical chapter assesses the sub-national economy of China by examining 31 provincial income per capita data from 1993 to

2016. The data is obtained from the National Bureau of Statistics China. This chapter is going to introduce group analysis. The groups are assigned based on the provincial income per capita with the help of group-based trajectory model (GBTM). To identify groups income per capita data will be used and within-and between-group convergence analysis will be carried out using the X-convergence technique to identify fast-moving, overtaking, stagnating, and lagging behind provinces.

The third empirical chapter assesses the United States income per capita data for 50 US States (1997-2017) and 383 metropolitan statistical areas (MSAs) level (2001-2017). The data is obtained from the Bureau of Economic Analysis. This chapter broadens the scope of the study by introducing regional level data of metro areas making it an analysis of two geographic levels. The chapter presents group analysis based on the States data and investigates the X-convergence estimates to identify fast-moving, overtaking, stagnating, and lagging behind regions. The chapter will compare the pre and post effects of the 2008 global crisis on regional convergence and inequality.

The fourth empirical chapter assesses the European income per capita convergence trend for 28 countries, 86 NUTS1 regions, and 252 NUTS2 regions from 1991 to 2015. The income per capita data is obtained from the Cambridge Econometrics database. This chapter is different from others because it will analyse the data at three geographic levels (details in the next section). The increasing complexity of adding three hierarchical levels makes the assessment comprehensive. The comparison of regions based on group analysis will be done using the X-convergence technique to identify fast-moving, overtaking, stagnating, and lagging behind provinces.

The discussion chapter, presents trends in the three different geographical locations (China, United States, and Europe). It investigates similarities and differences in the convergence behaviours of regions grouped in high-income, middle-income or low-income locations. In addition, the chapter compares the findings from each of the above empirical chapters on the effects of the 2008 global recession, patterns of regional income mobility, and research contributions and policy implications of the study.

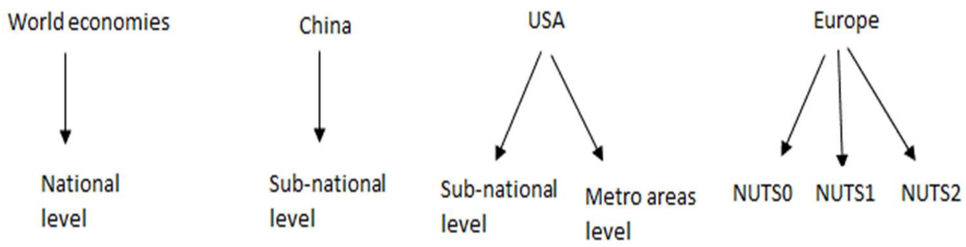


Figure 3. 8: Summary of increasing complexity of assessment by introducing levels of regional hierarchy in the empirical chapters

Source: Author's own work

3.7 Conclusion

This chapter has highlighted the need to measure convergence from the perspective of economic/growth mobility through the X-convergence technique. The mobility dynamics help understand how pairwise economies evolve in terms of growing fast, overtaking, stagnating, or lagging behind. This provides insights into understanding if the disparity between two economies is increasing or decreasing. If one economy shows signs of stagnation relative to the rest, then it becomes easy to identify. The focus of the analysis is to examine the individual behaviour of economies rather than the group average behaviour as demonstrated by the traditional measures of convergence. The X-convergence technique takes account of convergence/divergence with/without switching places. Despite all the benefits this technique offers, it has not been applied much in the income convergence context which is why the empirical chapters will use the technique to validate its benefits.

To understand the patterns of growth mobility among economies, it is important to identify regions with similar growth trajectories. The group-based trajectory model is explained in the chapter to identify groups that follow similar growth trajectories. Implementing this method makes it easier to assess mobility dynamics within- and between-groups. The benefits of grouping regions are drawn from the convergence clubs literature and grouping help to outline the scope of the study. Examining mobility dynamics within-and between-groups illustrates the subtleties of inequality between regions and helps to identify a conclusive convergence trend. Both of them will help scholars and policymakers to make better decisions and channel the funds accordingly. The benefits of using X-convergence and trajectory analysis methods are validated in the next four empirical chapters.

CHAPTER 4 WORLD ECONOMIES

4.1 Introduction

The debate on the convergence of per capita incomes across the world and, consequently, the persistence of inequality within the income distribution is an ongoing topic that has been studied widely across the globe (Barro, 1991; Barro and Sala-i-Martin, 1991; Martin and Sunley, 1998; Maasoumi et al., 2007; Le Gallo and Fingleton, 2019). The study of cross-country growth convergence at the national level has been very common. It started with an assessment of the growth and convergence dynamics for developed nations, particularly OECD countries, because of the available satisfactory data volume and quality. As data availability and its quality improved for developing countries, convergence studies across more countries started to gain attention (Desli and Gkoulgkoutsika, 2019), although the availability of regional data for the less developed countries is still a problem (Lessmann and Seidel, 2017). With the simultaneous analysis of data on developed and developing countries, the findings started to differ from the previous ones owing to their heterogeneities and hence the debate on getting a dominant trend of either convergence or divergence among economies started to strengthened (Desli and Gkoulgkoutsika, 2019).

Convergence has been interpreted in many different ways such as catching-up to a reference point, reducing differences/inequalities across certain variables, and approaching steady state (Acemoglu, 2012; Armstrong, 1995; Rodríguez-Pose, 1999). The difference in interpretation resulted in different convergence outcomes for economies based on the measures and indicators used such as beta and sigma convergence. These indicators have been widely used and interpreted according to their conceptual underpinnings. However, these indicators ignore the possibility of economic interactions between economies through trade, FDI flows, labour flows, etc., which could result in the change in rank order positions of economies. Highlighting this gap Boyle and McCarthy (1997, 1999) proposed a gamma-convergence indicator to assess variations in rank order positions within the set of economies. Although the gamma indicator can provide an indication of mobility within a distribution of economies, it is incapable of identifying the detailed features of changing income distribution.

Highlighting the significance of changing income distribution, distribution dynamics proponents emphasised the need to quantify the mobility behaviours of economies (Quah, 1997; Maasoumi et al., 2007). For instance, fast growing countries in East Asia showed convergence during the 1990s, but on the other hand, many developing countries failed to catch up with developed countries and thus showed the existence of divergent growth paths (Rodrik, 2014). A lot of explanations have been used to justify divergent growth paths between countries. One of them is the limitation of the assumption of a linear growth model for every country in the sample through the use of the beta convergence indicator. Countries were considered homogenous in terms of economic and structural characteristics and therefore, each country was assumed to follow a similar growth path. However, many studies showed evidence of non-linearity in terms of multiple regimes of growth paths exhibited by groups of countries that produce multiple locally stable states in per capita output (Galor, 1992; Durlauf and Johnson, 1995).

The heterogeneity among countries' income per capita highlights the significance of comparing countries' economic growth using appropriate scales of measurement. The difference between an advanced and a less developed country could be realised by the gap in their per capita GDP figures, for instance, per capita GDP in the US was $52364.24 while Ethiopia reported $511.12 in 2016 according to the World Bank database. This demonstrates a big difference between economies' income across the globe. Over the years, differences have not been uniform across developed and developing economies, as some low-income countries have successfully progressed to middle-income groups and some climbed up the ladder from middle-income to high-income groups, but some have stagnated or lagged behind. Thus, a disproportionate share of world income and a constantly changing income distribution empathise the need to compare income dynamics. To address this issue, this chapter is going to use relative ratio measures to compare the differences between per capita incomes over time.

Building on the arguments of rank concordance and highlighting the importance of quantifying economic mobility using an appropriate scale of measurement, Webber and White (2003, 2009) proposed the method of X-convergence. Using the idea of concordance and discordance, X-convergence identifies intertemporal properties of overtaking, lagging behind, stagnating or polarising within the distribution. This chapter focuses on addressing the problems of the scale of measurement of convergence and ignorance of intertemporal properties among countries by employing the X-convergence technique in relative ratios.

The chapter will extend Webber and White's (2009) study which identify the convergence trend for 97 countries from 1960-2000 using the X-convergence technique. This chapter analyses 109 countries from 1970-2015 to identify a dominant trend of convergence. In addition, this chapter will provide evidence of inconsistencies in findings generated by beta, sigma, and gamma convergence indicators. Hence, the two objectives of this chapter are: first, to compare the findings of standard measures of convergence with X-convergence findings, and second, to validate the benefits of the X-convergence technique by building on Webber and White's (2009) study and implementing the technique to generate a dominant convergence trend during the analysis period.

The aim of this chapter is to operationalise the X-convergence technique to find a dominant convergence trend during 1970-2015. This chapter contributes to the debate on inconsistent findings on dominant convergence trend by employing different measures of convergence. Specifically, this chapter will focus on validating the benefits of gaining more insights from the X-convergence technique.

The chapter is organised in the following sections: section 4.2 provides a background on the convergence and disparity trend across the world, section 4.3 provides information on the data, section 4.4 provides empirical findings using different convergence measures, section 4.5 discusses the interpretations and implications of the findings, and section 4.6 concludes the chapter.

2.2 Background

This section will analyse the evolution of regional growth and convergence literature. In addition, the section will throw light on the differences in the findings of regional convergence trends that are highlighted by many researchers. A variety of outcomes has strengthened the controversy on inconsistent findings on convergence trend across the world, particularly post-1990s. The purpose of this section is to provide evidence on inconsistent findings of convergence/divergence trend that contribute to the controversy of mixed findings in the literature and the need to find a dominant convergence trend for heterogeneous countries.

The economic growth studies have linked the growth and development of economies with welfare levels and living standards of citizens within countries (Gaspar, 2012; Rodrik, 2014). If there were higher economic growth, then governments would be willing to focus their expenditure on necessary welfare projects of citizens. For instance, the development of European welfare states from the 1950s to 1970s had been the result of favourable economic growth due to the stable manufacturing sector. This resulted in higher employment levels and the ability to provide necessary benefits/care for dependents like education and health (Taylor-Gooby, 2004). At the same time, it has also been argued that higher economic growth leads to the concentration of income in a few dominant places with high economic activities generating agglomeration economies (Grossman and Helpman, 1991; Romer, 1986; Aghion et al., 1998; Romer, 1994; Howitt, 2000; Aghion and Howitt, 2008; Klenow and Rodriguez-Clare, 2005; Bloom et al., 2013; Jones and Romer, 2010). Many urban centres within a particular country are highly rich compared to other cities within the same country. For instance, Paris and Milan are two rich cities in France. In this regard, the biggest concern for policymakers is that no cities should be left out. The cohesion policies around the globe strive to focus on the cohesion of regions and the well-being of people.

The neoclassical prediction of convergence reveals that low-income economies grow at a faster rate and eventually converge with the relatively high-income economies and reduce the disparity in the long run. On the other hand, the new growth theories highlight mechanisms that help the high-income economies to grow fast and diverge away from the rest and hence increase the disparity between them. Thus, the convergence theories have important implications/predictions on the evolution of regional income disparity across economies. In order to assess regional disparity, it is important to understand the convergence pattern in a comprehensive manner to yield conclusive findings. As highlighted in Chapter 3, the findings of the dominant convergence pattern are not inconsistent in the literature because of factors such as different indicators applied, sample size, and time period considered by the studies.

The differential findings are evident in the assessment of convergence across world economies. There are some studies that found a divergence between countries while others found convergence. For instance, differences in growth paths across the world have been supported by many studies that alluded persistence of divergence across the world over centuries (Islam, 2003; Webber and White, 2009; Tondl, 1999; Magrini, 2004; Badinger et al., 2004). One of the most cited studies on divergence in income levels across the world is by Pritchett (1997) in his seminal work ‘Divergence, Big Time.’ The study found a slower growth rate for developing countries than the developed ones during 1870-1990 producing divergence in income. Likewise, Ram (2018) used the GDP per capita data from Penn World Table for 110 countries from 1960-2010 applying the sigma convergence technique found that there was a prevalence of greater divergence or weaker convergence during the period. The study highlighted that many poor countries in Africa and elsewhere showed no signs of closing the gap between them and fast-growing rich nations. Likewise, Bleaney and Nishiyama (2003) showed that on average, sub-Saharan African countries experienced income inequality during 1965-1990. Therefore, the divergent growth paths were highlighted between countries until the 2000s based on a few studies.

However, the research has highlighted that there were a few countries that experienced successful convergence particularly during the 2000s (Johnson and Papageorgiou, 2020; Lessmann and Seidel, 2017; Morris, 1996). It has been highlighted that after the Second World War, the Southeast Asian Tigers such as Japan, Korea, Taiwan, Singapore, and Hong-Kong benefitted from rapid industrialisation which encouraged Malaysia, Indonesia and China to follow suit (Morris, 1996). These countries received the advantage of manufacturing commodities’ export penetration owing to the highly competitive manufacturing industries. Some of the middle-eastern countries like Saudi Arabia, Iran, United Arab Emirates and Kuwait benefitted from oil extraction and exportation. Therefore, some countries were growing at a faster rate

The recent trend on regional growth and convergence is based on the advent of a variety of spatial models and databases (Sanso-Navarro et al., 2020; Lessmann and Seidel, 2017; Mitton, 2016; Breinlich et al., 2014; Gennaioli et al., 2014). For instance, Gennaioli et al., (2013) developed a “Lucas-Lucas” model that examined the effects of human capital externalities on total factor productivity in 110 countries at subnational regions and found significant human capital effects on regional growth differentials. Afterwards, Sanso-Navarro et al. (2017) extended Gennaioli et al. (2013) model by applying the spatial dependence model and showed that higher human capital in a region promotes not only higher technological progress in the region but also helps in additional technological flows to neighbouring regions. Furthermore, analysing the income data from 1950 to 2010, Sanso-Navarro et al. (2020) found an increase in the estimated regional convergence rate for countries across the world after considering unobserved heterogeneity and spatial dependence

Commenting on the development of new databases, Lessmann and Seidel (2017) used satellite night-time light data to predict the regional income per capita for 180 countries from 1992 to 2012. The intensity of luminosity data measured by satellites was used as a proxy for regional income—higher the nightlight intensity of a country, then higher its level of economic activity and hence higher its income. In addition, the study found that more than 67 percent of all countries experienced sigma convergence between 1992-2001 and 2002-2012, which indicate higher instances of convergence prevailing between countries during the 2000s.

International convergence experience highlights the heterogeneities in the behaviour of economies. Johnson and Papageorgiou (2020) analysed the data from 1950 to 2001 and concluded that the experience of growth and, consequently, convergence/divergence is not a smooth process and is identified by country heterogeneity. The economic growth in many developing countries is episodic which suggests that the experience of convergence or divergence is not a continuous process or rather fragmented in these countries. Similarly, using data from 1965 to 2014, Hailemariam and Dzhumashev (2019) found that heterogeneity and nonlinearity existed between income inequality and economic growth. For assessing heterogeneity, the study performed a separate examination of inequity measures for developed and developing countries. Since each country has different socioeconomic conditions such as economic policy, saving propensity, and technology, each time series was separately examined to check for the presence of heterogeneity. The study of heterogeneity among countries indicated nonlinear relationship between income inequality and economic growth. The finding on a nonlinear relationship between income disparity and growth indicated that economic growth was expected to fall with greater inequality, specifically when Gini Coefficients were above 24 in developed countries and 41 in developing countries. Therefore, ignoring heterogeneity in income for a sample of countries could yield misleading and biased findings on economic growth and convergence.

There are very few studies that provide insights into the convergence trend for countries after 2010. In this regard, Sanso-Navarro et al. (2020) highlighted that within country regional level data analysis became more prevalent than convergence assessment for a large group of countries. The main reason for this was the advancement in the assessment techniques of income convergence and the wider availability of regional data within countries. Thus, the focus of studies recently changed from country comparisons to regional comparisons across the world.

However, international bodies such as the World Bank and IMF have been constantly working towards equal opportunities and poverty eradication across the world. The need to compare convergence behaviour across countries become more important when a disproportionate share of income is prevalent between countries. To fulfil the objectives of international bodies while taking account of heterogeneities across the world call for a holistic approach for the assessment of lagging and stagnating countries. By conducting a comprehensive pairwise assessment of convergence trends between countries, the allocation of resources to the lagging and stagnating countries will become easy.

To conclude, the period of income convergence assessment in this chapter for countries across the world has been performed for the period 1970 to 2015. There have been contrasting findings in literature as some studies showed a prevalence of convergence while others showed divergence between countries. The literature highlights the problems of limited data for small underdeveloped countries. As the availability of data for many developing countries improved, heterogeneities in income groups of countries were highlighted, and advancement in convergence measuring techniques became prevalent, the studies further contributed to the inconsistent findings on the convergence trend across the world. Consequently, the need to find a conclusive dominant convergence trend for policy initiatives to allocate resources was emphasised. More recently, the availability of regional data prompted researchers to analyse the convergence and inequality trend within countries at the regional level. This shifted the focus of convergence literature from between countries to within countries. However, to compare heterogeneous countries the same measuring scale is required to promote income equality and appropriate allocation of resources. This chapter will address the gap on the issue of lack of knowledge on recent conclusive trends on convergence and inequality.

4.3 Data

The chapter uses GDP per capita (in 2010 constant US dollars) data for 109 countries from 1970 to 2015. The World Bank has comprehensive data for every country from 1960. One of the priorities of the World Bank is to improve the statistical infrastructure of developing countries to help them develop national strategies (World Bank website). This suggests comprehensive data availability for developing countries. The data is, therefore, sourced from the World Bank database. Literature shows that many studies have used country data since 1960 because of the unavailability of data before that period and also because many colonies had not gained independence before 1960 (Barro, 1991; Durlauf et al., 2004). However, for this study the time period of 1970 has been chosen for two reasons: first, the period before 1970 experienced a consistent convergence and things started to change from the beginning of the 1970s (Boyle and McCarthy, 1999). It has been clarified that the 1970s experienced the oil crisis and the collapse of Britton Woods that could have influenced the convergence of countries. Secondly, 1970 provided information on almost 20 extra number of countries to study than 1960. The priority of this chapter is to examine as many countries as possible and also cover a longer period of time. An overview of the number of countries from six continents and their 2015 average income per capita within each continent is provided in Table 4.1.

Table 4.1 also shows a big difference in 2015 income per capita of countries within continents. Countries in Africa have the lowest income while European countries generate the highest income. Please note that the dataset has been sourced from the World Bank database which has a higher proportion of developing countries data than the developed countries. That’s why Noth America has more proportion of developing nations. In North America, the highest GDP per capita in 2015 is for the US and Canada at 51956.58 and 50132.38 units, respectively. The rest 16 countries have incomes ranging from 1879.71 (Nicaragua) to 41435.62 units (Greenland).

Table 4. 1: Overview of 109 Countries by Continents

Continent	**No. of Countries**	**2015 Average GDP per capita**
Africa	36	2851.00
Asia	20	13736.19
Europe	20	46271.93
North America	18	15394.64
South America	11	8363.72
Oceania	4	15784.17

Three standard measures of convergence beta, sigma, and gamma convergence and X-convergence techniques are applied to 109 countries for the 45-year period to cover as many countries as possible. The findings of four different techniques will be compared to identify convergence trends during the analysis period.

4.4 Findings

To show some basic characteristics of per capita GDP, Table 4.2 provides the descriptive statistics for 10 periods at five-year intervals. The standard deviation is continuously increasing indicating that the values are spreading out over a wider range from the mean. Figure 4.1 depicts that the minimum per capita GDP for low-income countries is highest in 1985 at $239.78 for Myanmar but declined thereafter with the lowest in 1995 at $115.794 for Liberia in Africa. From 2000 to date, the lowest per capita income country was Burundi in Africa. The highest value of $239.78 for Myanmar in 1985 has not been matched anytime afterwards, suggesting that some of the low-income countries are struggling to grow at a decent rate after 1985. On the other hand, the maximum per capita GDP trend shown in Figure 4.1 depicts the trend of the income of the richest country in the sample. Since 1990 the maximum value is represented by Luxembourg's GDP per capita which has a low population and small geographical area size compared to many other countries in the sample. So increasing slope of the maximum value reveals the increasing income per capita for Luxembourg only.

Looking at the difference between the minimum and maximum values in 1970 and 201 reveals that the disproportionate share of income between rich and poor countries is widening. The increasing gap makes a comparison between two countries in terms of absolute income differential difficult and misleading as highlighted in Chapter 3.

Therefore, the relative ratios assessment could provide better insights into the matter.

Table 4. 2: Descriptive Statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
GDPc_1970	109	6916.915	9138.746	169.688	42137.5
GDPc_1975	109	7961.533	10328.11	174.562	43158
GDPc_1980	109	9028.74	11640.47	211.368	48538.2
GDPc_1985	109	9344.651	12329.8	239.78	56604.4
GDPc_1990	109	10533.85	14195.82	197.21	65921.9
GDPc_1995	109	11320.49	15412.88	115.794	74776.8
GDPc_2000	109	13124.48	18257.16	228.248	93462.9
GDPc_2005	109	14366.32	19889.43	219.187	101381
GDPc_2010	109	14941.74	20073.39	231.194	104965
GDPc_2015	109	15917.79	21096.57	226.528	107649

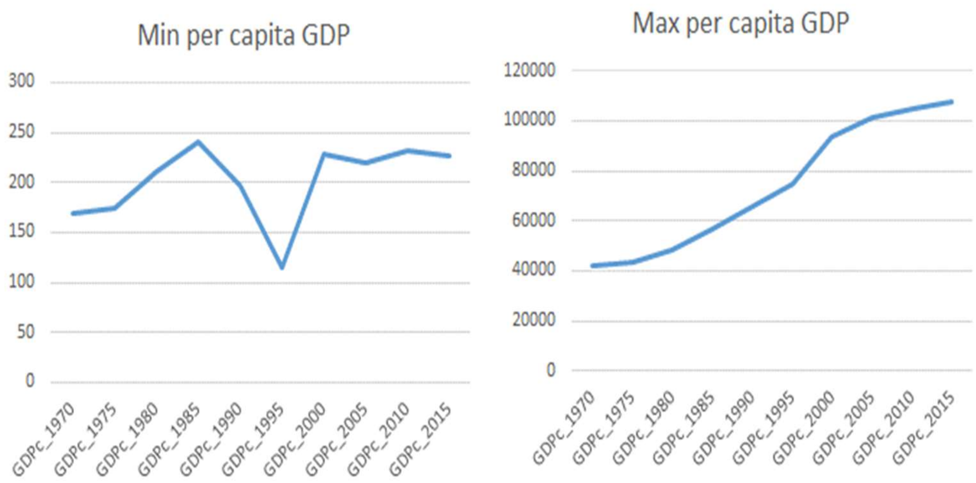


Figure 4. 1: Minimum and maximum per capita GDP values over time

4.41 Beta, sigma, and gamma convergence

The study applies the absolute beta convergence growth regression equation to identify the absolute/unconditional convergence among countries is happening or not as predicted by the neoclassical hypothesis of convergence. Absolute convergence does not take into consideration conditional variables like labour, capital and education that could affect the convergence process. The study uses a simple form of equation to determine the absolute beta convergence:

$$(1/T)\log(\frac{y_{it+}}{y_{it}}) = \alpha + (-\beta)\log(y_{it}) + \epsilon_{it} \qquad (7)$$

Where T is the total time period from 1970 to 2015 = 45

Dependent variable income growth = constant + βln(gdp1970) + error

Dependent variable income growth = 0.0194735 + (-0.0003787) lngdp1970 + error
(0.0085026*) (0.001056*)

(*Standard error in parenthesis)

Using the convergence equation (1) reveals a β coefficient of -0.0003787.

The negative sign on the beta coefficient estimate indicates that there is the presence of absolute beta convergence. The literature emphasises that the beta coefficient figure indicates the behaviour of an average country and gives a generalised result. Therefore, in general, the capital poor countries are growing at a faster rate to catch-up with the richer countries as suggested by the neoclassical hypothesis of convergence. However, the absolute value of beta coefficient is very small (0.04 percent) and not significant (as indicated by the standard error), thereby suggesting insignificance of beta coefficient for the sample.

The literature suggests that the generalisation or assumption of each and every country following the same growth trajectory is not feasible.

This highlights the problems of heterogeneity and the importance of non-linearities that beta convergence indicator ignores. Owing to the criticism that beta convergence received in literature, Islam (2003) stated that beta could be considered only a necessary pre-condition for convergence. Therefore, to explore the convergence trend further, sigma convergence is employed.

For sigma convergence, the chapter will analyse the coefficient of variation (CV) for the period 1970 to 2015. Lower CV depicts sigma convergence and vice-versa. An increased CV indicates greater dispersion of per capita income, which in turn suggests increased inequality within the income distribution of countries.

For the gamma convergence, this chapter uses Boyle and McCarthy (1997, 1999) variation in the rank of countries based on GDP per capita.

$$\gamma = \frac{Variance(RGDP_T + RGDP_t)}{Variance(RGDP_t \, X \, 2)} \tag{8}$$

Where, the variance (RGDP) is the corresponding variance of the ranks of per capita GDP. The rank of per capita GDP in each year is compared with the rank in the base time, *t* (1970). A gamma convergence indicator (γ) value close to 0 would depict high mobility and a value close to 1 would depict low mobility within the income distribution.

Figure 4.2 shows the trend of sigma and gamma convergence taking 1970 as the base year. The downward slope depicts convergence and the upward slope depicts divergence.

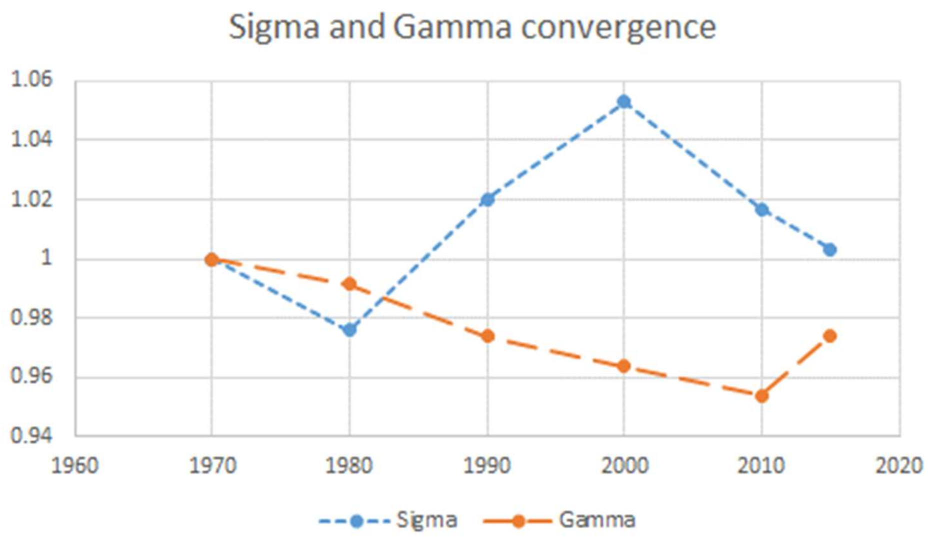


Figure 4. 2: Sigma and gamma convergence 1970-2015

The gamma convergence indicator is trended downwards until 2010 suggesting convergence until 2010. The process reversed afterwards. In terms of mobility among the group of 109 countries during 1970-2015, the gamma indicator value close to 1 indicates less change in the ranking of countries during 2015 compared to the base year 1970. In other words, fewer countries changed their ranks in 2015 compared to 1970.

The sigma convergence trend looks different from the gamma convergence trend. If we look at the start and end period, sigma convergence has almost the same value or the coefficient of variation is constant in 1970 and 2015 indicating almost the same dispersion of income in both years. Sigma convergence which lasted from 1970 to 1980, turned into sigma-divergence from 1980 to 2000, and after 2000 sigma convergence appeared again, which indicates a narrowing of the dispersion of per capita income across countries. Combining the findings of sigma and gamma convergence indicators suggests the presence of convergence during 1970-1980 and 2000-2010 (where both indicators sloping downwards) but for the rest of the period, the trend does not give any conclusive outcomes.

The insignificance of beta coefficient and variation in the outcomes of sigma and gamma convergence estimates indicate the need to find a conclusive trend on convergence. Moreover, with regards to gamma convergence, Boyle and McCarthy (1999) highlighted the failure of this indicator in capturing the features of changing income distributions which arise from pairwise comparisons between economies. Therefore, in the next section, the convergence trend is determined by employing the X-convergence technique on a year-on-year basis.

4.42 X-convergence

For X-convergence, a total of n(n-1)/2 pairs were analysed. Since there are 109 countries, there are 5,886 pairs analysed. Inspired by the neoclassical growth predictions of convergence that poor economies grow at a higher speed to catch-up with rich countries, Webber and White (2003, 2009) model outline that convergence could be referred as to a gradual decrease in the magnitude of differences between rich country (*i*) and poor country's (*j*) output per capita (s_i and s_j) between periods *t* and *t+T*. Hence, X-convergence compares two countries and two time periods.

If $s_{i,t} > s_{j,t}$ and $(s_{i,t} – s_{j,t}) > (s_{i,t+T} – s_{j,t+T})$, then there is 'convergence without switching'. Note that rich country *i*'s growth rate will be lower than the poor country *j*'s growth rate in t+T. In other words, convergence without switching based on ratios of per capita GDP happens when $(s_{i,t}/ s_{j,t}) > (s_{i,t+T}/ s_{j,t+T}) > 1$.

Following Webber and White (2009),

$$(s_{i,t}/ s_{j,t})^{X_{i,j}} = (s_{i,t+T}/ s_{j,t+T}) \tag{9}$$

And assume, $s_i > s_j > 0$

By defining X_{ij} as a solution for (1) and taking logarithms on both side gives:

$$X_{i,j} = \frac{\log(s_{i,t+T}) - \log(s_{j,t+T})}{\log(s_{i,t}) - \log(s_{j,t})} \tag{10}$$

Based on the value of $X_{i,j}$, the four types of behaviours are:

Type I = divergence in ratios without switching

Type II = convergence in ratios without switching

Type III = convergence in ratios with switching

Type IV = divergence in ratios with switching

Type V = countries have already converged

In this study, there was no evidence of Type V, so it was omitted hereafter.

For the illustration of the implementation of X-convergence let's take two countries—Australia and Zambia. The technique will show the type of behaviours followed by the two countries during 2014-15 periods.

$s_{i,t}$ = Australia's per capita GDP in 2014 = 54293.8

$s_{i,t+T}$ = Australia's per capita GDP in 2015 = 54800.4

$s_{j,t}$ = Zambia's per capita GDP in 2014 = 1620.82

$s_{j,t+T}$ = Zambia's per capita GDP in 2015 = 1618.46

$$X_{i,j} = \frac{\text{log(Australia's per capita GDP in 2015) – log(Zambia's per capita GDP in 2015)}}{\text{log(Australia's per capita GDP in 2014) – log(Zambia's per capita GDP in 2014)}}$$

$$X_{i,j} = \frac{10.91145 - 7.38923}{10.90217 - 7.390687} = 1.00306$$

Based on the X-value, which is greater than 1, Type I behaviour is identified between Australia and Zambia. This suggests that both countries are diverging without switching, i.e., Australia is growing faster than Zambia and diverging away between 2014-15. Similarly, the types of convergence behaviour that Australia shows with a few selected countries are shown in Table 4.3.

Table 4. 3: The matrix showing types of behaviours demonstrated by Australia with the selected countries from 2011-12 to 2014-15.

		2011-12				2012-13				2013-2014				2014-2015			
Base country	**Compared with**	**Type I**	**Type II**	**Type III**	**Type IV**	**Type I**	**Type II**	**Type III**	**Type IV**	**Type I**	**Type II**	**Type III**	**Type IV**	**Type I**	**Type II**	**Type III**	**Type IV**
Australia	Zambia	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
	Tunisia	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
	Togo	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Egypt, Arab Rep.	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0
	Myanmar	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Malaysia	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Korea, Rep.	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Japan	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0
	India	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Indonesia	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Hong Kong	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	China	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Bangladesh	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	United Kingdom	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Sweden	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0
	Spain	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0
	Portugal	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0
	Netherlands	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0
	Norway	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Malta	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Luxembourg	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0
	Ireland	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0
	Italy	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0
	Iceland	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0
	Germany	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0
	Greece	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0
	Georgia	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	France	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
	Finland	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
	Denmark	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0
	Belgium	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0
	Austria	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
	Andorra	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	United States	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0
	Brazil	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
	Argentina	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0

Table 4.4 illustrates the benefits gained from the four types of behaviours demonstrated by selected countries during 2014-15.

Table 4. 4: Types of behaviour demonstrated by selected countries in 2014-15

Country name	Type I	Type II	Type III	Type IV
Zimbabwe	86	21	0	1
Zambia	79	28	0	1
Togo	37	70	0	1
Sudan	35	73	0	0
Senegal	32	76	0	0
Nigeria	69	38	1	0
Malawi	90	17	1	0
Mali	37	71	0	0
Madagascar	81	27	0	0
Kenya	37	71	0	0
Gambia, The	67	40	0	1
Ghana	52	54	1	1
Egypt, Arab Rep.	38	70	0	0
China	54	52	1	1
Sri Lanka	37	70	1	0
Philippines	33	74	1	0
Pakistan	37	71	0	0
Nepal	44	63	0	1
Myanmar	26	80	2	0
India	29	78	0	1
Indonesia	39	68	1	0
Bangladesh	23	83	1	1
Norway	37	71	0	0
Luxembourg	28	80	0	0
Italy	41	67	0	0
Germany	38	68	1	1
Greece	47	61	0	0
France	38	69	1	0
Finland	28	78	1	1
Denmark	37	70	0	1
Belgium	38	69	0	1
United Kingdom	45	62	0	1
United States	61	47	0	0

Higher instances of Type I behaviour depict divergence without switching. For high-income countries, like the US, higher instances of Type I behaviour illustrate that the country is growing faster than relatively low-income countries and diverging away from them. For relatively low-income countries like Zimbabwe, Zambia, Nigeria, Malawi, Madagascar, etc., less instances of Type II behaviour indicates that they are able to converge with only a few high-income countries. Thereby showing that they are stagnating/lagging behind relatively high-income countries. Please note the relatively high- and low-income countries are based on the two countries in a pair—one country will have a higher income than another.

Greater instances of Type II behaviour depict convergence without switching places. If relatively low-income countries like Kenya, Egypt, Sri Lanka, Philippines, Pakistan, Nepal, Myanmar, India, Indonesia, Bangladesh, etc. are exhibiting high instances of Type II behaviour then they are growing faster than relatively high-income countries.

Higher instances of Type III behaviour demonstrated by Myanmar show that Myanmar performed better and hence switched places with Mauritania and Lesotho during 2014-15. Higher instances of Type IV behaviour demonstrated by Bangladesh with Chad shows that initially low-income country Bangladesh overtook Chad and diverged away.

These are some benefits of the X-convergence technique that helps identify the exact frequency of occurrence of converging pairs and also identify countries that are growing faster, slower, overtaking or stagnating, all at once. These changes in distribution are not captured by the standard measures of convergence—beta, sigma, and gamma convergence.

To identify the overall trend of convergence during 1970-2015, the percentages of types of behaviours demonstrated by pairwise countries are calculated as shown in Figure 4.3. Types III and IV are separately shown in Figure 4.4.

Figure 4.3 shows that from 1970-71 to 2000-01 (except a few periods) blue line is above the dashed line which indicates that Type I behaviour is dominant during this period. This implies that, overall, the percentage of pairs of countries diverging without switching is higher perhaps because relatively high-income advanced countries are growing at a faster rate to diverge their growth paths away from the low-income countries. This finding supports Webber and White's (2009) finding of 'strong divergence' than 'strong convergence' during 1960-2000.

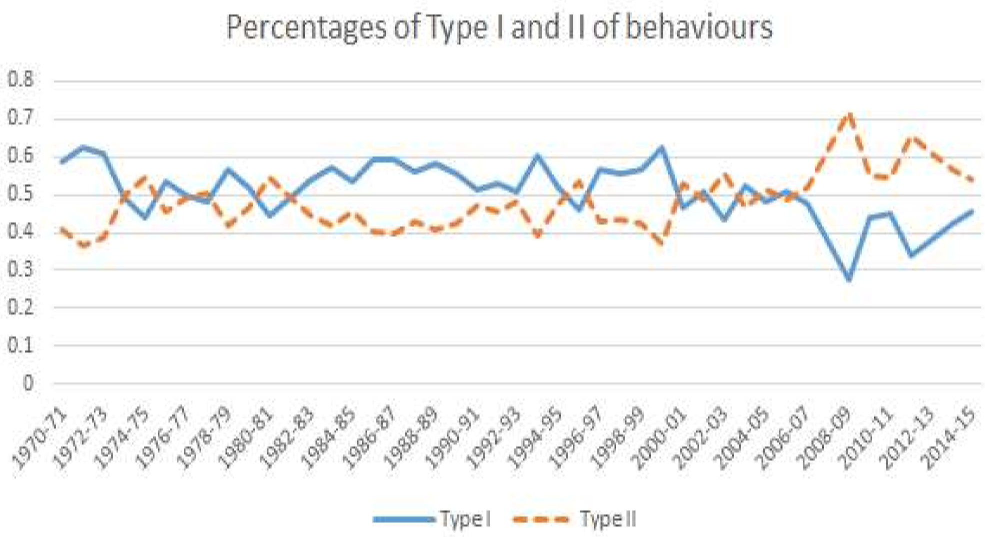


Figure 4. 3: Types of behaviours exhibited by 109 countries—Type I: divergence without switching; Type II: convergence without switching; Type III: convergence with switching; Type IV: divergence with switching.

The period from the early to mid-2000s seems to have alternate years of dominant convergence and divergence. Overall the converging pairs of countries are marginally greater than the diverging pairs. This is the period when many countries reaped the benefits of plans implemented during the 1990s, such as trade liberalisation. Thereafter, from the mid-2000s to 2015, the countries showing signs of convergence among themselves as the dashed line is above the blue line after the mid-2000s. The findings of convergence after 2000 are also supported by the sigma and gamma convergence as shown in Figure 4.2. This is the period of caching-up of developing countries with advanced economies. The income disparity seems to be reducing from 2000 onwards.

The trends indicate a significant increase and decrease in the mobility behaviour of countries, even though the aggregate frequency of switching behaviour is lower as shown in Figure 4.4. The highest mobility is recorded for the year 1989-90, with 52 instances of Type III behaviour. Some of the countries showing the switching phenomenon through Type IV behaviour during the period 2012-15 are China, Zimbabwe, Mexico, and Ireland. Looking at the per capita GDP of these countries in Table 4.5, they have shown big changes in income in subsequent years which could help them exchange places with other countries. Overall, low instances of Type III and IV behaviours suggest that countries have maintained their relative positions and there is very little evidence of change in positions.

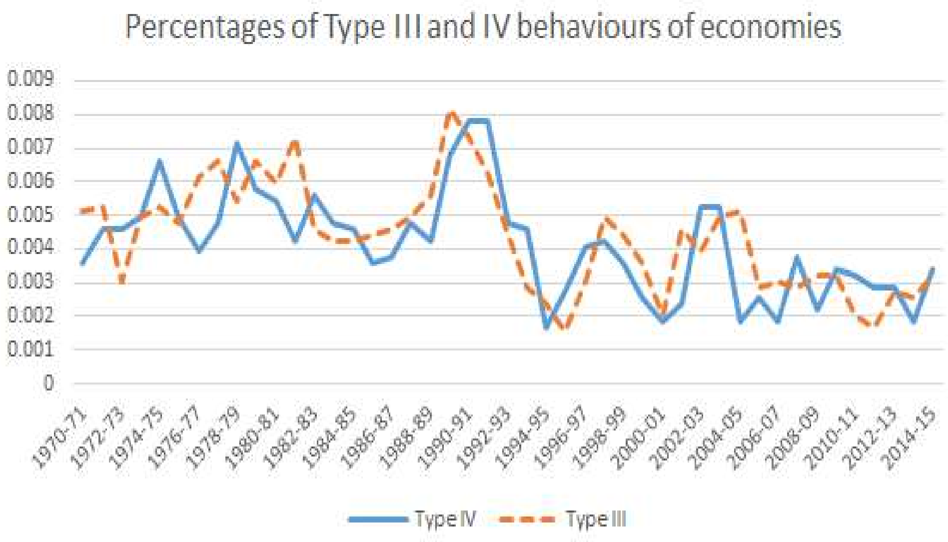


Figure 4. 4: Types of behaviours exhibited by 109 countries—Type III: convergence with switching; Type IV: divergence with switching.

Table 4. 5: GDP per capita for selected countries

Country	2012	2013	2014	2015
Zimbabwe	913.5306	942.0387	939.7803	933.5033
China	5336.06	5721.694	6108.239	6496.624
Mexico	9414.906	9409.965	9492.991	9615.312
Ireland	49851.02	50542.41	54527.29	68030.85

4.5 Discussions

The first objective of this chapter was to compare the findings of three measures of convergence (beta, sigma, and gamma) with the findings of X-convergence. The comparison of findings obtained from the four techniques used in this chapter asserts the inconsistencies in findings highlighted in the existing literature. It is evident from the findings that beta convergence estimates show a negative relationship between initial income and the subsequent growth rate, suggesting an eventual decline in income inequality. However, the sigma convergence showed little change in dispersion in 1970 and 2015 suggesting the persistence of the gap between countries. The dispersion increased significantly from 1980 to 2000 and declined afterwards. This suggests an increase in the income disparity between1980-2000 and a reduction in the disparity thereafter. Gamma convergence findings are generally used in conjunction with the sigma convergence to validate the findings of beta convergence. Hence, combining the findings of sigma and gamma convergence indicate a converging trend only for the 1970-80 and 2000-10 periods when both sigma and gamma are downward sloping. The joint findings corroborate beta convergence results during the two convergence periods of 1970-80 and 2000-10. For the rest of the period, the three convergence measures reveal inconclusive results.

The second objective of the chapter was to validate the benefits of the X-convergence technique. In this regard, the findings from the X-convergence technique provide a dominant trend of Type I behaviour i.e., diverging pairs during 1980-2000. This implies that the world income disparity has increased during this period. This is in line with the findings of Webber and White (2009) that found the prevalence of 'strong divergence' during this period. This finding is also supported by Pritchett (1997) that found a divergence in income per capita across countries during 1870-1990.

Rodrik (2011) highlights that in addition to a few Asian Tigers that grew by leaps and bounds, many Latin American and African countries started to close the gap with advanced countries during the 1990s. To get more insights on this, Table 4.5 demonstrates the behaviour of a selected few countries from the 1990s and shows their convergence trend.

Table 4.6 shows that China and Japan have mostly demonstrated convergence (more than 50%) with the rest of the 108 countries during the 1990s and 2000s. However, Brazil, Mexico and Ghana have demonstrated lower percentages of converging pairs with the rest during the 1990s. This implies that these countries are growing at a slower rate compared to relatively high-income countries. In addition, Table 4.5 highlights that Brazil, Mexico, and Ghana (being a part of Latin American and African countries) may not have started converging with the rest from 1990 as suggested by Rodrik (2011) and Sala-i-Martin (2006). This finding seems to partially support the findings of low evidence of convergence during the 1990s.

Table 4. 6: Selected countries showing percentages of Type II behaviour of convergence without switching from 1991-92 to 2014-15

	China	Brazil	Mexico	Ghana	Japan	US
1991--92	0.759	0.565	0.509	***0.463***	0.537	***0.417***
1992-93	0.750	***0.481***	0.500	***0.481***	0.583	***0.463***
1993-94	0.731	***0.407***	***0.361***	***0.324***	0.639	***0.370***
1994-95	0.731	***0.472***	0.611	***0.380***	***0.481***	0.630
1995-96	0.731	0.611	0.537	***0.417***	***0.481***	***0.491***
1996-97	0.685	***0.481***	***0.398***	***0.333***	0.778	***0.417***
1997-98	0.667	0.574	***0.352***	***0.491***	0.796	***0.352***
1998-99	0.630	0.546	***0.444***	***0.472***	0.657	***0.315***
1999-00	0.639	***0.333***	***0.343***	***0.296***	0.500	***0.444***
2000-01	0.657	0.500	0.583	0.602	0.602	0.657
2001-02	0.657	0.500	0.574	0.528	0.648	0.583
2002-03	0.648	0.657	0.667	0.620	0.611	0.556
2003-04	0.620	***0.417***	0.528	***0.417***	0.611	0.546
2004-05	0.602	0.620	0.574	0.537	0.639	0.565
2005-06	0.593	0.593	0.546	***0.463***	0.722	0.722
2006-07	0.593	0.537	0.574	***0.370***	0.704	0.778
2007-08	0.565	0.537	0.694	0.741	0.796	0.833
2008-09	0.565	0.731	0.639	0.750	0.870	0.741
2009-10	0.528	***0.463***	0.556	0.611	***0.398***	0.731
2010-11	**0.491**	0.556	0.528	0.759	0.722	0.685
2011-12	0.556	0.722	0.676	0.704	0.639	0.639
2012-13	0.509	0.630	0.685	0.731	0.565	0.704
2013-14	***0.481***	0.657	0.611	0.556	0.713	***0.463***
2014-15	***0.481***	0.639	0.583	0.500	0.583	***0.435***

** If the percentages of converging pairs exhibited by the countries are less than 50%, then it is highlighted in bold and italics.*

There are many studies that found conditional convergence instead of divergence during the 1970s and 1980s. For instance, Evans and Karras (1996) analysed 54 countries and found strong evidence of conditional convergence from 1950-1990 which also confirmed the findings of Barro (1991) and MRW (1992). Similarly, Sala-i-Martin (2006) found that the convergence effect of Asian countries offset the divergence effect of African countries during the 1980s and 1990s, which concluded to have a dominant trend on convergence during these periods.

Furthermore, the X-convergence findings indicate that during the 2000-2015 period the divergence trend has reversed. The overall instances of Type II behaviour of converging pairs of countries are more frequent than the Type I behaviour of diverging pairs, suggesting a declining income disparity among countries. There are not many studies that show the convergence trend for world economies or countries across the globe from the late 2000 onwards. The focus of studies shifted to the within country analysis such as López-Bazo (2017) who studied European growth convergence, and Andersson et al., (2013) who studied Chinese provincial growth convergence. In this regard, Sanso-Navarro et al. (2020) underlined that the easy availability of regional data and advancement of convergence measuring techniques prompted researchers to investigate the within country data rather than between countries data.

To provide insights on reasons behind convergence from 2000, developing countries have seen significant improvements in the conduct of monetary and fiscal policies through improvement in price stability and debt sustainability (Dervis, 2012). They opened for international trade and capital flows. They became more integrated into global markets which allowed for the faster spread of ideas and knowledge diffusion (Acemoglu et al., 2002). In addition, these countries were better governed than previously, which helped to restore stability in the economy. Many economists highlighted that the quality of institutions is a major determinant for economic growth (Mukand and Rodrik, 2005; Acemoglu et al., 2019; Henisz, 2000).

The year 2002-2007 experienced faster growth for the developing countries due to investments coming from the developed countries and catching up seemed inevitable (Nabli, 2011). The aim to achieve United Nations Millennium Development Goals (MDGs) seem optimistic in many developing countries. However, the global financial shock of 2008 slowed the growth experience for many countries. Ocampo et al. (2012) stated that the financial shock was severe for middle-income economies but it was for a short period. In addition to the massive bailout packages, these countries adopted the policies that assisted them to come out of the shock. Dependence on agricultural exports more than the manufacturing exports helped many low-income countries come out of the shock quickly. Another trend that has been underlined during this period for the emerging countries was the south-south cooperation in terms of FDI flows, trade, skill transfer, merger deals, etc. (Dutt, 2013). The development banks in countries such as Brazil and China invested in new opportunities across Southern developing economies. The FDI outflows from BRICS increased from 7 billion dollars in 2000 to 126 billion in 2012 (OECD Development Co-operation Report, 2014). Therefore, it seems that South-South cooperation has played a key role in mitigating the effect of the 2007/08 global crisis.

With regards to the mobility, findings related to the evidence of switching by analysing Type III and IV behaviours suggest that China, Zimbabwe, Mexico, Ireland, etc. are the countries that showed high evidence of switching during 2012-15. This could be related to their changing behaviours with other countries due to changes in their rate of change in income. The relatively low instances of Type III and IV suggest that the positions of relatively high-income and low-income countries are the same.

To conclude, the overall findings based on X-convergence provide better insights on the convergence trend and individual behaviour of countries. The comparison of individual country behaviour is easy to interpret and provides information on mobility behaviour. The findings suggest that convergence started from the 2000s instead of the 1990s, contrary to the existing literature.

4.6 Conclusion

This chapter provided an overview of per capita income convergence trends for 109 countries from the period 1970-2015. The chapter validates the benefits of X-convergence by comparing the findings of beta, sigma, and gamma indicators with X-convergence techniques and adds to the existing debate on the inconsistency in findings in the literature. The beta, sigma, and gamma measures show conclusive convergence trends for the 1970-1980 and 2000-2010 periods but provide inconclusive trends for 1980-2000. Employing the X-convergence measure indicates a dominant diverging trend during the 1980-2000 period and demonstrates the dominance of Type I behaviour. This indicates an increase in income disparities among world countries during that period. From 2000 onwards, Type II behaviours predominate between countries, suggesting convergence without switching. The high instances of converging pairs indicate relatively low-income countries are growing faster than the relatively high-income countries and hence reducing the gap between them.

The existing literature in the domain suggests that the world economies started to converge from the 1990s. However, this chapter suggests that countries demonstrated high instances of divergence during the 1990s and the convergence between relatively low-income and relatively high-income countries actually started in the 2000s. Analysing the Type III and IV behaviours, countries demonstrated these behaviours throughout the analysis period but the instances were low. Thus, there is less change in the positions of relatively high and low-income countries.

As the findings of this study are based on a mix of countries, the convergence trend can be skewed depending on the ratio of high or low-income countries. For example, if the sample contains a high number of low-income countries then the convergence instances could increase as they tend to grow faster. Therefore, to address this issue, the next chapter will use China as a case example and use a technique to group similar regions and then perform within and between-group analysis.

CHAPTER 5 CHINA

5.1 Introduction

The focus of this chapter is to examine within-country regional inequality in China as against the between country assessment that was conducted in the last Chapter. The last Chapter emphasised the importance of taking account of heterogeneity between regions. Regional income heterogeneity has a significant impact on the assessment of patterns of regional growth paths convergence and divergence. The heterogeneity has also been referred to in the literature as the nonlinear relationship between initial income and subsequent growth rates of regions or multiple regimes of growth paths followed by regions. The varying growth paths followed by regions give rise to club/cluster formation based on the similarity of certain characteristics of regions. Therefore, studies have shown that the assessment of members of clubs is required to take account of heterogeneity among regions.

China is a country that comes across as a fast-growing economy, however, at the same time, cripple by the presence of differences between coastal and inland regions. The coastal provinces have been more open to the rest of the world through seaport and merchant trading. These provinces initiated a regime of modernisation through the presence of foreign powers, colonial penetration, etc. (Lemoine et al., 2014). Coastal regions have modern textile and food industries, commerce, banks, etc. and, therefore, they were more developed than inland China. Reportedly, the gap between provinces' per capita output was very high during the 1990s.

Realising the increasing income gap between rich eastern (coastal) and poor western (inland) provinces, the government initiated a series of "go west" policies to encourage investment in the inland regions. The government tried to bridge the gap among provinces through policies and administration and enhance regional integration. However, every effort to strengthen regional growth has been overcast by local politics, bureaucracy, and chaos (Li and Wu, 2012). Moreover, the widely researched groups of high-income coastal and low-income inland provinces provide a base for group dynamics assessment which is an important part of the thesis. The widening gap between provinces necessitates the study of the investigation of the evolution of convergence and divergence between the groups of rich and poor provinces. Therefore, to take account of heterogeneity among regions in China, the analysis of group dynamics is important.

The group dynamics provide important insights on what is happening within as well as between groups of regions. The between-group convergence behaviour is important to assess the persistence in regional income inequality between the groups of regions. If the evidence of exchanging rank order positions is limited between pairwise group members, then there seems to be the persistence of income inequality between groups. With regards to the within-group analysis, it reveals important insights on how the group members behave with each other, whether they are converging and becoming similar or they demonstrate inequality through divergence. In addition, the within-group analysis provides an understanding of the behaviour of the richest of the rich and the poorest of the poor regions. If the within group members are converging towards each other, then this implies that the richest and the poorest regions are gradually becoming similar. However, the divergence within a group could indicate that the poorest of the poor regions are not growing fast enough to catch up with the rich regions. Therefore, the convergence of regions within and between groups is required for the prevalence of regional equality.

Literature has shown evidence of analysing the between-group behaviours but the within-group analysis has been ignored in most of the regional studies. To have a comprehensive understanding of regional inequality it is important to unveil the convergence behaviour of members within groups. It has been established that regional convergence stimulates economic activities that could work on intra-regional income distributions that could promote greater regional equality (Tam and Persky, 1982; Peacock et al., 1988). In the case of China, the wide income gap between provinces makes it a relevant subject to understand the within-group data analysis for identifying the behaviour of the richest of the rich and the poorest of the poor provinces. The identification of convergence behaviour of members within-group has not been explored much in the literature. This highlights a gap in the literature. For the identification of groups of provinces in China, Nagin's (2005) grouping algorithm called grouped based trajectory modelling will be used. The details of the group based modelling are provided in Chapter 3, section 3.4.

In addition to the gap related to group dynamics, the literature also lacks studies exploring the mobility dynamics of provinces in China. Mobility dynamics has been studied in terms of social mobility for individuals moving from one social stratum to another based on their income, education, health and nutrition, among others (Cheong and Wu, 2018; Chen and Cowell, 2017; Cowell and Flachaire, 2018; Khor and Pencavel, 2011; Corak, 2013). Similarly, economic mobility measured by changing rank order positions has important implications for the assessment of regional income inequality within the income distribution. The analysis of relative behaviours of regions also necessitates an understanding of regional growth mobility (Wu et al., 2019). The mobility dynamics of regions have been widely understood with the help of the transition matrix in the literature (Gluschenko, 2012). However, the dynamic income distribution and increasing inequality between and within groups of provinces in China require a comprehensive and detailed understanding of regional income mobility dynamics.

The ability to easily employ, interpret, and compare the findings of X-convergence will help to address this problem (Novotný, 2011). The understanding of the evolution of convergence patterns of pairwise provinces will provide insights on the mobility behaviour in terms of overtaking, stagnating, and lagging behind provinces with respect to their peers. The convergence patterns between and within high-and low-income groups will reveal an understanding of persistence within groups and stagnation in rank order positions of any particular province. Therefore, the X-convergence estimates have the potential to reveal many interesting insights on the regional dynamics in China for the detailed assessment of regional inequality.

This chapter employs the X-convergence technique to analyse convergence trends in per capita GDP for 31 provinces in China from 1993 to 2016. The chapter will also apply the standard measures of unconditional beta convergence, sigma, and gamma convergence to investigate the convergence process. However, it has been highlighted in earlier chapters that these indicators provide summary statistics for the evolution of the distribution and are incapable of providing details on mobility dynamics. Therefore, the X-convergence technique will also be employed to shed more insights on the evolution of per capita income convergence and regional mobility dynamics in order to provide an in-depth comprehensive study of provincial income inequality.

The chapter contributes to the literature by providing empirical evidence on Chinese regional income convergence, inequality, and mobility dynamics by employing the X-convergence method. The unit of analysis is province. The group-based trajectory model is applied to identify groups of relatively high-income and low-income provinces in order to provide an in-depth understanding of the evolution of convergence of income per capita within and between groups. The estimation of mobility dynamics within the Chinese distribution would fill the literature gap of assessing the dynamic and increasingly unequal distribution. The identification of relatively stagnating and lagging behind provinces has the potential to help policymakers allocate resources and funds to struggling regions to mitigate regional income inequality and promote sustained balanced growth.

The chapter is organised in following sections: section 5.2 provides background on provincial inequality in China; 5.3 provides information on data; section 5.4 discusses findings of different measures of convergence used; section 5.5 discusses the mechanism and literature behind the prominent findings of this chapter; and section 5.6 concludes the chapter.

5.2 Background

One of the sustainable development goals of the United Nations is to promote balanced growth within a nation[1]. Rising inequality poses a threat to the long-term sustainable growth of a country through economic, social, and political risks (Kanbur and Lustig, 2000). Based on primary household survey data, the inequality among individuals is measured by the Gini coefficient for every country by the World Bank. The World Bank has set an inequality Gini Coefficient benchmark of 0.40 which demonstrates severe inequality. The 2017 Gini coefficient stood at 0.47 for China, which was much higher than the World Bank's acceptable benchmark. Jain-Chandra et al. (2018) employ China Household Income Project (CHIP) data and highlights that severe inequality in educational opportunities and access to financial services to the common man are prominent reasons behind income inequality. The World Bank report mentioned that in 2010 tertiary education was unequally distributed based on differences in geographical units and individual wages. Moreover, on the aspect of financial inclusions in terms of borrowing and other transaction services, in 2014 only 10 percent of the Chinese population borrowed from financial institutions and only 17 percent used bank accounts for receiving wages, which is very low compared to many other emerging countries.

[1] https://www.un.org/development/desa/dspd/2030agenda-sdgs.html

The high inequality among Chinese individuals is also reflected in the geographical inequality across China. The divide between rich and poor provinces in China can be illustrated with the gap between the richest and poorest provinces. In 2016, the highest income was for Beijing at 118,198 yuan/person and the lowest was for Gansu at 27,643 yuan/person (see Figure 5.1). In 2016, out of the 10 top income provinces, 8 were coastal. The divide between coastal and inland provinces are studied by many researchers (Tian et al., 2016; Yang et al., 2016). For instance, Tian et al. (2016) used Philip and Sul (2007) method to identify clubs of 31 provinces using GDP per capita data from 1978 to 2013. The study identified two clubs including Shanghai, Tianjin, Jiangsu, Zhejiang, Guangdong, Shandong, Fujian (eastern coastal provinces), and Inner Mongolia converge into a high-income club, and the remaining provinces converge into a low-income club.

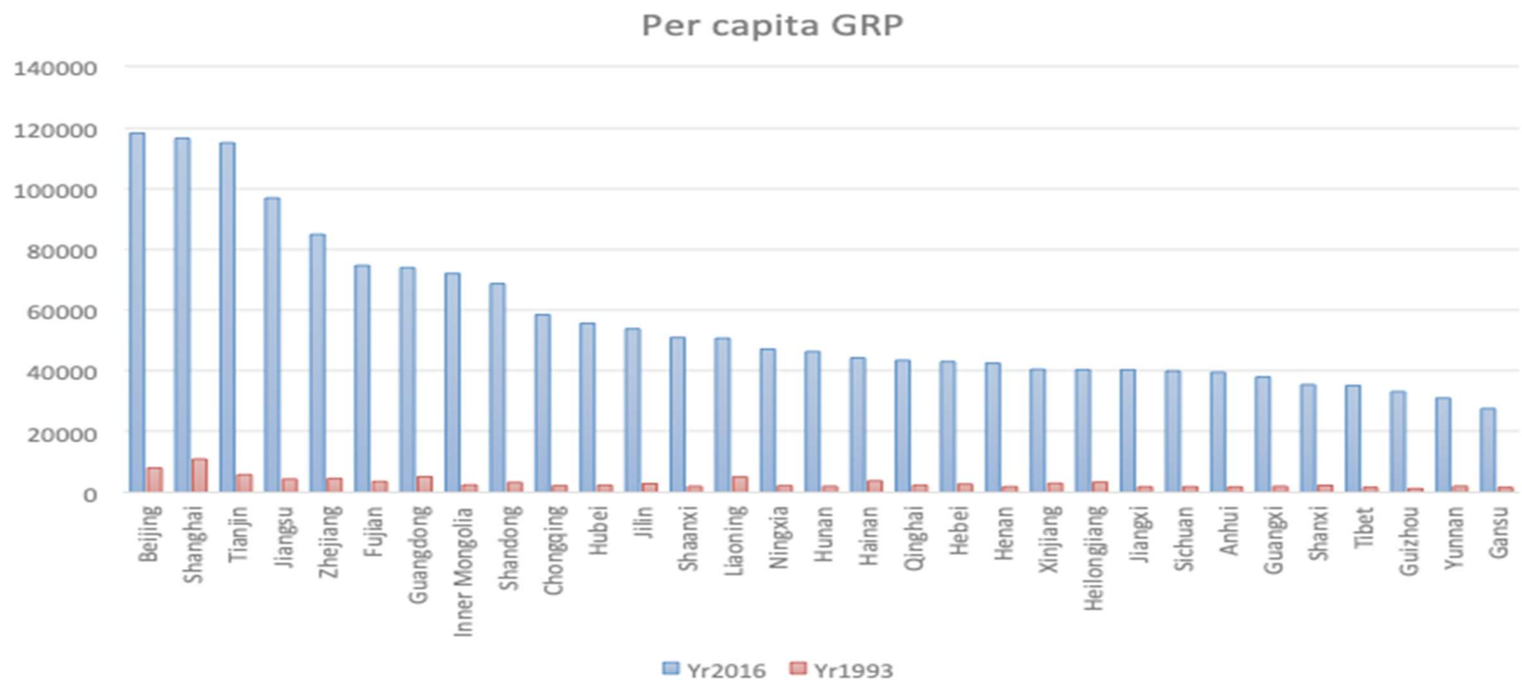


Figure 5. 1: GRP per capita of 31 provinces in 1993 and 2016

Source: National Bureau of Statistics China

Considering the economic background, China had been a centrally planned economy with lots of state-owned enterprises and the economy was growing at a relatively meagre 2-3 percent per annum until 1970. During the 1970s, the Chinese economy almost stagnated. In addition, the death of the Communist leader Chairman Mao in 1976, led to widespread dissatisfaction on economic growth and inequality in China. As a result, from 1978 a lot of reforms were introduced in China to ease trade and exports, flows of investments, land use, setting up of private businesses, etc. Owing to the reforms, the economy experienced a boost during the 1980s and coastal areas having location advantages grew at a very high speed due to increased trade, investments, and exports. Moreover, the reforms of 1978 marked the beginning of fiscal and economic decentralisation in China. Due to decentralisation, autonomous power was delegated to regional local governments and they were incentivised to stimulate economic growth (Lin and Liu, 2000; Yang, 2002; Jian et al., 1996). Decentralisation helped China grow, however, it promoted competition among economies to become rich (Li and Haynes, 2011). Government fund transfers directed to poor regions were easily manipulated by the rich provincial and municipal governments (Li and Wu, 2012). Therefore, the economic divide between coastal and inland provinces appear to be the result of the unprecedented growth of coastal provinces, partially due to the nature of government policies and programmes designed to achieve further economic growth.

Trends on regional inequality reveal that China has been showing evidence of conditional convergence, after controlling for factors such as physical and human capital, investment, employment, etc. (Cai et al., 2002; Weeks and Yao, 2003; Chen and Fleisher, 1996; Raiser, 1998; Zhang et al., 2001; Tian et al., 2010). According to the conditional convergence hypothesis of neoclassical theory, economies experience conditional convergence depending on the similarity of their structural characteristics such as preferences, technologies, and savings rate (Galor, 1996; Islam, 2003). Chen and

Fleisher (1996) using beta and sigma convergence provided the evidence of conditional convergence among 25 Chinese provinces between 1978 and 1993 by controlling for coastal location, physical and human capital, employment growth, and foreign direct investment. However, at the same time, evidence of unconditional (absolute) convergence has been provided by Gundlach (1997) by employing beta and sigma convergence for regional income per worker in 29 provinces from 1978 to 1989. Please note that unconditional (absolute) convergence suggest that convergence between capital rich and poor economies occurs because capital poor economies experience higher growth over time than capital rich economies due to factor mobility and factor price equalisation.

Exploring the reasons behind the coastal and inland regional inequality, Jian et al. (1996) observed that the convergence from 1978 was the result of rural areas of coastal provinces growing faster and not the rural areas of inland provinces. Later, Raiser (1998) further investigated the convergence phenomena of Chinese provinces from 1978 to 1992 and found a weakening of convergence from 1985 mainly because the rich coastal areas were growing at a faster rate due to redirection of capital towards rich coastal provinces rather than poor inland regions. Simialrly, Liu et al. (2004) investigated the provincial income for the period from 1980 to 2001 and using the Gini Coefficient found increasing regional disparity from the 1990s. Increasing regional disparity during the 1990s is in line with studies such as Cai et al. (2002), Demurger et al. (2002), Lu and Wang (2002), and Wu (2002).

Realising the increasing income gap between provinces, the government started to implement “go west” strategies for the development of western/inland regions—Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Ningxia, Xinjiang, Inner Mongolia, Guangxi, and Qinghai (Singh, 2002; Goodman and Edmonds, 2004; Lin and Chen, 2004). The government started to implement policies to make regions conducive to foreign investments by investing in infrastructure, educational facilities, reskilling labours, etc. (Lemoine et al., 2014; The State Council, 2016). These initiatives started to show signs of improvement for regional inequality and inequality reversed during the second half of the 2000s when inland provinces started to converge with the coastal provinces. Sun (2013) using the coefficient of variation, Gini and Theil index showed declining interprovincial inequality around 2005.

The reduction in regional inequality was reflected in the reduction of household inequality as well. In 2010 China became the first developing country to achieve the World Bank's Millennium Development Goals (MDGs) before the target year. However, research shows that the absolute income gap has reduced but the relative gap still needed attention (Wang et al., 2020; Yu et al., 2019). For instance, Jain-Chandra et al., (2018) outlined that a moderate decline in the Gini coefficient from 2008 has been driven by a decline in the income share of the top 20 and gains in the middle of the income distribution, instead of an increase in the income share of the bottom group. Therefore, it appears that an improvement in the middle-class segment led to a reduction in income inequality rather than the poor class. This inference is also applicable to the most backward regions that still need support to show growth improvements (Ma and Summers, 2009; The Economist, 2019).

It has been argued that China has experienced a deceleration in its growth rate since 2011 (Zhang, 2017). The average growth rate declined from around 10.4 percent in 2010 to 6.7 percent in 2016 with a risk of further deceleration (Tian, 2019). Moreover, China experienced a surge in non-financial debt after the global crisis from 134 percent of GDP in 2008 to 257 percent in 2018 (Zhu et al., 2019). The declining growth and increasing debt raise questions on the sustainability of economic growth in China. Tian (2019) underlined imbalance in governance structure in terms of the gap between decision making at the centre and implementation at local levels. The study further argued that the imbalances have resulted in unbalanced and unsustainable growth in China. To promote balanced and sustainable development, Yang (2016) suggested the “rise of Central China” plan was important to establish the link between rich eastern and poor western regions.

To conclude, the literature on the evolution of regional convergence and inequality in China suggest that the government's focus on increasing economic growth for the country led the coastal provinces to grow at a faster speed than the inland ones after the policy reforms of 1978. The rich coastal provinces’ growth paths started to diverge from the poor inland provinces’ paths and regional inequality was at its peak during the 1990s. The government realised the consequences of increasing inequality and introduced a series of “go west” policies during the early 2000s for the development of poor western/inland provinces. The literature suggests that regional inequality started showing signs of improvement from the mid-2000s. The chapter is going to investigate the evolution of regional convergence and inequality trends for 31 provinces from 1993 to 2016.

5.3 Data

Per capita Gross Regional Product data (yuan/person) was obtained for 31 provinces from 1993 to 2016 from the National Bureau of Statistics China. Even though there have been lots of changes during the 1970s and the 1980s in terms of opening up to help the fast growth of Chinese economy, the analysis period starts from 1993 because of two reasons. First, during the 1990s the widening gap between rich and poor provinces was highlighted by researchers and the government started to impose policy changes to help the poor inland provinces grow at a reasonable rate. During the 2000s government imposed “Go-West” policies to invest in the poor western provinces. Hence the analysis period starting from 1993 will provide an overview of widening disparity and the impact of "Go-West" policy changes. The second reason to use data from 1993 is the non-availability of structured provincial data prior to 1993. Therefore, the time period justifies the aim to evaluate the evolution of regional convergence and disparity issues as the literature suggests that the mid-1990s experienced a widening gap between the growth paths of rich and poor provinces in China.

For different measures of convergence—beta, sigma, gamma and X-convergence, data on regional per capita output has been used to calculate the convergence patterns between 1993 and 2016. The group-based trajectory analysis also uses per capita GRP data to identify the groups of high and low-income provinces in order to conduct an assessment of within-and between-group convergence empirics.

5.4 Findings

To show some basic characteristics of per capita Gross Regional Product (GRP), Table 5.1 provides the descriptive statistics for four periods—1993, 2000, 2007 and 2016. The mean per capita GRP is increasing thereby revealing an increase in the average income of provinces in China. The standard deviation is continuously increasing since 1993 indicating that the values are spreading out from the mean. Figure 5.2 shows the minimum and maximum values for per capita GRP over these years. The minimum value depicts the minimum per capita GRP for the low-income provinces such as Guizhou, Gansu, Yunnan, etc. Whereas, the maximum value depicts the maximum per capita GRP for the respective years. Shanghai was the richest province until 2011 and, thereafter, Beijing secured the top position. The maximum value reflects Shanghai's per capita GRP in 1993, 2000, and 2007 and Beijing's in 2016. The minimum and maximum values have an increasing trend showing increasing incomes for low and high-income provinces, however, the big difference between the two values indicates a large income differential between the richest and the poorest provinces over the years.

Examination of the difference between the minimum and maximum values in 1993 and 2016 reveals a disproportionate share of income between rich and poor provinces. Comparison between two provinces in terms of absolute income differential becomes less appropriate in a situation where high differences between provincial income per capita exist. Thus, the comparison of income in relative ratios become significant in the case of China because there is a big gap between the richest and the poorest province.

Table 5. 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
1993	31	3211.871	2077.605	1234	11061
2000	31	8520.129	5938.547	2759	29671
2007	31	22189.81	13672.5	7878	62041
2016	31	56766.23	25721.24	27643	118198

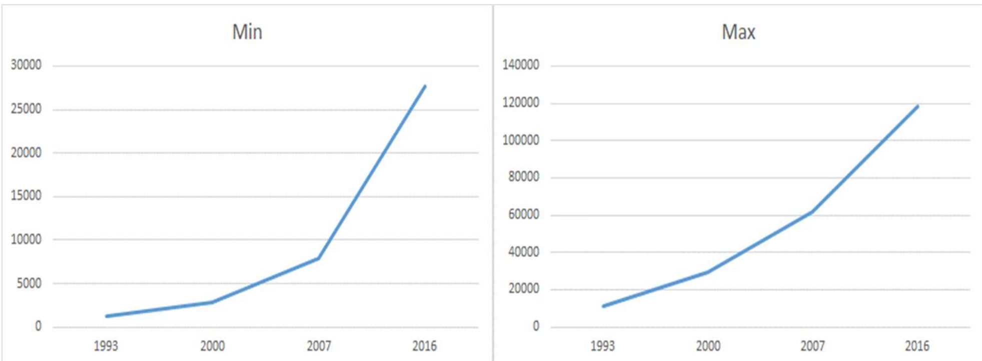


Figure 5. 2: Minimum and maximum per capita GRP values trend

5.41 Beta, sigma, and gamma convergence

This chapter applies the absolute beta convergence growth regression equation to identify whether the absolute/unconditional convergence among provinces is happening as predicted by the neoclassical hypothesis of convergence. Absolute convergence does not take into consideration the conditional variables like labour, capital and education that could affect the convergence process. The study uses a simple form of the equation to determine the absolute beta convergence for the 23-year period from 1993 to 2016. The model looks like below:

$$(1/T)\log(\frac{y_{it+T}}{y_{it}}) = \alpha + (-\beta)\log(y_{it}) + \epsilon_{it} \qquad (11)$$

Where, T is the total time period from 1993 to 2016 which is equal to 23 years

Dependent variable income growth = constant + βlngdp1993 + error

And the application of this model to the data gives;

Dependent variable income growth = 0.32311 + (-0.02069) lngdp1993 + error

(0.02206*) (0.00231*)

*Standard error in parenthesis. The *p-value* is 0 indicating highly significant coefficients.

The negative sign on the beta coefficient indicates that there is evidence of convergence among the 31 provinces from 1993 to 2016. The presence of absolute beta convergence indicates the dependence of growth on the initial level of income per capita. Hence, the result satisfies the conditions for convergence in income per capita. As emphasised in the literature, the beta coefficient figure provides the behaviour of an average country to give a generalised result. Therefore, in general, the capital-poor countries are growing at a faster rate to catch-up with the richer countries as suggested by the neoclassical hypothesis of convergence.

Because of the criticism that beta convergence received, Islam (2003) stated that beta could be considered only a necessary pre-condition for convergence. Therefore, sigma convergence is employed to validate the findings.

For sigma convergence, the chapter analyses the coefficient of variation (CV) for the period 1993 to 2016, where lower CV values depict sigma convergence. An increase in the CV value indicates increased dispersion in per capita income, which in turn suggest increased inequality within the income distribution.

CV = Standard deviation/Mean

For the gamma convergence estimate, the chapter applies Boyle and McCarthy's (1997, 1999) variation in the rank of countries based on GRP per capita, such that:

$$\gamma = \frac{Variance(RGDP_T + RGDP_t)}{Variance(RGDP_t\ X\ 2)} \tag{12}$$

Where variance (RGRP) is the corresponding variance of the ranks of per capita GRP. The rank of per capita GRP in each year is compared with the rank in base time *t* (1993). A gamma convergence indicator (γ) value close to zero (0) would depict high mobility and value close to one (1) would depict low mobility within the income distribution.

Figure 5.3 shows the trend of sigma and gamma convergence taking 1993 as the base year. The downward slope depicts convergence and an upward slope depicts divergence.

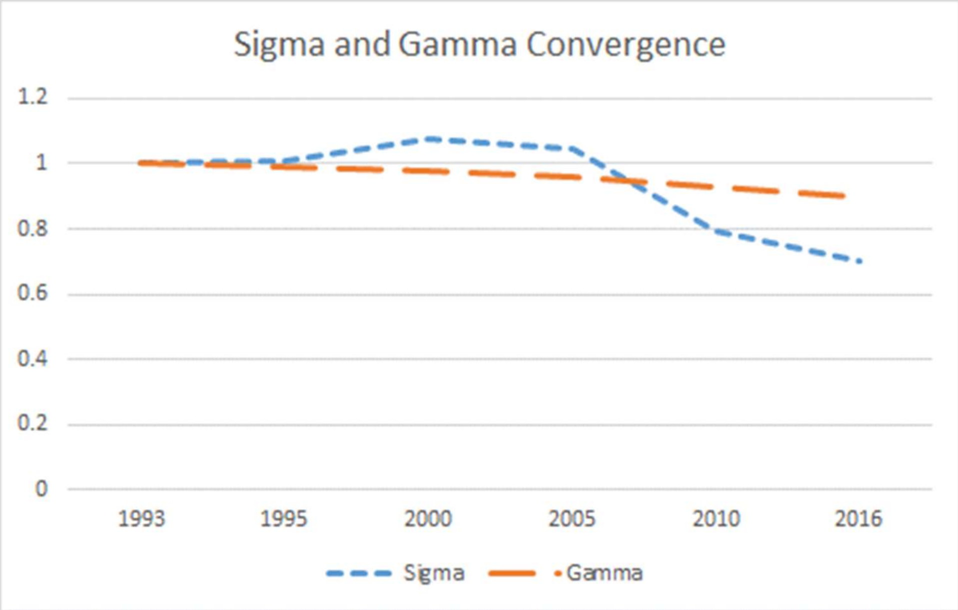


Figure 5. 3: Sigma and gamma convergence 1993-2016

The sigma convergence indicator in 2016 is a lower value than the corresponding 1993 values which indicates a narrowing of dispersion of income over time. The sigma and gamma convergence indicators are trended downwards after 2000 indicating convergence. The beta convergence estimates indicate limited mobility between provinces as the value is close to 1. Combining beta, sigma, and gamma convergence findings indicate the prevalence of convergence in per capita income in China from 2000. This finding is supported in the literature by many researchers citing that the convergence between high-and low-income provinces started in the mid-2000s in China (Lu and Deng, 2011; Fan and Sun, 2008; Liao and Wei, 2016).

To validate the findings revealed by standard measures of convergence and get a comprehensive picture of the convergence trend, the next section will apply the X-convergence technique to 31 provinces from 1993-2016. For the evaluation of the disparity among rich and poor provinces in China, the chapter identifies two groups of provinces with the help of group-based trajectory model.

5.42 X-convergence

This section discusses the findings obtained by employing the X-convergence technique. It starts by investigating the aggregate trend on convergence among 31 provinces to compare the findings with those revealed by beta- sigma, and gamma convergence indicators. To shed more light on the income disparities within and between relatively high-income and low-income provinces, groups analysis will be conducted and X-convergence within and between groups will be estimated.

<u>Whole sample: Aggregate provincial convergence trend</u>

Figure 5.4 shows the percentage occurrence of convergence and divergence in relative ratios for 31 provinces compared in pairs. Between 1993-2005, barring a few exceptions, Type I behaviour is predominant throughout. This finding suggests that high percentages of pairs of provinces demonstrated divergence without switching (blue line is above the orange line). This could mean two things, first, that high-income provinces are growing at a very fast speed and diverging away, secondly, low-income province is growing at a very slow rate creating a gap with their counterparts. In the case of Chinese provinces, the rich coastal provinces were growing at faster rates during the 1990s and diverging away with the rest as demonstrated below in Table 5.2. Table 5.2 shows that during 1993-2003, except for the year 1995-96, all the 10 coastal provinces were demonstrating higher percentages of Type I behaviour with the rest of the provinces. This underlines an increase in provincial income disparity led by higher growth rates experienced by relatively high-income provinces during the 1990s. On the other hand, Table 5.3 shows the Type I and II behaviour demonstrated by 21 inland provinces with the rest of the 31 provinces. It shows higher instances of Type II behaviour which is convergence without switching with others. The low-income inland provinces have attained higher growth to converge with the rest as explained by the neoclassical convergence hypothesis.

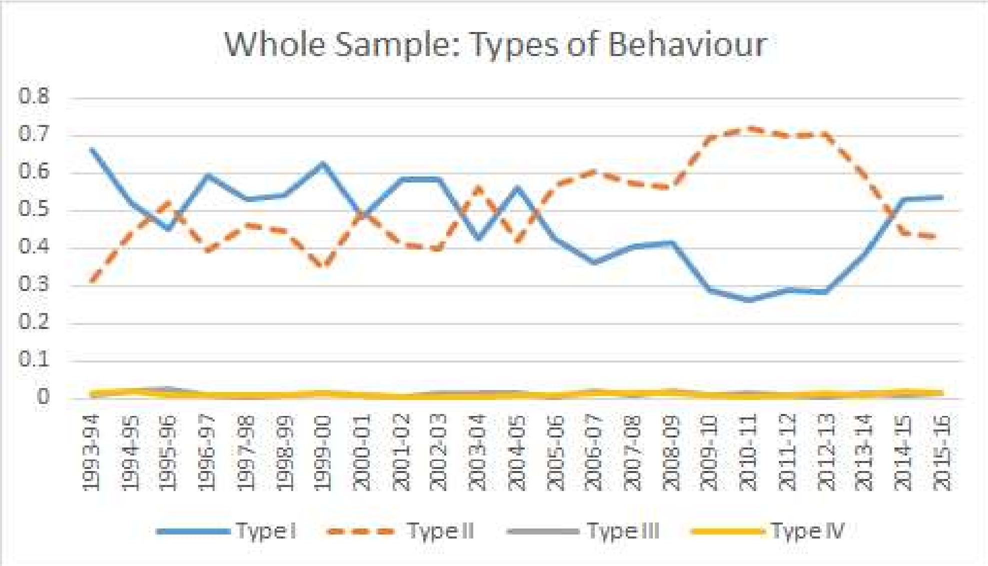


Figure 5. 4: Percentage of instances of types of behaviour exhibited by provinces. Type I = Divergence without switching, Type II = Convergence without switching, Type III = Convergence with switching, Type IV = Divergence with switching.

Table 5. 2: Percentages of Type I and II behaviour demonstrated by 10 coastal provinces with the rest during 1993-2007

	Type I	Type II
1993-94	0.657	0.330
1994-95	0.537	0.440
1995-96	0.447	0.550
1996-97	0.610	0.373
1997-98	0.640	0.360
1998-99	0.693	0.307
1999-00	0.617	0.383
2000-01	0.550	0.443
2001-02	0.647	0.353
2002-03	0.580	0.413
2003-04	0.447	0.540
2004-05	0.467	0.510
2005-06	0.387	0.610
2006-07	0.263	0.723

Table 5. 3: Percentages of Type I and II behaviour demonstrated by 21 inland provinces with the rest during 2005-2013

	Type I	Type II
2005-06	0.444	0.544
2006-07	0.408	0.551
2007-08	0.478	0.494
2008-09	0.468	0.489
2009-10	0.341	0.635
2010-11	0.332	0.654
2011-12	0.324	0.662
2012-13	0.281	0.702

The findings of the prevalence of divergence during the 1990s and convergence during the mid-2000s are supported by the literature (Lu and Deng, 2011; Fan and Sun, 2008; Liao and Wei, 2016). These findings also confirm the outcomes of standard measures of convergence that reveal a prevalence of convergence during 2000s. The trend seems to reverse from 2014-15 when the instances of divergence have surpassed the instances of convergence. This indicates a slowdown in the economy for the inland provinces; for instance, Gansu experienced an increase in GRP per capita from 26433 to 27643 yuan/person in 2014 and 2016. Similarly, Guangxi experienced an increase in per capita income from 33090 to 38027 yuan/person only. On the other hand, Beijing and Shanghai experienced increases in income from 99995 to 118198 and from 97370 to 11652, respectively.

Examining the Type III and Type IV behaviour in Figure 5.5, the proportion of pairs of provinces switching is very low compared to those without switching. The highest switching behaviour is observed for Type IV behaviour which is divergence with switching for the period 2014-15. Provinces have switched places at 10 instances. Provinces that changed positions mostly are Xinjiang, Anhui, Jiangxi, Fujian, Hainan, Shanxi, Liaoning, Guangdong, Heilongjiang, Yunnan, Guizhou, Hebei, Hunan, and Qinghai. Most of these provinces are low-income inland provinces. The low instances of Type III and IV behaviours for the high-income coastal provinces indicate that they are mostly permanently placed in their rank positions. The evidence suggests that there is a persistence in the income groups of the provinces.

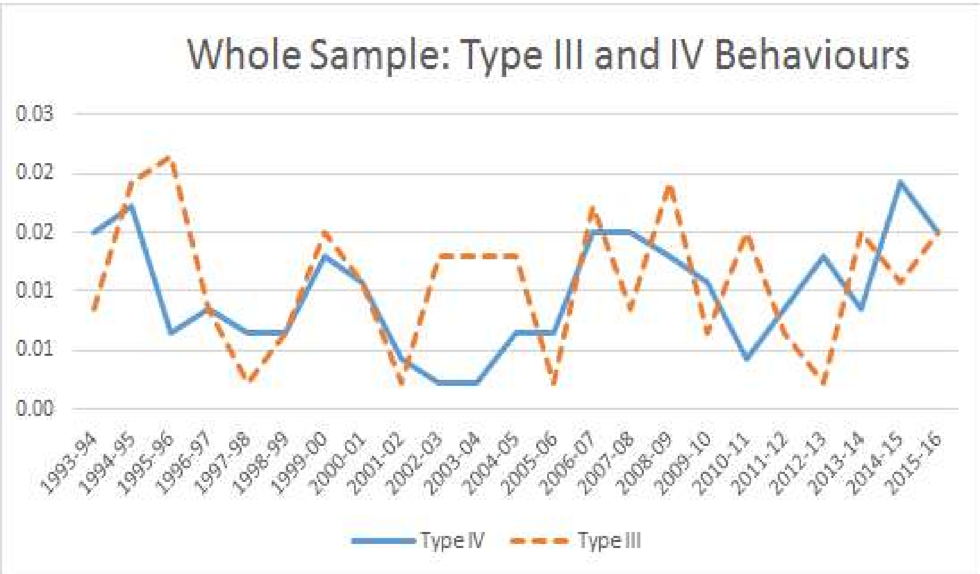


Figure 5. 5: Percentage of instances of types of behaviour exhibited by provinces. Type III = Convergence with switching, Type IV = Divergence with switching.

Combining the findings of all four measures of convergence employed in the study, absolute beta convergence indicates catching-up of low-income regions throughout the period. Sigma and gamma convergence indicates the prevalence of convergence after 2000 which also validates the occurrence of absolute beta convergence. However, the X-convergence technique suggests the prevalence of higher instances of convergence from the mid-2000s and not before. Due to these inconsistent findings in identifying convergence patterns and to shed more light on provincial income disparities, this study conducts group analysis. The next section identifies the groups of high- and low-income provinces and then analyse the change in regional dynamics within and between groups to understand their mobility behaviours.

Group analysis

Two groups of provinces were identified using Nagin's (2005) group based trajectory modelling approach. The trial and error showed that the BIC is highest at -2172.79 for two groups with linear growth paths for group members. The other deciding factor is the p-value for every parameter. Table 5.4 shows a significant p-value for every parameter. The group membership for the first group indicates that there is 32.25 percent of total provinces lie in group 1. This turns out to be 10 provinces (0.3225X31 provinces) in group 1. Similarly, there are 21 provinces (0.6774X31 provinces) in group 2. Table 5.4 provides a list of provinces in group 1 and group 2.

The high-income group consists of 10 provinces and the low-income group consists of 21 provinces as shown in Table 5.4. The high-income group consists of eight coastal provinces in addition to Inner Mongolia and Liaoning. Liaoning relies on the steel industry and had a higher income per capita than Inner Mongolia in 1993 but Inner Mongolia surpassed Liaoning's income per capita in 2007. Inner Mongolia, rich in rare earth mineral resources, has experienced sustained and stable flourishing in regional industries including dairy, clean energy, processing, and rare earth industry. The increasing regional investment in fixed assets with sustained regional industries helped Inner Mongolia show significant improvement in economic growth. The growth supports Inner Mongolia to surpass some coastal provinces' output growth.

Table 5. 4: Names of high-income and low-income provinces

Group	Parameter	Estimate	Prob > |T|
1	Intercept	1.8419	0
	Linear	0.00001	0
2	Intercept	1.87837	0
	Linear	0.00003	0
Group	membership		
1	(%)	32.25811	0.0001
2	(%)	67.74189	0

Beijing	1
Tianjin	1
Inner Mongolia	1
Liaoning	1
Shanghai	1
Jiangsu	1
Zhejiang	1
Fujian	1
Shandong	1
Guangdong	1
Hebei	2
Shanxi	2
Jilin	2
Heilongjiang	2
Anhui	2
Jiangxi	2
Henan	2
Hubei	2
Hunan	2
Guangxi	2
Hainan	2
Chongqing	2
Sichuan	2
Guizhou	2
Yunnan	2
Tibet	2
Shaanxi	2
Gansu	2
Qinghai	2
Ningxia	2
Xinjiang	2

Between high-income and low-income provinces

The between group analysis of high and low-income groups as shown in Figure 5.6 reveals that the percentage of instances of Type I behaviour was higher during the 1990s than in the 2000s and Type II behaviour was higher after the mid-2000s. The finding suggests that the low-income provinces were growing at a faster rate than the richer provinces from 2005 and catching up with the high-income provinces. This is consistent with the literature that reveals that inequality reduced after the mid-2000s (Fan and Sun, 2008).

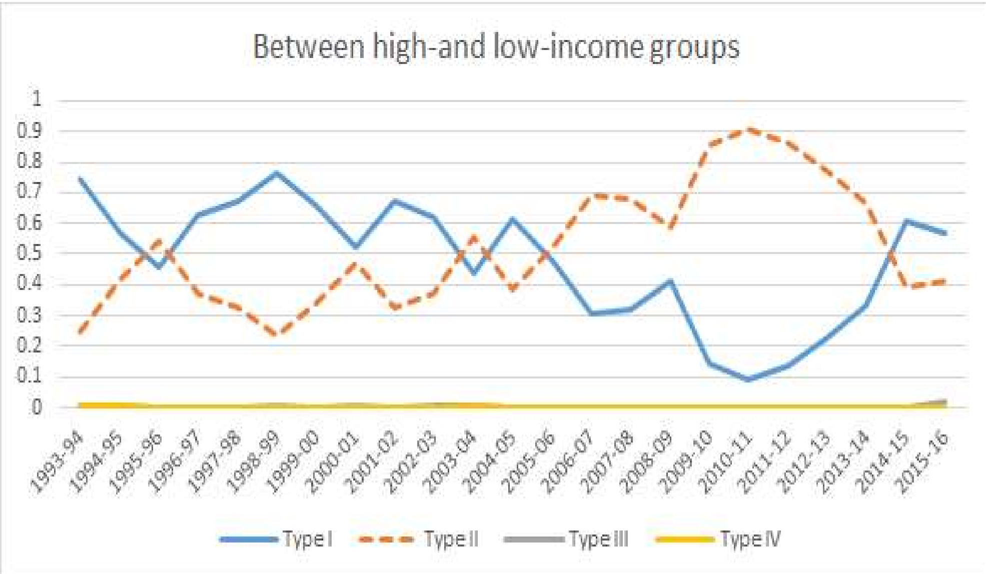


Figure 5. 6: Percentage of instances of types of behaviour exhibited by provinces. Type I = Divergence without switching, Type II = Convergence without switching, Type III = Convergence with switching, Type IV = Divergence with switching.

The instances of switching places as shown by Type III and IV behaviours between high-income provinces and low-income provinces during 2000-2016 are shown in Table 5.5:

Table 5. 5: High-income provinces switching rank order positions with low-income provinces during 1993-2016

Coastal province	**Switching places with inland provinces**
Beijing	No Switch
Shanghai	No Switch
Tianjin	No Switch
Jiangsu	No Switch
Zhejiang	No Switch
Fujian	No Switch
Shandong	No Switch
Guangdong	No Switch
Liaoning	No Switch
Inner Mongolia	Jilin, Xinjiang, Heilongjiang, Hubei

Table 5.5 suggests that except Inner Mongolia, no other high-income province has changed positions with any low-income province. Instead, there is evidence of stratification and persistence between high-income and low-income provinces. In other words, the rich provinces were still rich and the poor were still poor throughout the period of analysis.

<u>Within high-income group</u>

As shown in Figure 5.7, the high-income provinces show higher instances of Type II behaviour of convergence within themselves roughly from 2002 to 2014.

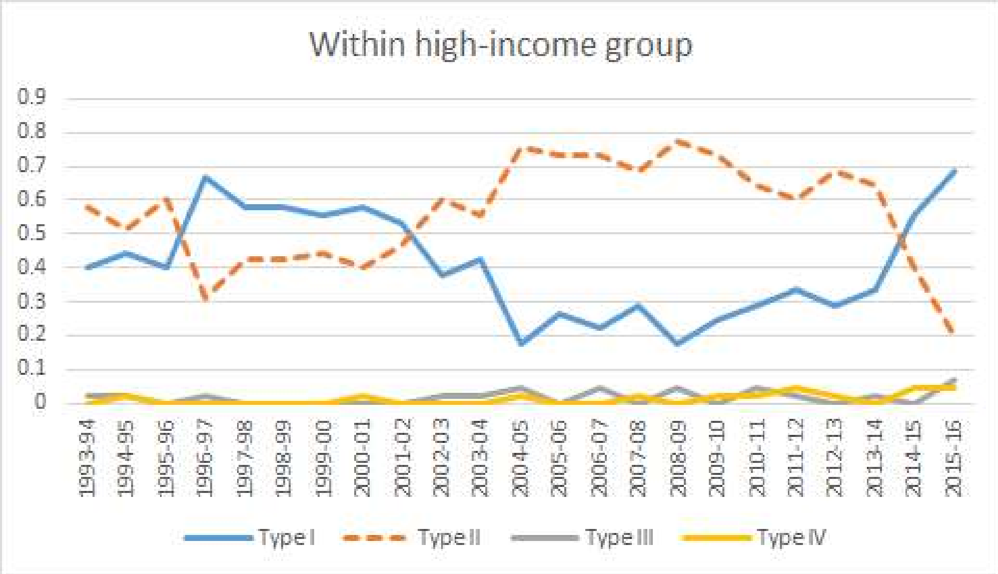


Figure 5. 7: Percentage of instances of types of behaviour exhibited by provinces. Type I = Divergence without switching, Type II = Convergence without switching, Type III = Convergence with switching, Type IV = Divergence with switching.

The prevalence of convergence is evident for a greater number of years than divergence for high-income provinces (1993-1996 and 2003-2014) indicating a decline in inequality among these provinces. Coastal provinces are mostly converging with each other which is in line with the literature (Fujita and Hu, 2001; Démurger et al., 2002; Jian et al., 1996). The preferential government policies and transfers, and industrial agglomeration have helped coastal areas to integrate into the international economy (Raiser, 1998). These factors, to a large extent, helped coastal provinces to converge their growth paths with each other.

For the nation as a whole convergence trend shown in Figure 5.4 and within coastal provinces shown in Figure 5.7, the percentage of Type I behaviour is surpassing the Type II behaviour from 2014. This indicates the phase of income disparity starting to come back during these years.

In terms of mobility, Figure 5.8 suggests limited evidence of Type III and Type IV behaviour exhibited by provinces. Consequently, the rank order positions of provinces have not altered very much thereby indicating persistence within the rich group with the top three rich positions taken by Beijing, Shanghai, and Tianjin throughout.

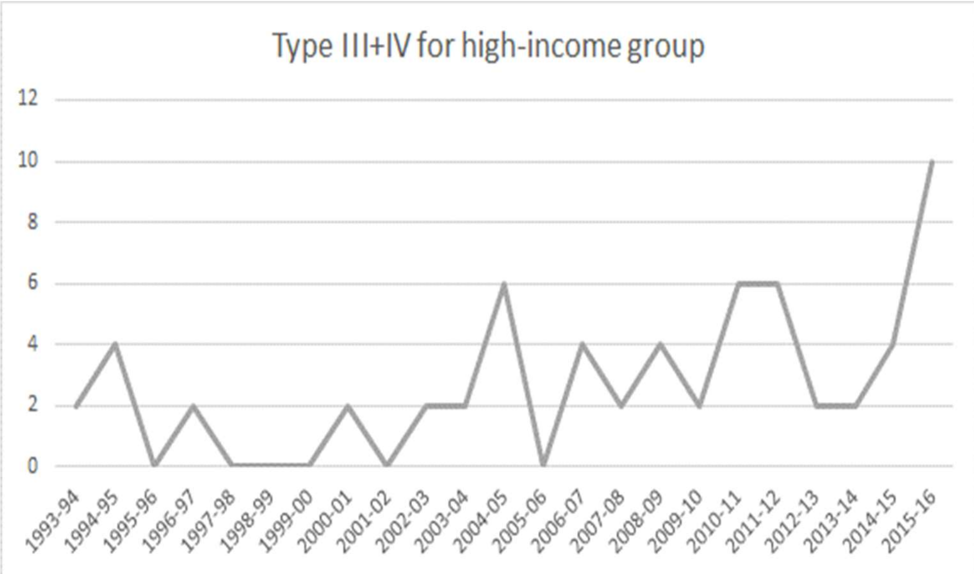


Figure 5. 8: Frequency of Type III and IV behaviours within high-income group during 1993-2016

The frequencies of Type III and IV behaviours are very low for within high-income provinces. One pair (2 instances) in 1993-94 and five pairs (10 instances) in 2015-16 have shown switching behaviour. This implies that the switching of places is very low within high-income provinces.

Within low-income group

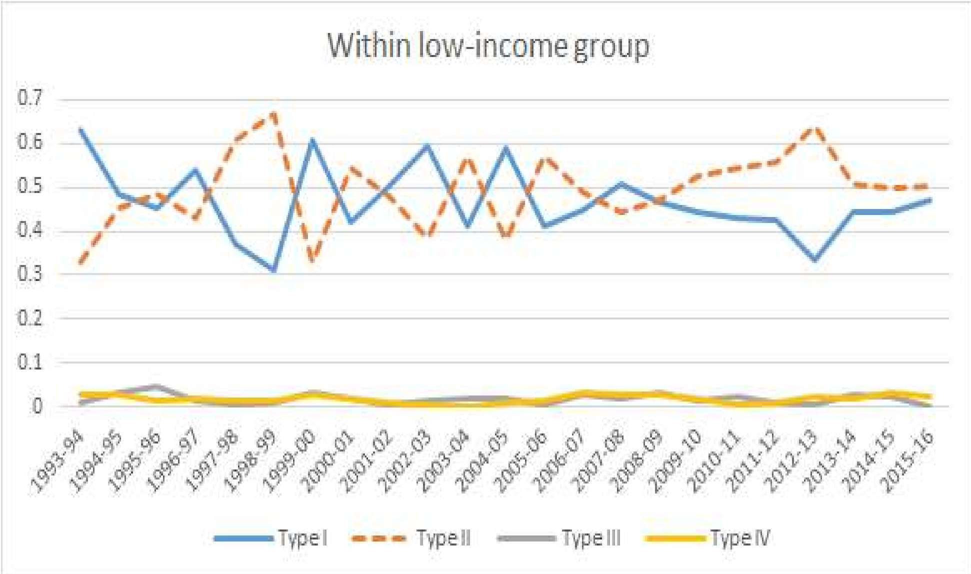


Figure 5. 9: Percentage of instances of types of behaviour exhibited by provinces. Type I = Divergence without switching, Type II = Convergence without switching, Type III = Convergence with switching, Type IV = Divergence with switching.

The within low-income provincial convergence/divergence pattern is very different from what is shown in Figure 5.4 for the whole sample. As shown in figure 5.8, until 2009 the patterns of convergence/divergence for low-income inland provinces are irregular and after 2009 there is a presence of higher instances of Type II behaviour of convergence without switching. Thus, the presence of convergence for the whole sample (Figure 5.4) after 2005 is mostly driven by high-income provinces' higher instances of convergence (figure 5.7) and not inland provinces. This indicates that the reduction in disparity among provinces in China after 2005 is mostly due to a reduction in disparity within high-income provinces and not low-income provinces.

The divergence within inland provinces poses higher risks for already poor inland regions because it could be the case that the poorest of the poor regions did not receive much attention to evolve and perform better which led to a widening of the gap between rich and poor provinces. This seems to have gone unnoticed as literature only talks about the declining disparity between rich coastal and poor inland provinces from the mid-2000s. Between2000 and 2008, the low-income provinces mostly show higher instances of divergence which indicate that some of the poorest of the poor regions have not performed well in terms of economic growth.

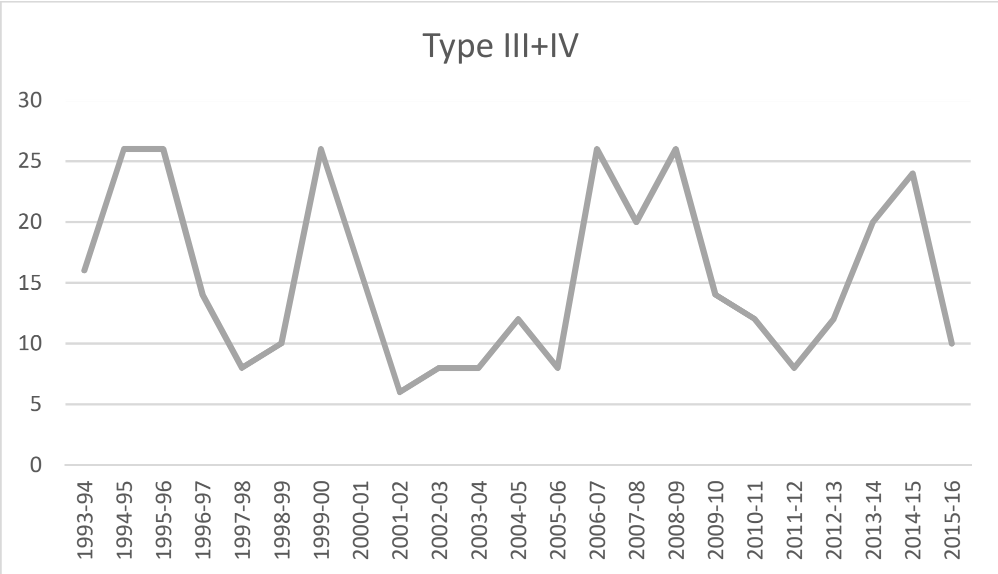


Figure 5. 10: Frequency of Type III and IV behaviours within low-income group during 1993-2016

In the light of mobility dynamics, there has been a reasonable amount of switching places between the low-income provinces. This indicates that low-income provinces are showing attributes of intra-distributional mobility. Type III, which is convergence with switching indicates relatively high-income regions lag behind the relatively low-income region within the distribution. Type IV, which is divergence with switching, indicates some relatively low-income regions overtaking some relatively high-income regions within the distribution. Delving deeper into identifying the provinces that have demonstrated these two types of behaviour would indicate which region is lagging behind and which one is overtaking within the distribution. To shed more insights on identifying provinces lagging behind and overtaking, Table 5.6 provides details on the name of provinces that have shown Type III and IV behaviours between 2004-05 and 2015-16. This period was chosen because during this period the whole sample analysis shows the prevalence of convergence. The names of the province that are repeated during one time period indicate that the province has changed places two times with two different provinces. For example, Henan in 2004-05, showed Type III behaviour with two different provinces.

Table 5. 6: Names of provinces changing rank order positions within group.

2004-05	Type III	Guangxi, Hainan, Chongqing, Anhui, Henan
	Type IV	Tibet, Ningxia, Jiangxi, Hunan
2005-06	Type III	Qinghai, Shaanxi
	Type IV	Henan, Hubei, Chongqing, Hainan, Tibet, Sichuan
2006-07	Type III	Xinjiang, Chongqing, Shaanxi, Ningxia, Henan, Hubei, Gansu, Hainan, Yunnan
	Type IV	Jilin, Heilongjiang, Henan, Hubei, Shaanxi, Ningxia, Tibet, Chongqing, Hainan, Guangxi, Hunan
2007-08	Type III	Shaanxi, Ningxia, Xinjiang, Qinghai, Henan, Hunan, Hubei
	Type IV	Jilin, Hebei, Tibet, Hainan, Hunan, Qinghai, Xinjiang, Gansu, Anhui, Yunnan, Hainan, Chongqing
2008-09	Type III	Hubei, Shaanxi, Ningxia, Hubei, Chongqing, Sichuan, Shaanxi, Heilongjiang, Xinjiang, Heilongjiang, Jiangxi, Shaanxi, Hunan
	Type IV	Chongqing, Guangxi, Xinjiang, Qinghai, Anhui, Shaanxi, Xinjiang, Hunan, Henan, Ningxia
2009-10	Type III	Shaanxi, Xinjiang, Heilongjiang, Hunan, Henan
	Type IV	Sichuan, Hunan, Chongqing, Henan, Hubei, Jiangxi, Gansu, Yunnan
2010-11	Type III	Hubei, Chongqing, Ningxia, Hainan, Hebei, Hubei , Henan, Heilongjiang
	Type IV	Qinghai, Henan
2011-12	Type III	Xinjiang, Gansu, Yunnan, Shaanxi
	Type IV	Shaanxi, Sichuan, Jiangxi, Hebei
2012-13	Type III	Hainan, Shanxi
	Type IV	Ningxia, Hunan, Qinghai, Jiangxi, Anhui, Shaanxi, Shanxi, Hubei, Hebei
2013-14	Type III	Hunan, Xinjiang, Sichuan, Qinghai, Shaanxi, Shanxi, Hubei, Hebei, Gansu, Guizhou, Heilongjiang
	Type IV	Henan, Hunan, Xinjiang, Jiangxi, Anhui, Shanxi, Heilongjiang
2014-15	Type III	Hainan, Xinjiang, Guangxi, Chongqing, Shanxi, Hebei, Xinjiang, Jilin, Hebei, Hainan
	Type IV	Qinghai, Anhui, Jiangxi, Hainan, Shanxi, Shaanxi, Xinjiang, Heilongjiang, Yunnan, Guizhou, Hebei, Xinjiang, Hunan, Qinghai
2015-16	Type III	No evidence
	Type IV	Henan, Hubei, Sichuan, Heilongjiang, Xinjiang, Jilin, Qinghai, Jiangxi, Hainan

Table 5.6 indicates that recently, between 2013-14 and 2014-15, Hebei has shown Type III behaviour indicating that it has lagged behind some provinces during these years. Based on the occurrence of a high number of provinces during 2012-16, the study did a detailed analysis on these a few provinces to identify which provinces lagged behind and overtook based on the instances of Type III and IV behaviours.

Hebei lagged behind Hainan from 2014 and Hunan from 2014.

Shanxi overtook Henan in 2012 but lagged behind Henan since 2014. Anhui, Guangxi, Sichuan, and Jiangxi overtook Shanxi from 2015. Hunan overtook Shanxi from 2013. Therefore, comparing these five provinces, Shanxi has lagged behind all of these provinces—Henan, Anhui, Jiangxi, Guangxi, Sichuan, and Hunan in 2015. Thus, comprehensive details on lagging behind and stagnating regions is a strength of the X-convergence estimates.

5.5 Discussion

5.51 Convergence of per capita income

The chapter employed a range of convergence measures to understand the evolution of convergence among 31 provinces in China from 1993-2016. These measures provided mixed outcomes for the prevalence of convergence. For instance, the beta-convergence indicator found that convergence was a predominant phenomenon for 31 provinces during the analysed period. Sigma and gamma convergence indicators show that the process of divergence since 1993 reversed to convergence after 2000. In addition, to add to the controversy of the prevalence of convergence, the X-convergence technique suggests that instances of convergence increased more after 2005 compared to the 1990s. Owing to the mixed findings, the study performed a comprehensive analysis by comparing the economic growth of provinces within and between high-income and low-income groups separately to understand the provincial income inequality.

One important trend that became prominent after the implementation of 1978 reforms and reforms during the 1980s was an increase in the polarisation of income between coastal provinces and inland provinces in China. Aziz and Duenwald (2001) used kernel density estimates and highlighted that provinces were stratified into a bimodal distribution during 1978-1997 with coastal provinces forming one mode and the rest of the provinces forming another, suggesting club formation of rich and poor regions. After the implementation of reforms, regional heads were given more levies to increase the income of regions which created competition among regional heads to achieve a high economic growth rate by experimenting with policies, reforms, rules, laws and so on. Competition among regions was so intense that it killed the spirit of cooperation among regions (Yang, 2002). Regional heads started to work on their own and were less concerned about regions that were slow in generating income. Moreover, government funds transfer directed to poorer regions were easily manipulated by the rich provincial and municipal governments (Li and Wu, 2012). Therefore, differences among regions appear to have been facilitated by the result of government policies and programmes that were implemented to achieve extraordinary economic growth rates. There is no doubt that China has achieved unprecedented growth rates due to these reforms, however, the reforms fuelled the inherent regional gap and increased regional disparities during the 1980s and 1990s.

Studies have explained Chinese regional inequality at various levels such as urban-rural and coastal-inland divides (Kanbur and Zhang, 1999; Zhang and Zou, 2012; Zhang et al., 2001; Knight, 2017; Tian et al., 2016). Various studies have used a number of data sources, different time periods, and a range of methodologies to draw inferences on regional growth and disparity in China. For instance, Kanbur and Zhang (1999) used a generalised entropy class of inequality and showed that the rural-urban contribution to overall inequality decreased over time, while the contribution made by the coastal-inland divide had increased manifolds. Deng et al. (2017) used kernel density estimates and found evidence of divergence of economic growth rate since 1978 between and within provinces. Chang (2002) employed the coefficient of variation and revealed that regional inequality had increased in the late 1990s but was smaller than it was in the late 1970s and early 1980s. Jian-hua et al. (2005) used the Theil index to conclude that regional economic disparities in China have existed since 1952. Therefore, studies demonstrate a variety of different findings of convergence and inequality among provinces in China.

During the 1990s, increased growth rates experienced by relatively high-income coastal provinces demonstrated by Type I behaviour in Table 5.3 annuls the existence of the neoclassical hypothesis of convergence. Divergent growth paths followed by coastal regions can be explained by the new growth theories. Under this theoretical perspective, the fast growth rate assisted capital-rich provinces to diverge away from the rest of the provinces via increasing returns to capital, innovative ideas, accumulation economies, knowledge diffusion, etc. One of the important determinants of growth that helped rich coastal areas grow faster during the 1990s is capital assets. Raiser (1998) investigated the convergence phenomena of Chinese provinces and found a slowing of convergence after 1985 mainly because the rich coastal areas were growing at a faster rate due to a redirection of capital towards rich coastal provinces rather than the poor inland regions. Since the early 1980s, government attention has been drawn to the development of infrastructure, telecommunication services and the energy sector as a part of fixed capital assets investment based on the priority investment program for priority regions (Démurger, 2001). Efforts have been made to increase road and railway networks to open up mineral-rich areas and make them easily accessible. For instance, the development of networks was intended to connect the resource-rich (coal and steel) regions of Shanxi with the rest of China. Likewise, the construction of transportation facilities was located next to coastal provinces or to strategic locations with rich mineral resources. Therefore, investment in capital assets helped coastal areas grow faster, however, at the same time widened the gap between coastal areas and the remote areas of Xinjiang and Ningxia provinces.

International trade is another determinant of growth that has helped the coastal provinces grow at faster rates (Chen and Feng, 2000; Fujita and Hu, 2001; Huang, 2013). Rodriguez-Pose and Gill (2006) observe that foreign trade has a more negative impact on developing countries than on developed countries because the share of agriculture based trade declines at a faster rate in developing countries. The study argues that the decline in the composition of the trade from agriculture to non-agriculture goods has a negative relationship with the economic equality between regions. As expected, China's policy of promotion of exports and adoption of international technology and best practices helped the country to grow at a rapid pace, however, its impact on regional equality was negative (Yao, 2006; Zhang and Zhang, 2003).

To illustrate the mechanism of the growth through trade, studies have shown that participation in international trade helped the eastern or coastal regions of China grow faster than the central and western regions through productivity and efficiency increases (Sun and Heshmati, 2010). Grossman and Helpman (1990) emphasised the process of technology diffusion and spillovers that take place due to access to many new products through trade. Exchanges of knowledge and goods reduced effort and cost of duplication of technology and research. Trade also enlarged the distribution markets of various goods and help firms increase operations on a large scale and reaped the benefits of economies of scale and scope. Furthermore, trade facilitates competition through open markets, agglomeration activities, product specialisation, etc. In China, foreign trade helped regions that were closer to the coast and helped them grow at a faster rate than the interior regions, as a result, coastal regions diverged away from inland regions. Foreign trade has increased economic disparity and competition between provinces instead of promoting cohesion and cooperation. Therefore, the explanations put forward by the new growth theories for increasing divergence and disparity among regions describes the divergence that Chinese provinces were experiencing during the 1990s.

The trend of divergence reversed during the mid-2000s (Fan and Sun, 2008). This was the period that saw increased growth rates experienced by the low-income inland provinces. Table 5.4 show the inland provinces that demonstrated Type II behaviour of convergence without switching. This phase of convergence is explained by the neoclassical hypothesis of convergence. The high growth rate is facilitated by physical and human capital accumulation. To help the inland provinces catch up with the coastal ones, China launched a strategy of “go west” in the early 2000s to promote the economic development of 12 inland provinces—Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Ningxia, Xinjiang, Inner Mongolia, Guangxi and Qinghai (Lemoine et al., 2014). The government built infrastructure, promoted educational facilities, helped to attract foreign investment, etc. to support these regions perform better. The government invested 6.35 trillion yuan on the “go west” strategy from 2000-2016 (The State Council, 2016). Efforts to promote indigenous industries in medicine and handy craft were enhanced, at the same time, the advanced manufacturing sector was developed too. As a result, the inland regions were in the best period of development. Figure 5.11 shows that between 2000 and 2005, all of the 12 provinces experienced better growth but Inner Mongolia seems to have benefited more than others by demonstrating more than a doubling in income per capita in five years.

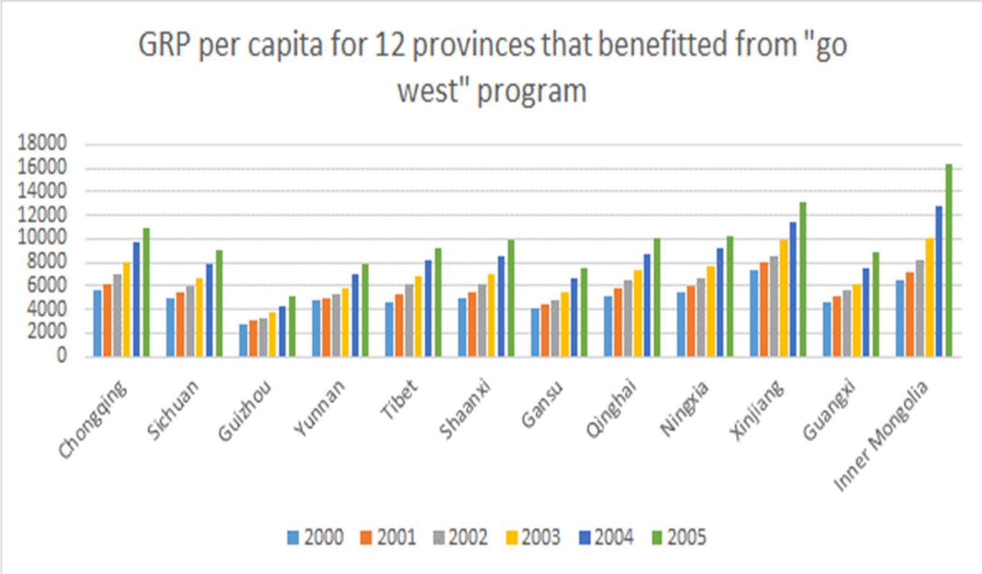


Figure 5. 11: Income per capita of 12 provinces to implement "go west" strategy during the early 2000s

The contribution of 12 inland provinces to total GDP only increased from 17 percent in 2000 to 21.2 percent in 2015 (The State Council, 2016). The controversy on the benefits of the "go west" policy was shown by Wu (2009), which shows that during 2000-2005, although the western region experienced higher growth rates in attracting foreign investments, the rate of investment was not enough to help them catch-up with the developed provinces. Perhaps a five-year time span was too short to comment on the growth and contribution of western regions to national GDP. Lu and Deng (2011) analysed a decade after the "go west" strategy implementation and conclude that the policies promoted economic development which enhanced the convergence process with the rest of China during the second half of 2000. Liao and Wei (2016) indicated that a reduction in the interprovincial disparity after 2005 was the result of both development policies for western regions as well as negative impacts of the global financial crisis on trade/export activities of coastal provinces.

Ma and Summers (2009) argue that the policy support to develop west and combat the 2008 global financial crisis assisted the western provinces to boost the economy but the challenge of developing the most backward regions of China still needed to be addressed. The lagging regions of China are very far behind the developed ones and it could take a long time to eliminate the disparity between these regions. Furthermore, it has been emphasised that China's everchanging legal system posed a risk for foreign investments in the country. According to Santander Trade Portal[2], bureaucratic and administrative complexities, lack of transparency, corruption, weak intellectual property rights protection and high employee churning are hindering investment growth within the country.

To address these concerns, the current 13th Five Year plan (2016-2020) aims to create a conducive environment for investment and improve government administrative reforms in the inland provinces. Another initiative undertaken by the Chinese government in 2013 to build connectivity with global economies is the Belt and Road Initiative (BRI). The plan was to develop ports in order to accommodate the trade traffic from Southeast Asia, East Africa, and parts of Europe. The implications and challenges of this project are still being discussed by reports like Kuo and Kommenda (2018) and Ghiasy and Zhou (2017).

Government initiatives to eradicate poverty also helped to reduce income disparity to some extent. In 2010 China became the first developing country to meet the Millennium Development Goals (MDGs) set by the World Bank by reducing the population living below the poverty line by 100 million (by half) before the 2015 target. To improve the living conditions of people living in rural areas, China invested in infrastructure and public services for building houses, providing cheap electricity and clean water, improving medical and educational services. Therefore, government initiatives helped to eradicate poverty on a large scale by facilitating economic activity. As a result, the geographical areas developed and demonstrated improved regional growth rates.

[2] https://santandertrade.com/en/portal/establish-overseas/china/foreign-investment

5.52 Persistence in high-income and low-income groups

The persistent groups of rich coastal and poor inland Chinese regions have been highlighted in the literature. This chapter contributes to the literature by empirically finding the types of behaviours demonstrated by provinces between high-income and low-income groups. Table 5.5 shows that no coastal province has ever changed ranks or switched places with any inland province during 1993-2016. Only one high-income province changed places with some low-income inland provinces, namely Inner Mongolia. Inner Mongolia follows the trajectory of high-income provinces according to the grouping technique used in the study but it is not a coastal province. So switching places with Inner Mongolia would not influence the persistence of the divide between coastal and inland provinces in China. Therefore, the tendency for rich provinces to remain rich and poor provinces to remain poor was high in China. This is explained by the literature on club convergence.

The existence of clubs consisting of rich regions located in the east and poor regions located in the western part of China has been shown by many studies (Zhang and Zou, 2012; Aziz and Duenwald, 2001; Bin, 2015). The coastal provinces have always been more open to the rest of the world through seaport and merchant trading. These provinces initiated a regime of modernisation through the presence of foreign powers, colonial penetration, etc. (Lemoine et al., 2014). Coastal regions have modern textile and food industries, commerce, banks, etc. and are, therefore, more developed than inland China. Reportedly, the gap among provinces' per capita output was very high during the 1990s.

The growth model suggests that the labour force is a very important factor for stimulating growth for developing countries like China. However, within China the mobility of labour is restricted due to the presence of the hukou system, which gives permits to people to legally reside in an urban area and to urban amenities such as housing and education is limited and expensive to those without this permit. To restrict rural labour mobility, many provinces have limited the number of hukou stamps. The highly skilled workers and investors could purchase the stamps but the option to purchase this is very limited to a vast majority of rural workers. Owing to the barrier of mobility, rural-urban migration is transitory in China and many rural workers prefer to stay in their homeland and engage in non-farming activities which is an important source of employment in rural areas (Hertel and Zhai, 2006; Lin et al., 2004).

Due to easy access to input and output markets, the importance of non-farming opportunities increased more in coastal than inland regions. The rapidly growing urban and coastal areas needed a labour force facilitated by the ease of movement of rural workers which could also help support the rural economy. However, the restrictions on labour mobility contributed to the wage differentials between regions (Whalley and Zhang, 2004). The prevalence of wage differentials is in contrast to the factor price equalisation hypothesis for driving the convergence process (as proposed by neoclassical growth models). Therefore, wage differentials contributed to the income disparity between poor and rich regions in China.

Some studies have explored the relationship between investing in human capital and infrastructure capital to promote economic growth and reduce regional inequality (Fleisher et al., 2010; Zhang and Zhuang, 2011; Ding and Knight, 2011; Whallee and Zhao, 2013; Qian and Smyth, 2008). Heckman and Yi (2012) found that to enhance growth and equality, China needs to expand access to education at all levels, reduce the mobility barrier, and expand the private sector. Fleisher et al. (2010) stated that even though government expenditure accelerated after 1999, the proportion of college graduates in the total population remained low in 2003. Realising the low government expenditure on education, Khor et al. (2016) found that China’s human capital level is low, as only 24 percent of the entire labour force has ever attended upper secondary school. Emphasis on human capital enhancement is supported by many growth models to stimulate regional growth. Thus, in addition to labour mobility restrictions, low human capital is another factor that contributes to the widening of the gap between rich and poor regions in China.

The biased nature of China's budgetary transfers to rich provinces is another significant factor that increased economic disparities between provinces. Since the procurement of funds to finance infrastructure development facilities depend on the amount of revenue generated by the local governments and the ability of local governments to negotiate with the central government, the already rich (coastal) provinces were in better positions to negotiate and procure funds from the central government. Because of easy access to informal borrowing channels, local governments did not pay much attention to project efficiency and productivity. Their confidence in a central government's bailout prompted them to repay the debt by new borrowings. Moreover, less coordination with neighbouring regions led to wasteful duplication of infrastructural facilities and inefficient use of resources (Démurger, 2001). For instance, a number of docks and airports were constructed at places close to each other because of a lack of coordinated decisions (Démurger, 2001). To show the duplication of facilities, Shi and Huang (2014) highlighted that most provinces were under-invested in infrastructure in 1997 and most western regions were over-invested in 2008.

Although the government funds were one of the factors that helped to accelerate the development of regions, Huang (2016) reported that the local government borrowing debt was largely uncontrollable. There has been criticism of the government's poorly managed investment on unproductive projects that were debt-financed (Tsui, 2011; Pan et al., 2017; Ansar et al., 2016). Many studies have highlighted the problem of lack of clear criteria to transfer funds between central and local governments that made the regional disparity worse (Kanamori, 2004; Kim, 2002; Lu and Sun, 2013). The problem of lack of criteria has led to a favourable funds transfer situation for the high-income coastal provinces that widened the gap between high- and low-income provinces and the income gap persists between the groups.

5.53 Regional income mobility within the distribution

In this chapter, regional mobility dynamics are defined to track regions' change in rank order positions based on income growth within the distribution over time. The change in rank order positions is captured by Type III and Type IV behaviours of X-convergence. Figures 5.8 and 5.10 show the mobility behaviours within high-income and low-income groups. The high-income group showed very limited switching of places with similar provinces. Compared to the high-income group, the low-income group showed a higher number of instances of switching behaviour among themselves. This could be because the low-income group has regions with a similar range of income per capita. These provinces demonstrate the ability to overtake, lag behind or stagnate within the distribution. For instance, in light of the findings, Shanxi which is a part of the low-income group lagged behind Henan, Anhui, Jiangxi, Guangxi, Sichuan, and Hunan in 2015.

The benefits of mobility dynamics have been widely acknowledged and employed in studies based on the Chinese context (Cheong and Wu, 2018). For instance, Chen and Cowell (2017) studied income and rank mobility of household income and health and nutrition. Cowell and Flachaire (2018) and Khor and Pencavel (2011) have measured the mobility in individuals status using income, social rank, etc. Jin et al., (2019) and Corak (2013) have discussed the intergenerational income mobility in China. Clément (2016) studied income mobility and inequality in rural China. Many studies assess income mobility, wealth mobility, and education mobility of individuals or households.

Regional income mobility analyses use transition matrices to assess the mobility dynamics within a distribution. For instance, Bhalla et al. (2003) showed high persistence in high-income (eastern region) and low-income groups (western region) and high mobility in the middle-income group (central region) during the pre-reform period of 1952-77 than the reform period of 1978-97. The probability of a middle-income province joining the low-income group was higher than the probability of moving to a high-income group in the pre-reform period. The persistence in high and low-income groups was more prevalent during the reform period.

Measuring regional income mobility becomes important for understanding the changing dynamics of the income distribution (Wu et al., 2019). This helps to identify regions that move slowly or stagnate for a long time. In the context of China, measuring regional income mobility has become important because the per capita income distribution is changing at a rapid pace and generating an increasing regional gap. To get more insights on the details of regions changing rank order positions could help to acquire more clarity on income disparity. Owing to the limited studies in this domain, Wu et al. (2019) highlighted the need to examine regional income mobility based on individual incomes.

The X-convergence indicator applied in this chapter addresses a gap by estimating pairwise economies change in rank order positions. The findings reveal that within the low-income group, provinces exhibit more instances of Type III and IV behaviours than the high-income group. Development of capital, labour, industries, etc. in the low-income group change the income distribution constantly and makes it necessary to understand the changing behaviour of provinces. By analysing the changing behaviour of regions in terms of mobility assessment using the X-convergence technique, it becomes easy to identify regions that are stagnating or lagging behind. Identifying these problem areas help by highlighting problem areas that require productivity attention and will help to balance regional growth disparities that China has been trying to achieve since 2000.

To conclude, the purpose of the discussion section was to support the findings generated in the chapter using the appropriate literature. The evolution of the convergence pattern reveals that income convergence started from 2008-09 for low-income provinces and demonstrates the prevalence of equality in incomes. The gap between high-and low-income groups of provinces leads to the persistence in groups throughout the analysis period. The regional income mobility is prominent within low-income provinces implying that the evidence of overtaking and lagging behind provinces is high for this group.

5.6 Conclusion

This chapter provides an overview of China's regional convergence and disparity patterns between 1993 and 2016. China's economy is growing at a fast rate but at the same time struggling to bridge the divide between rich and poor provinces. The country's bureaucratic and administrative complexities, lack of transparency, corruption, and weak intellectual property rights protection make investors sceptic to invest in the interior parts of China. These factors together with the preferential policies by the government to provide funds to provinces that are earning higher incomes contribute to the growing disparity between rich and poor provinces.

Analysing the convergence trend for the whole sample of 31 provinces, the evidence shows the presence of convergence between 2005-2014, thereby indicating a reduction in provincial inequality. Moreover, assessing the convergence trend within high-income group shows a prevalence of convergence after 2005 but only for low-income provinces and a within group pattern shows the prevalence of convergence from 2008-09. This implies that when the national disparity was reducing from 2005, some of the poor inland provinces were still struggling to catch up with the rest. In addition, the between group analysis shows less mobility between coastal and inland provinces suggesting persistence in their positions as high-income and low-income groups of provinces. This implies that the rich remain rich and the poor remain poor during the analysis period. Lastly, the study found that the regional income mobility was prominent within the low-income group provinces, i.e., this group has more evidence of stagnating, overtaking, and lagging behind other provinces. These important insights could be found only by conducting a separate study for within and between group effects with the help of X–convergence technique.

There are two limitations cited in the study. First, data inaccuracy. Even though the data set used in the study is procured from the national agency of China, it does not guarantee a credible source. It has been reported that some Chinese provinces inflated their GDP figures in the past. For instance, Liaoning inflated its gross regional product from 2011-2014 (Asian Review, 2017). Some studies highlight the issues on data quality and credibility for Chinese regions in detail (Xiao and Womack, 2014; Fischer and Fromlet, 2015). Despite data manipulation and backward corrections, reports highlight that ignoring one or two data points is still valuable to do a comparative study. From the academic research perspective, the study on regional data will make a significant contribution to the literature on regional disparity and growth. In addition, the study will motivate future researchers to seek a robust data set to challenge the existing findings.

A second limitation is the need to take account of spatial dependence. Literature suggests the use of spatial weights to assess spatial dependency and heterogeneity. This gap can be filled in future work and could help to understand the spillover effect between neighbouring provinces on output growth.

This chapter adds to both existing theory and practice. From the theoretical perspective, this study adds to the existing limited literature that emphasises the importance of analysing the changing distribution of income across economies to get a complete picture of growth and disparity. Some of the features that have not been emphasised enough in the literature are the dynamic nature of an economy's growth and consequently, changing equations with other economies. These changes have a great impact on economic growth, convergence, and disparity across economies. To assess these changes one needs to conduct a detailed comparative study on a regular time interval. This helps to detect any small change in the evolution of income distribution that could be alarming for future growth. To examine these changes, the literature suggests the need for a simultaneous assessment of regional dynamics of convergence, mobility, persistence, and stratification of economies. The simultaneous assessment will help to understand the dynamic nature of one economy's association with another. Moreover, to understand the nature of growth, it is important to examine the relationship between the dynamics of convergence/divergence with/without switching places of one economy relative to others and its own output level. The study fills an existing gap by assessing the regional dynamics of convergence and mobility together.

In terms of the practical contributions, the findings of the study could help government authorities, local and regional governments to make informed policy decisions. The implications of this study is particularly important for regional governments. The finding of low convergence or divergence within the inland provinces from the mid-2000s onwards provides information on the stagnation of the low-income regions within inland provinces. This will help in regional planning for economic cohesion.

CHAPTER 6 UNITED STATES

6.1 Introduction

The previous chapter on China presented evidence of convergence and divergence at a single geographical unit of analysis which is provinces. The analysis provided insights into the regional convergence, persistence and mobility trends for 31 provinces in China. With regards to regional inequality in China, the previous chapter underlined that the coastal vs inland inequality is persistent and the affluent provinces are either located on the coast or are rich in rare earth materials. The economy of China is constantly compared with the economy of US in many respects. For instance, the US economy is the world-leader in total GDP generation and is closely followed by China and there has been a notion that China will overtake the US GDP soon. However, Grinin et al. (2015) argued that limited resources and demographic problems would limit the Chinese economy from growing fast.

These two rival countries experience a wide gap between their respective rich and poor populations, as shown by the Gini coefficient index. Gini coefficients as per the World Bank (0.42 in 2016 for the US and 0.47 in 2017 for China) indicate high inequality within both countries. Although China’s Gini coefficient is higher than the US, a few reports show that the US has worse inequality as people with low education levels lag behind tremendously in the US (Picchi, 2017; Frank, 2017). However, Milanovic (2014) argued that Chinese inequality is worse than the US because corruption at all levels of government inhibits policy implementation that could benefit the poor. Thus, it would be interesting and insightful to compare the patterns and persistence of inequality within the two countries. It would be interesting to find if there are any similarities between the two countries with respect to regional convergence.

Furthermore, chapter 4 presented a cross-country analysis and raised questions on how a heterogeneous mix of developed and developing countries influence the convergence and divergence trends for the whole world. It was suggested that it is better to compare similar economies together in groups to find out whether they are converging to one another or not. A within-group analysis is important but between-group analysis cannot be ignored too. A between-group analysis provides insights into the gap between two groups and whether the gap is persistent or not. An assessment of within and between-group analysis will be performed in this chapter by identifying groups of US regions and then a separate within- and between-group analysis will be performed.

Many studies have found that the US regions are diverging since the 1970s and divergence was worse in the 1980s (Young et al., 2008; Yamamoto, 2007; Berr and Glaeser, 2005). For example, Drennan et al. (2004) used sigma convergence and found that divergence among the MSAs was not decreasing during the period 1969 to 2001. On the other hand, a few studies have shown that the convergence of regional growth rates has continued during the 1990s (Kane, 2001; Drennan and Lobo, 1999). For instance, using the absolute beta convergence measure, Miller and Genc (2005) found that 172 Bureau of Economic Analysis (BEA) Regions have experienced convergence in growth rates during the 1969-1997 period. There are studies that highlight the controversy over employing different methodological techniques to reveal mixed outcomes (James and Campbell, 2013; Genc et al., 2011). This chapter aims to gain a better understanding on the evolution of regional convergence by applying a pairwise comparison technique for 50 States and 383 (metropolitan statistical areas) over the 2001-2017 period.

In the US growth literature, the convergence of incomes between coastal and landlocked areas have been examined and revealed that some coastal provinces have performed better than landlocked States (Bleakley and Lin, 2012; Rappaport and Sachs, 2003). This is demonstrated in figure 6.1, which shows that in 2017, out of the richest 10 States, 8 were coastal; and out of the top 30, 15 were coastal.

However, the question arises whether the same pattern applies at the regional level of cities (metros) within the coastal and landlocked States? Are the metros that are located within the coastal States performing better in economic growth terms than those located within the landlocked States? Therefore, the study will assess the income differentials between MSAs lying within the coastal and landlocked States and reveal instances of convergence with the rest.

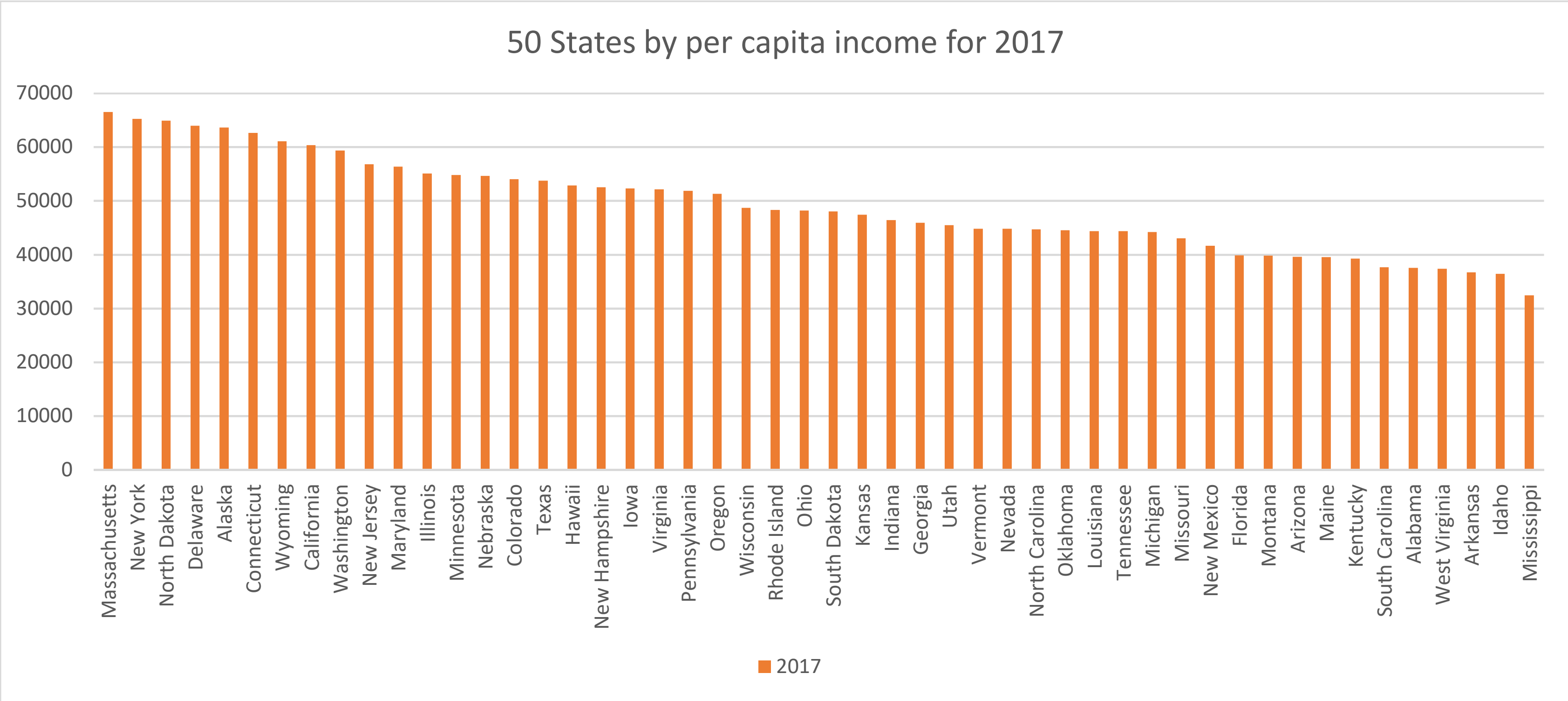


Figure 6. 1: List of 50 US States arranged in the descending order of 2017 per capita income.

A widely accepted view is that the 2008 global recession originated in the US due to the collapse of Lehman Brothers and this motivates another objective of this chapter. The focus of regional studies changed towards assessing regional resilience in the wake of this recession. The recession had a big impact on the average income of States as shown in figure 6.2. Average incomes declined drastically in 2009 and it took 4-5 years to get back to the pre-crisis levels. Some States like Mississippi, did not return to their pre-crisis levels of income per capita until 2017, which is 10 years post-crisis. On the other hand, there were States like New Hampshire that returned to their pre-crisis levels of income within two years. Thus, the impact of the recession was not the same across every region. The impacts of the recession on issues such as employment have been studied in the US literature (Thiede and Monnat, 2016; Connaughton, 2012). However, its impact on regional convergence and inequality has received relatively little attention. This chapter will, therefore, investigate the impacts of the 2008 crisis on regional convergence and inequality within and between high and low-income groups of States and MSAs in the US. The time span chosen for this study (2001-2017) provides a good span to analyse the post-crisis impacts on regional convergence and disparity.

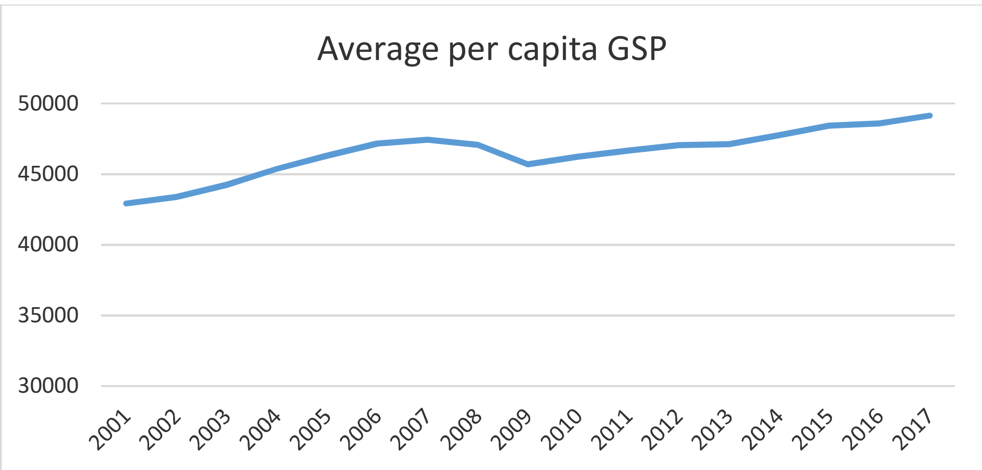


Figure 6. 2: Average per capita GDP by States during 2001-2017 Source: BEA

Therefore, the aim of this chapter is to examine the regional convergence, persistence and mobility trends for 50 US States and 383 metropolitan statistical areas (MSAs) from 2001 to 2017. Convergence will be analysed at these two levels to understand if they show similar or different patterns. The findings will help understand the persistence of inequality and identify stagnating or lagging behind economies. Moreover, one of the objectives of the chapter is to understand the differential impact of the 2008 global recession on the States and MSAs.

This chapter increases the level of complexity of the analysis by introducing two geographical hierarchies: States and metropolitan statistical areas (MSAs). The findings of this chapter reveal the predominance of divergence in income per capita at the State and MSA levels. The gap between high and low-income groups is widening and the income growth rates of the poorest of the poor States are declining. The MSAs lying within the coastal States are growing slowly and diverging away from the rest of the group members. Recessionary impacts on convergence show convergence driven by the slow growth of high-income States.

The chapter is organised in the following sections: section 6.2 highlights the mixed findings in the literature for the US; section 6.3 provides information on the source of the data and geographical levels for data analysis; section 6.4 presents the findings using different techniques; and section 6.5 presents a discussion of the results; and 6.6 provides conclusions.

6.2 Background

The convergence literature on US regions assesses key trends on the convergence of income per capita, factor prices, housing prices, etc. Various measures of convergence have been used in regional context by studies such as beta and sigma convergence, comparison of reductions in the number of percentage points over time, etc. (Pfitzner and Lang, 2014; Young et al., 2008; Caselli and Coleman II, 2001). Studies have found that the rate of convergence across states declined drastically after 1990 and until the 2008 global recession, there was no convergence among regions (Ganong and Shoag, 2017). However, studies also indicate an issue of inconsistency in findings using different techniques (Genc et al., 2011; James and Campbell, 2013). This section provides a review of the literature on the mixed outcomes of the convergence and divergence trends in the US.

Studies in the area of growth and convergence for the US have used different techniques to draw different inferences at different spatial levels for different regional clubs. Accordingly, the outcomes on the prevalence of regional growth convergence and inequality change depending on the scale, scope, and methodology adopted in the study. Regional inequality studies widely outline the causes behind inequality which lead to persistence in groups of high- and low-income regions.

Studies focussing on convergence across US regions have employed varied methodologies and revealed mixed conclusions (Miles, 2019). There are a few studies that show evidence of regional growth convergence during the 1990s. For instance, most of the studies on US convergence until the 1990s found convergence among regions. Rupasingha et al. (2002) used regional per capita income growth data from 1990-1997 as the dependent variable with a range of independent conditional variables (e.g., ethnicity, labour force, county income inequality, etc.) and found conditional convergence. Lim (2007) found evidence of conditional convergence for metro areas between 1990 and 1999. Miller and Genc (2005) used absolute beta convergence and revealed convergence of growth rates across regions in the US during 1969-1997. Rey and Mountouri (1999) found that 48 States are converging from 1929 to 1994 based on the spatial error model. Christopoulos and Tsionas (2007) used a combination of non-linear techniques and found evidence of convergence during 1929-2001.

On the other hand, there are studies that found the prevalence of divergence and increasing disparity among US regions during the 1990s. Tsionas (2001) found no support for convergence for the US regions using techniques like cointegration during 1929-1997. Yamamoto (2008) used multi-scale data from 1955 to 2003 and found that the disparity was increasing at smaller scales (county-level) using exploratory analytical tools including kernel density estimation, mobility indices, scale variance, and spatial autocorrelation. Drennan et al. (2004) used metro areas data from 1969 to 2001 and found that the rate of income divergence is not decreasing.

There are a few studies that highlight the problems of finding mixed outcomes on convergence trends using different techniques using the same data (James and Campbell, 2013). Building on different conclusions based on the use of different tests for a unit root, Genc et al. (2011) applied unit root tests (ADF and KPSS) to metro and non-metro counties per capita personal income including wages, salaries, dividends, rent, and interest from 1969-2001. ADF tests indicated no convergence while the KPSS test supported the existence of convergence of income between metro and non-metro counties. Similarly, Young et al. (2008) found the presence of beta convergence but the absence of sigma convergence for over 3000 counties from 1970 to 1998.

The US regional patterns of convergence and inequality show very limited evidence in the literature from the 2000s. Some of the studies that provide evidence of convergence/divergence are listed here. Doran and Jordan (2016) employed Theil index to over 3000 counties across the US States and found greater variation in the convergence/divergence trends during the 2000s. Blanco and Ram (2019) showed a regular-U pattern (and not a Kuznets inverted-U pattern) between income and inequality in the US States during 2006-2016.

Another important issue that contributes to the mixed findings on regional convergence is the formation of clubs of regions. Researchers have found evidence of convergence clubs in the US (Johnson and Takeyama, 2003). Using the log-*t* test, Choi and Wang (2015) found that for a sample of 48 US States output per worker convergence decreased after the 1970s and there was the presence of four regional clusters. The first club consisted of mostly the States lying in the eastern coast that is traditionally rich. The second and third clubs had States that were geographically scattered and there was no pattern of systematic distribution of States within convergence clubs. Group four had States with low productivity. The study identified variables related to technology (per capita patents) and educational attainment (college graduates) helped States achieve higher levels of productivity.

Similarly, studies have found various causes of growth disparity and club formation among US regions (Neckerman and Torche, 2007). Regional disparities are considered to be a consequence of differences in education, occupations, incomes and housing prices across places (Glaeser and Gyourko, 2018; Van Ark et al., 2008; Gyourko and Molloy, 2015; Dao et al., 2014). Many studies have analysed the mobility of the skilled labour force to explain differential regional growth rates and disparities across the US (Giannone, 2017; Berry and Glaeser, 2005).

To conclude, this section provides evidence of the presence of inconsistencies in empirical findings on convergence and divergence trends for the US. These inconsistencies arise from employing different techniques as well as the regional tendency to converge with similar economies. These two issues have been addressed in this chapter by using a comprehensive pairwise technique to identify the convergence trend and to group similar regions together to assess the within- and between-group trends separately.

6.3 Data

Data used in this study are obtained from the Bureau of Economic Analysis (BEA), U.S. Department of Commerce. The units of geography considered in this chapter are the State level and the metropolitan statistical area (MSA) level. Per capita real GDP by State (chained 2009 dollars) is examined for 50 States from 2001 to 2017. Similarly, per capita real GDP data by metropolitan area are examined for 383 MSAs for 2001-2017. MSAs are defined to consist of one or more county that contains a city with a population 50,000 or more inhabitants, or contain a Census Bureau-defined urbanized area (UA) and have a total population of at least 100,000. The MSAs are the smallest unit of analysis and are divided into those lying within coastal States and those lying within landlocked States to find the difference in behaviours between and within-group. The 220 metro cities lying within the coastal States are analysed separately assuming that the coastal effect is uniform among all metros. The assumption implies that all metro cities have homogenous growth opportunities brought about by the coastal effect of the coastal States. Likewise, for the 163 landlocked metro cities the growth opportunities brought about by the effects of lying within landlocked States are assumed to be homogenous.

6.4 Findings

This section provides the outcomes of the convergence analysis carried out at the national level among 50 US States using traditional beta and sigma convergence techniques. Later, to understand changes in convergence dynamics, a pairwise analysis is undertaken with the help of the X-convergence technique for States and MSAs. The difference between the outcomes of traditional and X-convergence analysis is highlighted in the study.

To begin with, the descriptive statistics of per capita real GDP by State (chained 2009 dollars) for the years 2003, 2009, 2013 and 2017 are observed in table 6.1. The year 2009 is chosen to show the change that happened immediately after the 2007/08 global recession. Figure 6.3 shows the trend on mean per capita income earned by States. After 2003 the rate of growth is increasing consistently for 50 States. Looking at the minimum and maximum per capita State income in figure 6.4, minimum earnings have not increased a lot during the years and maximum earnings have consistently declined after 2009. This suggests that the richest State in the US has experienced a decline in their per capita earnings after the global recession. On the other hand, the poorest State's incomes have been growing although at a slow rate throughout the period analysed. Thus, the evidence suggests that the richest State suffered more after the global recession than the poorest.

Table 6. 1: Descriptive statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
gdp2003	50	44239.9	7792.086	30139	67956
gdp2009	50	45706.58	9073.848	31658	72204
gdp2013	50	47118.8	8921.837	31952	69711
gdp2017	50	49141.88	8848.058	32447	66500

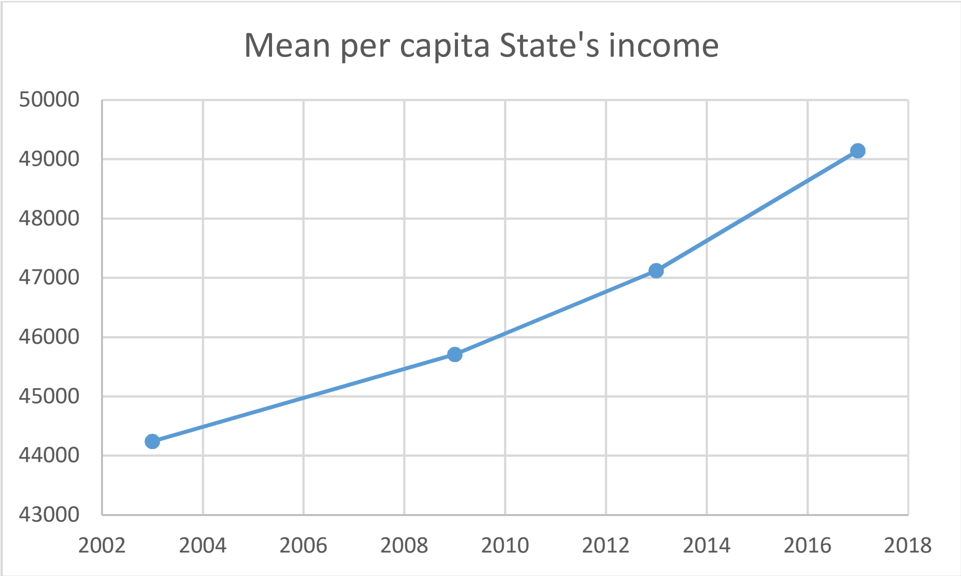


Figure 6. 3: Mean per capita GDP for 50 States in 2003, 2009, 2013, and 2017.

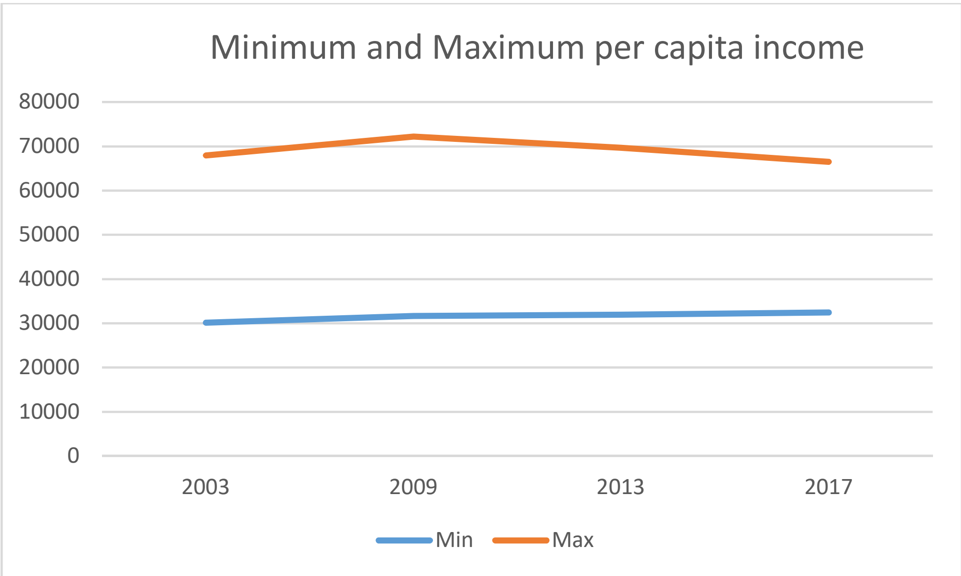


Figure 6. 4: Minimum and maximum per capita GDP for 50 States in 2003, 2009, 2013, and 2017.

6.41 Beta convergence and sigma convergence

The unconditional or absolute beta convergence is used to identify whether absolute convergence is happening among the 50 States or not as predicted by the neoclassical hypothesis of convergence. The absolute convergence is calculated for the 20 years from 2001 to 2017.

$$(1/T)\log(\frac{yit+T}{yi}) = \alpha + \beta \log(\mathrm{yit}) + \varepsilon\mathrm{it} \qquad (13)$$

Where, income growth = constant + βlngdp2001 + error

Income growth = 0.2692035 + (-0.024124) lngdp2001 + error

(0.0501301*) (0.004682*)

*Standard error in parenthesis. The *p-value* is 0 indicating a highly significant coefficient.

The negative sign on the beta coefficient indicates that there is evidence of convergence among the 50 States from 2001 to 2017. As emphasised in the literature, the beta coefficient figure provides the behaviour of an average economy to give a generalised result. Therefore, in general, the capital-poor States are growing at a faster rate to catch up with the richer provinces as suggested by the neoclassical hypothesis of convergence.

For sigma convergence, this chapter analyses the coefficient of variation (CV) for the period 2001 to 2017. The lower the value of CV, then the lower the dispersion of income among a set of economies. Lower dispersion indicates sigma convergence among the group of economies. Figure 6.5 shows almost constant sigma convergence (blue dashed line). This situation demonstrates the failure of sigma convergence to identify any conclusive finding on the convergence trend. The constant sigma value is an indication of neither convergence nor divergence. This is because the average distance between economies is the same during the period within the income per capita distribution.

Boyle and McCarthy (1997, 1999) highlighted the case of a constant sigma estimate and threw light on how the failure of sigma convergence could lead to biased results. The constant sigma convergence estimate may imply a similar distribution during the years but it does not say anything about what is happening within the distribution (intradistributional features) which is why it becomes important to understand what is happening within the distribution and the quantification of the mobility of economies. In this light, Boyle and McCarthy (1997, 1999) proposed a gamma convergence technique based on rank concordance to understand the mobility of economies within their per capital incomes distribution. This chapter is, therefore, going to apply gamma convergence techniques to improve understanding of the situation of 50 US States. For gamma convergence, the variation in rank concordance is calculated following Boyle and McCarthy (1997, 1999). The gamma indicator is close to one which implies less mobility of economies among themselves. Figure 6.5 shows that the value of gamma convergence is close to one which implies that economies have not changed their rank order positions much during 2001-2017.

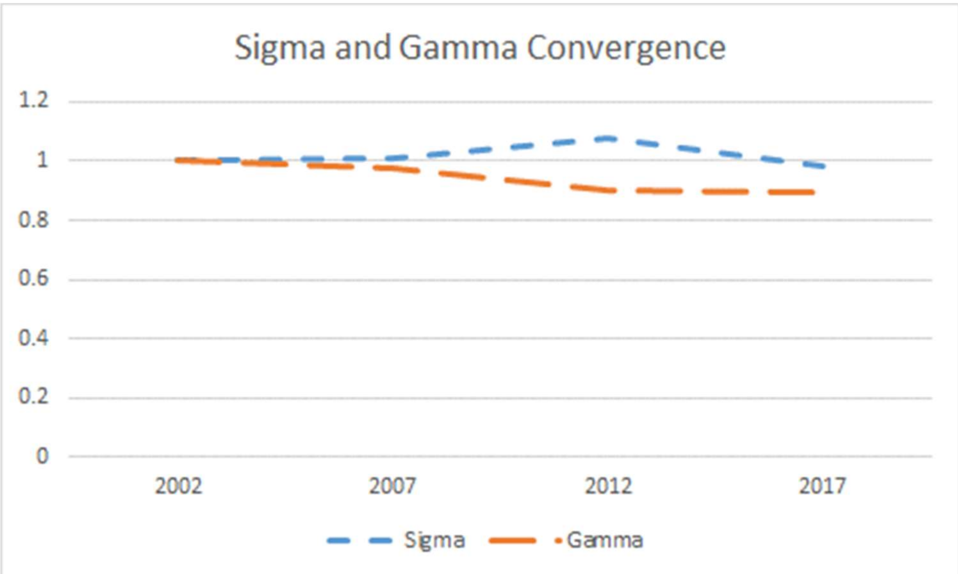


Figure 6. 5: Sigma and Gamma convergence among 50 US States

To conclude, the beta convergence indicator suggests the prevalence of convergence among the group of 50 US States. However, the constant sigma convergence indicator does not reveal much information on convergence. It could imply that the distribution is almost the same during the years. This finding seems to be an extension of what was revealed by Young et al. (2008) during 1990-1998, which revealed that beta convergence was not followed by the sigma convergence for the 50 States and 3058 counties.

In the case of the constant sigma convergence, the pattern of convergence is not conclusive. Consequently, to understand what is happening within the distribution, the gamma indicator was used and the outcome suggested less mobility of economies within the distribution. This indicates relatively high-income regions remain rich and low-income regions remain poor. As the evidence suggests, beta convergence revealed little support from sigma and gamma indicators. Therefore, beta, sigma, and gamma convergence tests collectively fail to provide a definite trend on convergence. To get a detailed picture on the convergence pattern, the next section employs the X-convergence technique to the same data.

6.42 X-convergence

The trend on convergence for the whole sample of 50 States was examined using the X-convergence technique from 2001 to 2017. The relative per capita income is compared for 50 States 49 times and categorised into four types of behaviours for two States every year. For instance, the pairs considered include California-Texas, California-Ohio, Ohio-Texas, Massachusetts-Michigan, and so on. In total, 2,450 pairs (50x49) of regions were analysed for each pair of years.

Figure 6.6 shows the percentage occurrence of convergence and divergence in relative ratios for 50 States compared in a pairwise setting. During 2001-2017, States have diverged in 9 periods out of 16

(Type I > Type II) is the majority of diverging periods for States. The States have mostly diverged (except 2001-03) with each other before the 2007/08 global crisis. The percentage of diverging pairs is highest at 58.2 in 2008/09. This suggests that the high-income States grew at a faster pace than the low-income States before the crisis. After the global recession, there is erratic behaviour with high percentages of occurrence of converging and diverging pairs of States. The occurrence of convergence during 2009-11, 2012-13, and 20015-16 could be the result of slow-growing rich States, the evidence of which was provided in the descriptive statistics in figure 6.6 with the help of maximum per capita State GDP values decline after 2009. Overall, there is a high number of periods in which pairs have diverged away from each other than converged. This indicates the prevalence of divergence and inequality among the US Sates during 2001-2017. The findings obtained from the X-convergence technique are contrary to what the beta convergence technique revealed in section 6.41. Thus, the discrepancy of convergence findings due to different techniques used is evident in sections 6.41 and 6.42.

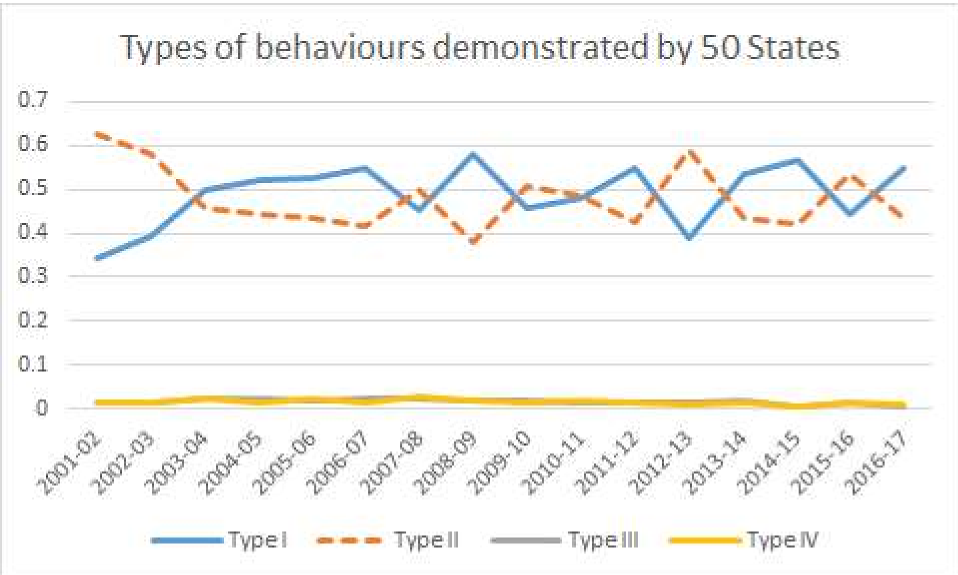


Figure 6. 6: Percentage of instances of types of behaviour exhibited by States. Type I = Divergence without switching, Type II = Convergence without switching, Type III = Convergence with switching, Type IV = Divergence with switching.

One of the advantages of the X-convergence technique is that we can group the data to do the within- and between-group analysis. This helps to understand the convergence trend where polarisation in data exists or when data is divided into groups. The next section will group States with the help of Nagin's (2005) group based trajectory modelling approach.

6.421 Group analysis—States

It is important to group regions first and then identify the convergence trend within- and between-groups to understand the subtleties of regional disparity. Two groups of provinces were identified using Nagin's (2005) group based trajectory modelling approach. The trial and error showed that the BIC is highest at -3808.43 for two groups with linear growth paths for group members. The other deciding factor is the p-value for every parameter. Table 6.2 shows a significant p-value for every parameter. The group membership for the first group indicates that there is 39.23 percent of total states lying in group 1. This turns out to be 20 states (0.3923X50) in group 1. Similarly, there are 30 states (0.6076X50) in group 2. Table 6.2 provides a list of states categorised in group 1 and group 2.

The application of GBTM finds that the States are grouped into two categories— first, a high-income group of 20 States (group1) with a 2017 average income of 57,770.05 dollars. Out of these 20, 13 have a coastline ranging from 21 to 10,690 km based on nautical charts and seven are landlocked (Wyoming, North Dakota, Nebraska, Nevada, Colorado, Minnesota, and Illinois). These 20 States are mostly lying near the coast or are mineral-rich States or both.

A second category is a relatively low-income group of 30 States (group 2) with a 2017 average income of 43,389.77 dollars comprising mostly the landlocked States. The groups follow the coastal and landlocked categorisation with a few exceptions.

Table 6. 2: Group membership for 50 US States

Group	Parameter	Estimate	Prob > |T|
1	Intercept	0.84405	0
	Linear	0.00003	0
2	Intercept	0.5844	0
	Linear	0.00004	0
Group	membership		
1	(%)	39.23577	0
2	(%)	60.76423	0

Group1	Group 2
Alaska	Alabama
California	Arizona
Colorado	Arkansas
Connecticut	Florida
Delaware	Georgia
Hawaii	Idaho
Illinois	Indiana
Maryland	Iowa
Massachusetts	Kansas
Minnesota	Kentucky
Nebraska	Louisiana
Nevada	Maine
New Hampshire	Michigan
New Jersey	Mississippi
New York	Missouri
North Dakota	Montana
Texas	New Mexico
Virginia	North Carolina
Washington	Ohio
Wyoming	Oklahoma
	Oregon
	Pennsylvania
	Rhode Island
	South Carolina
	South Dakota
	Tennessee
	Utah
	Vermont
	West Virginia
	Wisconsin

Within group 1 and group 2

Figure 6.7 shows that States within- and between-groups 1 and 2 are having higher instances of diverging pairs which imply that the disparities within and between relatively high and low-income groups of States are high during the 2001-2017 period. That is, Type I behaviour between pairwise States has been higher for the majority of this period. Type I behaviour indicates that relatively high-income regions are growing at a faster rate or relatively low-income regions are growing at a slower rate and stagnating. The outcome of higher instances of Type I behaviour within the two groups seems to reveal that the relatively high-income regions are growing at a higher speed in both groups.

Type III and Type IV behaviours have been demonstrated by a limited number of pairs of regions. Within the relatively high-income group 1, States that demonstrate mobility are Texas, Illinois, Massachusetts, New York, etc. These States have increased economic growth throughout the period with a lot of ups and downs in their speed of growth. The fluctuations in the economic growth rate for these States caused a switch in their positions with the rest of the States. These States are changing their rank order positions while either converging or diverging with others. Similarly, within the relatively low-income group 2, South Dakota, Louisiana, Oklahoma, South Carolina, Indiana, Ohio, etc. show a change in their rank order positions during 2001-2017. These States have demonstrated a slight increase in growth with lots of ups and downs on their per capita income and hence switched places with others.

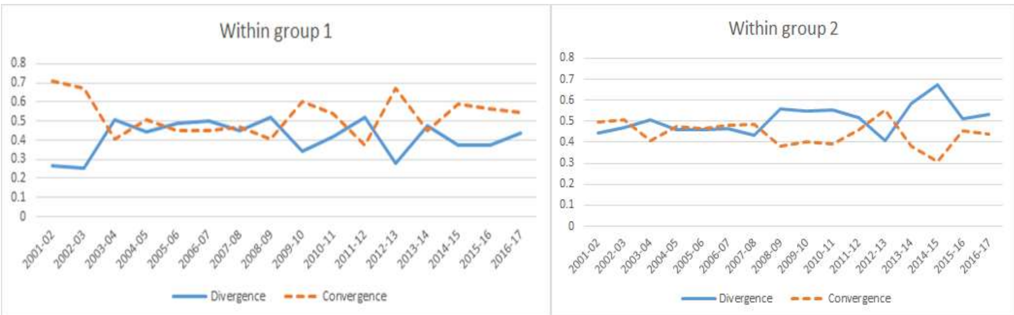


Figure 6. 7: Within-group behaviour of 50 US States to show the effect of the 2008 global recession

In the US, many States have been hit hard by the 2008 global recession which experienced slow growth or depressed growth after

2008. Interestingly, the relatively high-income group 1 has experienced higher percentages of converging pairs within the group members almost every period after the global recession as shown in figure 6.7. This indicates that a high number of relatively low-income States in group 1 exhibited faster growth compared to their high-income counterparts or otherwise certain high-income States are lagging behind or stagnated. For instance, Connecticut and Wyoming were among relatively high-income States but due to their poor performance, their post-recession per capita income never reached their pre-recession income figures.

To provide a deeper understanding of what is happening within high-income groups of States, Table 6.3 shows the 2016-17 types of behaviours of the top 5 and bottom 5 States based on their per capita income in 2017. Out of the 19 States in group 1, Alaska demonstrated Type I behaviour of divergence with only 6 States and Type II behaviour of convergence with 13 States. Thus, Alaska has exhibited more instances of convergence with others within group 1. Massachusetts is the only State that showed more instances of divergence (Type I) than convergence (Type II) during 2016-17. The State has experienced constant increases in per capita income, from 60,723 dollars in 2008 to 66,500 dollars in 2017. Massachusetts's high rate of income growth helped the State perform better and diverge away from the rest in group 1. All other top four States show more instances of convergence, indicating slow growth in income. This also implies the existence of convergence from the top during the time period. The bottom 5 States show more instances of Type II behaviour of convergence than Type I behaviour of divergence. This indicates that all of these States are growing at a faster rate and converging with the relatively high-income States (as per the neoclassical convergence hypothesis). The overall conclusion confirms that group 1 has a few high-income States that have lagged behind or stagnated.

Table 6. 3: Types of behaviour demonstrated by top 5 and bottom 5 States in group 1 based on 2017 per capita income

2017 Top 5 High-income	**Type I**	**Type II**
Alaska	6	13
Delaware	6	13
Massachusetts	15	4
New York	9	10
North Dakota	8	11
2017 Bottom 5 High-income		
Hawaii	8	11
Nevada	6	13
New Hampshire	7	12
Texas	5	14
Virginia	7	12

On the other hand, within the relatively low-income States, group 2, the number of diverging pairs exceeded the number of converging pairs in almost every period after the 2008 global recession. This implies that a high number of relatively high-income States grow faster than the low-income States and diverge away from them. For the relatively low-income States, these findings suggest a slowdown or stagnation in income per capita post-recession. Since group 2 consists of relatively low-income States, some of the poorest of the poor States were stagnating or lagging behind during the post-recession period, such as Idaho and Mississippi.

To provide a deeper understanding of what is happening within the high-income groups of States, Table 6.4 shows the 2016-17 types of behaviours of the top and bottom 5 States based on their per capita income in 2017. Out of the 29 States in group 2, Iowa demonstrated the Type I behaviour of divergence with only 4 other States and Type

II behaviour of convergence with 25 States. All other top States showed more instances of divergence (Type I) behaviour than convergence (Type II) behaviour, suggesting that they are growing faster and diverging away from others. The bottom 5 States in group 2 showed more instances of Type I behaviour of divergence than Type II behaviour of convergence (except West Virginia). This implies that the majority of the bottom States are growing relatively slowly and increasing the gap between them and the rest. For instance, Mississippi's per capita income decreased from 33,128 dollars in 2008 to 32,447 dollars in 2017. Therefore, the divergence in group 2 indicates that the relatively low-income States are stagnating or lagging-behind and widening regional income inequality. The poorest of the poor regions in group 2 need help to revive their economy.

Table 6. 4: Types of behaviour demonstrated by top and bottom 5 States in group 1 based on 2017 per capita income

2017 Top 5 low-income	**Type I**	**Type II**
Iowa	4	25
Oregon	16	13
Pennsylvania	26	3
Rhode Island	17	12
Wisconsin	18	9
2017 Bottom 5 low-income		
Alabama	19	10
Arkansas	23	6
Idaho	23	6
Mississippi	23	6
West Virginia	2	27

In terms of mobility behaviour within group 2, very few States have shown Type III and Type IV behaviours. This suggests the regions have not changed their ranks much. States that have exchanged places with other group members during the period of analysis are Oregon, Iowa, Louisiana, Pennsylvania, North Carolina, Ohio, etc.

Combining the findings, the post-recessionary effects indicate two scenarios: first, in group 1, the relatively high-income states grew at a slower rate to converge with relatively low-income States; secondly, in group 2, the relatively low-income States (poorest of the poor) stagnated or lagged behind their high-income counterparts. The slow growing high-income States also experienced declining maximum values after 2009, as shown in Figure 6.5.

Between group 1 and group 2

Analysing the between groups behaviour of group 1 and group 2, figure 6.8 shows higher instances of divergence between the two groups. After the 2008 recession, there were lots of variations in convergence and divergence behaviours between the two groups of States. This indicates a widening gap between relatively rich and poor States.

In terms of assessing the mobility behaviour with the help of Type III and Type IV behaviours, there was no presence of these two behaviours between the groups. This suggests there was no exchange of places between group 1 and group 2 States. There is the persistence of high-income and low-income groups in the US just like in China (see Chapter 5). The high-income States remain high-income throughout the analysis period and low-income States remain low-income.

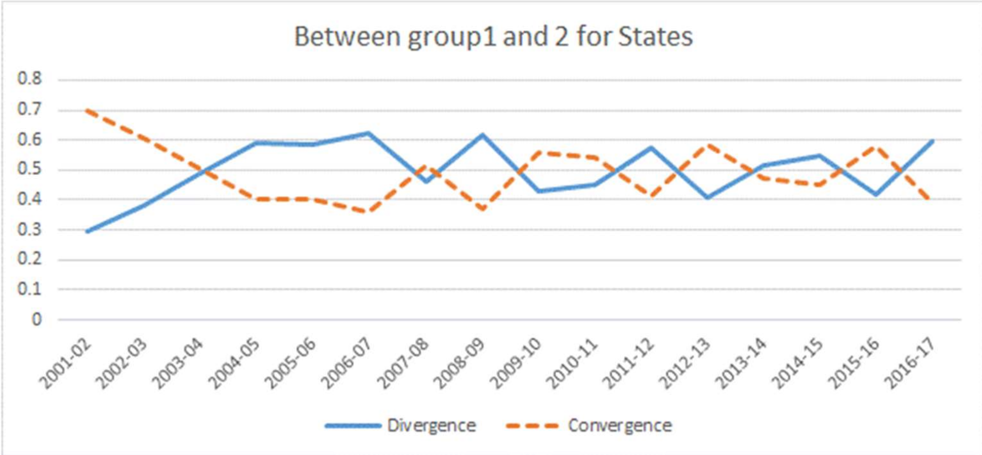


Figure 6. 8: Between group behaviour of 50 US States during 1997-2017

Combining the within- and between-group analysis for the 50 US States provides evidence of a widening gap between the relatively rich and poor States within and between groups from 2001-2017. The dynamics of high-income States in group 1 changed after the 2008 global recession. The group demonstrated convergence by showing high instances of converging pairs between group members. Some of the relatively rich States in group 1 showed slow rates of growth and poor States showed high rates of growth and hence demonstrated a high frequency of convergence post-recession. The within group 2 analysis shows that the poorest of the poor States were not able to cope with the slowdown and they lagged behind. The between group analysis shows that the two groups are diverging away from each other and there is the persistence of relatively high-income and low-income groups.

6.422 Group analysis—Metrostatistical Areas (MSA)

The States level findings indicate that the States are diverging away from each other, i.e., increasing the economic gap. In addition, there is the persistence of groups of high-income and low-income groups as they remain high and low income throughout the analysis period. The next step is to validate whether the same findings are followed by a lower spatial scale, in this case, metropolitan statistical area (MSA) level data.

There is a limitation posed by the software package—Stata on conducting the GBTM for 383 MSAs. Due to a large number of observations, Stata was unable to do the analysis. The groupings for a total of 383 MSAs were not successful by Stata software, so the MSAs were first divided into two groups—220 MSAs lying within coastal States (supposedly relatively high-income) and 163 MSAs lying within landlocked States. Thereafter, the GBTM was applied within these two groups of 220 and 163 MSAs.

The model gives two optimal groups for the 220 MSAs lying within the coastal States. The trial and error showed that the BIC is highest at -13525.12 for two groups with linear and quadratic growth paths for group members. The other deciding factor is the p-value for every parameter. Table 6.5 shows a significant p-value for every parameter. The group membership for the first group indicates that there is 13.4 percent of 220 MSAs lying in group 1. This turns out to be 28 metro areas (0.134X220) in group 1. Similarly, there are 192 states (0.866X220) in group 2.

Group 1 has 28 metro areas with a 2017 average income of 71,475.92 dollars and Group 2 has 192 MSAs with 2017 average income of 37,979.6 dollars. The extent of disparity between the two groups could be understood by the difference between the average incomes of the two groups.

Table 6.5: Group membership for 220 coastal MSAs

Group	Parameter	Estimate	Prob > |T|
1	Intercept	0.55	0.0293
	Linear	0.00	0
	Quadratic	0.00	0
2	Intercept	0.94	0
	Linear	0.00	0
	Quadratic	0.00	0
Group	membership		
1	(%)	13.4	0
2	(%)	86.6	0

Both the groups are exhibiting higher percentages of diverging pairs (Type I). The mobility of metro areas is high with high instances of Type III and IV behaviours. Some of the metros that show a tendency for mobility behaviour include Wenatchee, WA; Bakersfield, CA; Redding, CA; Jacksonville, NC; Albany, OR; etc. Both the groups lying within the coastal States are diverging away after the 2008 recession making the inequality worse. The poorest of the poor regions may be declining in growth and diverging away from their group members.

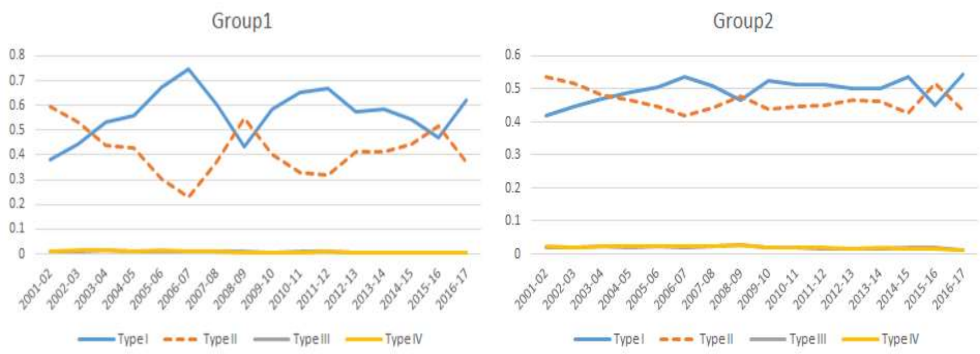


Figure 6. 9: Group behaviour of 220 MSAs lying within coastal MSAs

Similarly, the group-based trajectory method (GBTM) was applied to 163 MSAs to analyse the number of groups that each of them are divided into.

The model gives two optimal groups for the 163 MSAs lying within the coastal States. The trial and error showed that the BIC is highest at -9325.50 for two groups, first group with a linear and the second group with linear and quadratic growth paths. The other deciding factor is the p-value for every parameter. Table 6.6 shows a significant p-value for every parameter. The group membership for the first group indicates that there is 14.97 percent of 163 MSAs lying in group 1. This turns out to be 25 metro areas (0.1497X163) in group 1. Similarly, there are 138 states (0.85X163) in group 2.

Table 6.6: Group membership for 163 inland MSAs

Group	Parameter	Estimate	Prob > |T|
1	Intercept	-1.60	0
	Linear	0.00	0
2	Intercept	2.48	0
	Linear	0.00	0
	Quadratic	0.00	0
Group	membership		
1	(%)	14.97	0
2	(%)	85.03	0

The model gives two optimal groups for the 163 MSAs lying within the landlocked States. Group 1 consist of 25 MSAs with a 2017 average income of 48,355.04 dollars and group 2 consist of 138 MSAs with a 2017 average income of 43,112.84 dollars. Both groups exhibited higher percentages of diverging pairs (Type I). The mobility of metro areas is high with high instances of Type III and IV behaviours. Some of the metros that demonstrated a tendency for mobility behaviour were Beckley (West Virginia), Midland (Michigan), Charleston (West

Virginia), Sioux City (Iowa) etc. The mobility of these metros indicate high frequency of change in income per capita for them.

Both groups lying within the landlocked States diverged away from each other after the 2008 recession making the inequality worse. The poorest of the poor regions may be experiencing slower growth and diverging away from their group members.

Figure 6. 10: Group behaviour of 163 MSAs lying within landlocked States

The between group behaviour of 220 and 163 MSAs is demonstrated in figure 6.11. Out of the 16 time periods from 2001 to 2017, 11 coastal and land-locked MSAs have a higher percentages of diverging pairs (Type I > Type II) than converging pairs. This suggests that the high-income MSAs, which are mostly lying within coastal States, are growing at a faster rate and diverging away from the rest of the MSAs. Alternatively, low-income MSAs grew very slowly leading to stagnation of these MSAs.

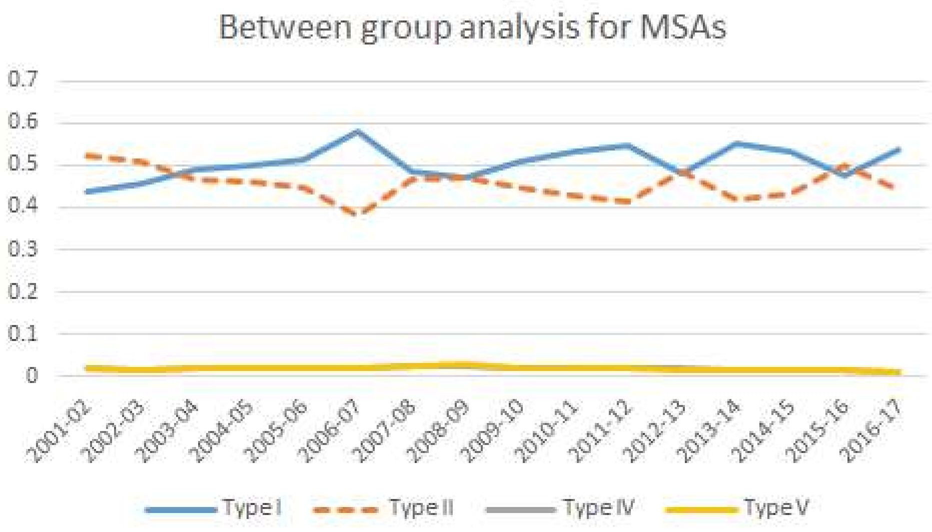


Figure 6. 11: Between group behaviour of 383 US MSAs during 1997-2017

It is evident from within group analysis that MSAs lying within the coastal and landlocked States are not showing convergence with each other. This is against the convergence hypothesis suggested by the neoclassical theory, i.e., a higher growth rate of the low-income regions so that they can catch-up with the high-income regions. This could be due to strikingly differential behaviour of regions within each group with relatively high-income regions growing at a faster rate or relatively low-income regions growing at a slower rate. To delve deeper into the behaviour of MSAs in coastal and landlocked groups, the study assesses the behaviour of the 2017 bottom five (low per capita income) MSAs within each group. The number of instances of behaviours of Type I (divergence) and Type II (convergence) in 2016/17 exhibited by the rest in the group is shown in Table 6.7. This will help identify the low-income regions that are stagnating (Type I behaviour) and fast-growing (Type II behaviour).

Table 6. 7: 2017 bottom MSAs for coastal and landlocked States

Bottom 5 Coastal MSAs	**Type I**	**Type II**
Homosassa Springs, FL	148	71
Punta Gorda, FL	150	68
Sebring, FL	163	56
The Villages, FL	76	143
McAllen-Edinburg-Mission, TX	121	97
Bottom 5 Landlocked MSAs		
Bay City, MI	148	14
Lake Havasu City-Kingman, AZ	17	145
Prescott, AZ	34	128
Pueblo, CO	48	114
Sierra Vista-Douglas, AZ	73	89

Table 6.7 indicates that the bottom four out of five coastal States' MSAs demonstrated more instances of Type I behaviour than Type II behaviour. It appears that low-income MSAs in coastal States are showing evidence of stagnation and hence diverging away from the rest of the MSAs. Sebring in Florida exhibits highest instances of Type I behaviour at 163 out of 220 suggesting that it has diverged with 163 MSAs out of 220. According to the 'bestplaces.net' web site on the economic reports of Sebring, the unemployment rate is higher and job growth rate is much lower than the national average and hence the household income is nearly half the average US income. Similarly, Homosassa Springs in Florida has higher unemployment, lower job growth opportunities and lower household income than the US average.

The stagnation behaviour of MSAs in coastal States partially explains the behaviour of almost persistent divergence within MSAs in coastal States. The evidence suggests that even though the coastal States are contributing a lot towards the total income of the country, at the regional level metros cities have high economic inequality in terms of economic mobility. This study only looked at the poorest five MSAs in coastal States but the divergence behaviour could be prominent in other middle-income regions too. This finding supports the presence of divergence within the MSAs in coastal States as shown in Figure 6.7.

On the other hand, only one MSA among the bottom five landlocked States in figure 6.7 demonstrates more instances of Type I behaviour than Type II behaviour. That is, Bay City in Michigan diverged with 148 MSAs out of 163 within landlocked States, implying a slowdown in the growth. In addition, the high instance of divergence seems to suggest that the economy has shown evidence of stagnation among its peers. The other four poor MSAs show greater frequency of Type II behaviour than Type I indicating the signs of convergence with the rest. This implies that low-income MSAs in landlocked States are growing at a faster rate than the rest lying within the landlocked States. Thus, the evidence suggests that the low-income metro cities located within landlocked States are growing at a relatively faster rate than those located within the coastal States. Therefore, MSAs located within the landlocked States are relatively better performing than those located within the coastal States.

To conclude, MSA level areas are diverging away from each other lying within and between coastal and landlocked States. This shows the widening inequality between the metro areas in the US in general. Analysing particularly the bottom five MSAs lying within the coastal and landlocked States, MSAs lying within the coastal States are diverging away or slowing down compared to the rest. This finding suggests that the metro areas that are lying supposedly within high-income coastal provinces are lagging behind or stagnating. Therefore, high-income States with stagnating metro areas need attention from policymakers and researchers to cope up with the slow down in order to achieve long-term growth.

6.5 Discussion

This section will provide an overview of theoretical underpinnings that could explain the changing trends of convergence and divergence identified in this US sample. The findings suggest a dynamic trend of convergence which differed based on groups of regions and time periods. Changing trends could follow different principles of convergence and divergence. This section discusses the theories and literature behind the findings obtained in section 6.4.

6.51 Principles of convergence applicable to US regions

The findings on divergent growth paths between the US regions is in line with many studies such as Young et al. (2008); Yamamoto (2007); Berr and Glaeser (2005); and Drennan et al. (2004). This study covers the time period between 1997-2017 that is not investigated much in the domain of US regional convergence and disparity. This time period is important to consider because of the slow growth of some regions in the US after the 2008 global recession. Some of these regions have not been able to match the pre-crisis per capita income figure, hence diverging away from the rest.

The closest study that relates to the finding of divergence in metro areas is by El-Montasser et al. (2016). Their study analysed 384 US MSAs from 1969 to 2011 and found the predominance of divergence of per capita income between the MSAs. This chapter's finding on divergence between 383 US MSAs is in line with El-Montasser et al. (2016), however this chapter also extends the analysis of convergence until 2017 and provides more insights on the group dynamics (e.g. information on stagnating and lagging areas) of MSAs. El-Montasser et al. (2016) did not study the MSAs lying within and between groups of high-income and low-income States, a gap in the literature that this chapter fills.

The evidence from the literature suggests that the nature of regional income divergence and inequality for the US States is driven by the principles of new economic geography (NEG) and urban economics (Manduca, 2019). Breinlich et al. (2014) States that new economic geography has focussed on the economic convergence of mostly developed nations including the US, Europe, and Japan. The new economic geography, as a part of endogenous growth models, explains the ability of certain regions to outperform others and diverge away from them. Some of the factors that lead to the agglomeration of economies, spillovers, increasing returns to investment, positive externalities, etc. have been widely studied in the literature (Myles Shaver and Flyer, 2000; Head and Ries, 2001). As opposed to the neoclassical hypothesis of convergence, Easterly and Levine (2001) observes that divergence in growth paths happens in a cross-country analysis in the long run because rich countries like the US is not slowing down and returns on their capital investment is not diminishing. Therefore, the divergent growth paths experienced by capital rich economies in the US was explained by the new economic geography principles.

The theories of NEG work perfectly for regions showing high growth rates and hence diverging away from the rest before the 2008 global recession. However, the findings on the convergence trend after the 2008 global recession for States in the high income group 1 reveal that relatively richer States have slowed down and demonstrated high instances of convergence within the group. This is inconsistent with NEG principles and requires explanations in terms of low growth rates demonstrated by high-income regions. It seems the neoclassical hypothesis of convergence advocates low growth rates for capital rich regions due to diminishing returns on capital and investment.

The 2008 recession led to numerous redundancies in the US and capital was sitting idle. This was echoed in the work of Connaughton and Madsen (2012) who showed the impact of recession on job losses during 2008/09 and found varied impacts on States. Nevada had the largest job loss during the period and Florida, Michigan, and California followed suit. Assessing the determinants of growth for rich and poor regions is beyond the scope of the chapter, however, some factors are briefly discussed to highlight the issues that are constantly discussed in the literature.

Piketty (2015) argued that factors such as imbalance in supply and demand of skills, access to skills and higher education, and insufficient government expenditure explain the economic growth inequality in the US. Labour market is studied extensively in literature to understand the reasons behind economic inequality. Literature emphasised that increased labour productivity through human capital accumulation help regions grow faster (Gennaioli et al., 2013; Florida et al., 2008; Faggian et al., 2019). Labour productivity growth in the US accelerated from mid-1990s due to the development of highly productive industries, such as information and communications technologies (Van Ark et al., 2008). This escalated the demand for highly skilled labour with desired technical knowledge. The shift in demand is termed as Skill-Biased Technical Change (SBTC) in the literature, which explains that the productivity increase was skill-biased during the 1990s is contrary to the fact that productivity was largely skill-neutral earlier (Giannone, 2017). The skill premium was translated into wage differentials across the US and studies found divergence in skills and hence wages, across regions after 1980 (Berry and Glaeser, 2005).

Amongst the rich OECD countries, wage inequality grew the most in absolute terms in the US in the 1980s and 1990s (Kenworthy and Pontusson, 2005; Smeeding, 2005). Citing differences in community in the US, Moretti (2012) Stated that the divergence in educational levels initiated the divergence in labour productivity and hence salaries. Wage inequality started growing in the mid-1970s, which accelerated sharply in 1980s and afterwards stabilised in the 1990s (Card and DiNardo, 2002; Alderson and Nielsen, 2002). This wage differentials have been explained through the gender gap, racial wage gap, and educational wage gap (Card and DiNardo, 2002; Neckerman and Torche, 2007). The wage differential notion is inconsistent with the factor price equalisation mechanism of convergence as predicted by the neoclassical theory. Therefore, growing inequality wage differentials supports the divergence experience of US regions as predicted by the propositions of new economic geography.

Another factor that has been widely researched for differential regional growth and regional inequality in the US is the housing market (Glaeser and Gyourko, 2018; Gyourko and Molloy, 2015; Dao et al., 2014). Housing regulations have played an important role in changing skill-specific labour mobility and income convergence. Ganong and Shoag (2017) developed a model to show that rising housing prices in high-income regions prevent migration of low-skill workers. The study shows that workers of all skill types tend to choose to move to the more productive locations. However, due to housing supply constraints and land use regulations in the productive areas, the housing prices rise consistently. The low-skilled workers being (housing) price sensitive are likely to be discouraged to migrate to productive areas. The imposition of barriers to labour mobility through increasing housing prices is a condition that is inconsistent with neoclassical hypothesis of convergence. The evidence shows that US regional divergence is demonstrated by the new economic geography’s theoretical standpoint of one region surpassing another.

6.52 Grouping of identical regions

Growth models provide insights on identifying the factors that help an economy grow at a faster rate, such as capital flows, technology transfers, spillovers, agglomeration of economies, etc. Even though a lot of studies provide insights on the factors that help economic growth, the identification of determinants of the growth of income and productivity is a complex topic. One factor may work for one economy but not for the other. In this regard, researchers emphasise the need to take account of country-specific factors while assessing convergence trends. The underlying assumption is that regions within a country share similar institutions, market structure, technology, etc. which should make regional conditions more homogeneous.

However, growth studies reveal more instances of divergence between regions than within a country. This highlights the significance of factors that make regions heterogeneous rather than homogenous. This heterogeneity could come from the geographical differences that could help certain regions outperform others. This holds significance for countries like China and the US where regional disparities are high and many regions are diverging away from one another. In this line of research, the club convergence literature provides a mechanism to find convergence within groups with similar characteristics and initial conditions. The idea of club convergence, as proposed by Galor (1996), States that economies or regions with similar structural characteristics including infrastructure, technological preferences, population growth, and government policies would converge to one another if their initial conditions were similar as well. This chapter adds to the existing empirical studies on club convergence for US regions.

This chapter found two diverging groups of high-income and low-income States based on a grouping algorithm (GBTM) that assesses the evolution of growth trajectories of economies over time. One group consisted of 20 high-income States and the other group consisted of 30 low-income States. Using the same data set that this chapter has used, González et al. (2020) also found two clubs of States from 1997 to 2017 but by using a different technique called log-*t* regression based convergence test of Philips and Sul (2007). Thus, González et al. (2020) study is in line with what this chapter has found in terms of the number of high- and low-income clubs of 50 States. However, the configuration of clubs is different in this chapter compared to González et al. (2020). González et al. (2020) high growth club consisted of 28 States out which nine States are at the risk of moving to low-income club 2. In this chapter, there are 20 high-income States that are grouped together (as shown in table 6.2) which are almost the same high-income States identified by González et al. (2020) after deducting the nine borderline States. All of the high-income 20 States (except Nevada which is rich in gold) identified in this chapter are also a part of González's et al. (2020) high-income club 1 States.

The high-income States lying in group 1 are mostly located near the coast or are mineral rich States. Rappaport and Sachs (2003) highlights that over the twentieth century, economic activities have been highly concentrated along the two ocean and Great Lakes coasts. The coastal proximity is an important factor that enhances the growth of a region via greater transport facilities (Rappaport and Sachs, 2003). Bleakley and Lin (2012) examine some of the US portage sites and conclude that these sites are having continued historic advantages due to the evidence of path dependence. Coastal proximity makes a place attractive to businesses or manufacturing units that want to be near the port for easy accessibility and in turn attract complementary businesses. The associated economies of scale and agglomeration effects lead to further increases in growth of the coastal areas. Similarly, natural resource abundance has been identified as an important determinant of growth for US regions (Papyrakis and Gerlagh, 2007). For instance, Schmid (2012) found that the natural gas production that expanded in Colorado, Texas, and Wyoming since late 1990s has 1.5 percent increase in employment levels. Michaels (2011) found that oil abundant counties in the southern US have higher population growth, per capita income, and better infrastructure.

On the other hand, James and Aadland (2011) provided evidence of reduced growth rate for resource-dependent counties in Maine and Wyoming. Suggesting a mixed outcome for the relationship between resource-dependent counties and their growth rates, Munasib and Rickman (2015) found that North Dakota has positive effects of oil and gas production on the regional labour market in general but only four counties seem to have positive effects of shale oil and gas production in Arkansas. In addition, the study found no significant positive effects for counties in Pennsylvania perhaps due to its slow pace of development relative to North Dakota and Arkansas. Therefore, all locations rich in mineral resources are not able to grow at a fast rate or they may take time to reap the benefits of mineral-based production. In addition, this highlights the importance of other factors like infrastructure that are needed for a region to grow fast.

A lot of changes in the ocean economy, such as the evolution of tourism and recreation, are replacing traditional activities of fisheries, boat building and marine transportation in the US (Colgan, 2004). Studies have highlighted the importance of marine resources and coastal endowments for the US. This chapter identifies groups of high-income and low-income States which seems to agree with the importance of port cities and coastal cities. 13 out of 20 States have coastline and 7 are mineral and oil-rich (Wyoming, North Dakota, Nebraska, Nevada, Colorado, Minnesota, and Illinois). Nebraska and North Dakota are rich in oil and gas minerals, which is likely to be why they do not appear in figure 6.12.

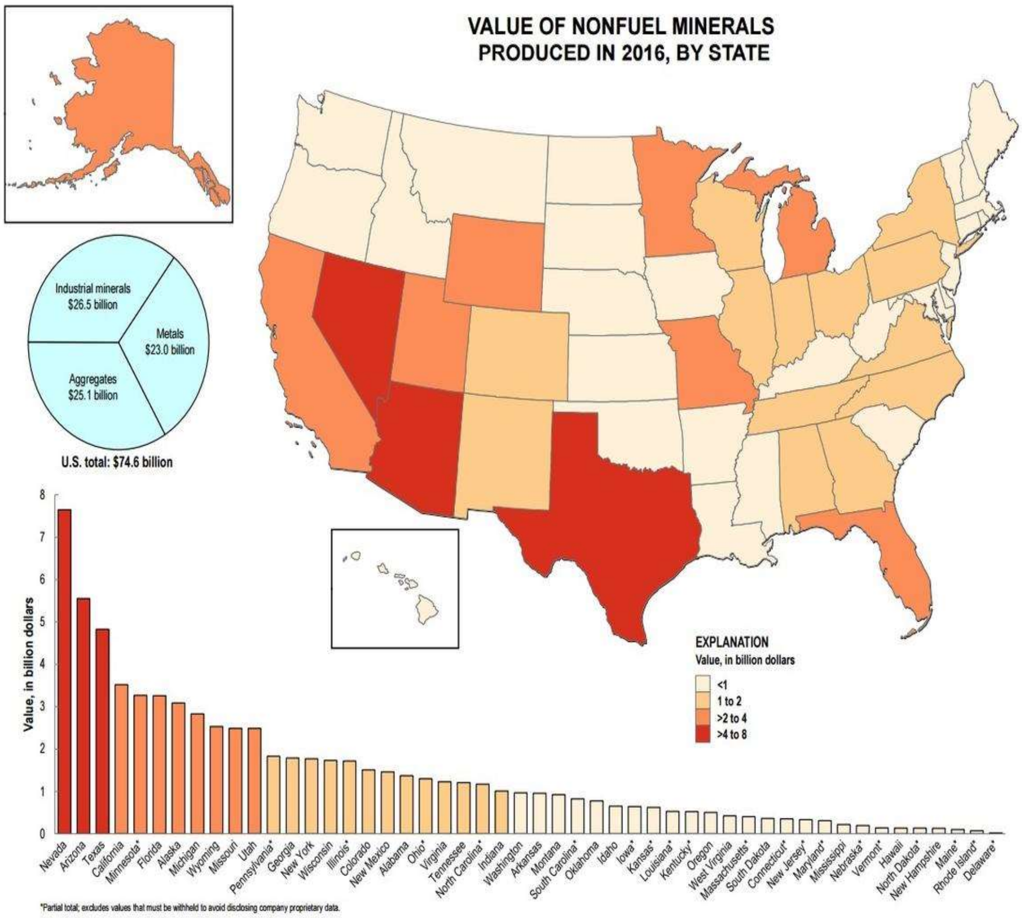


Figure 6. 12: Value of nonfuel minerals produced by States in 2016 Source: US Geological Survey

In summary, this section provides an overview of different theoretical perspectives that could be used to explain the findings of this chapter. The chapter relates the divergence phenomenon experienced by regions within and between the US to the principles of new economic geography. NEG models explain the reasons behind the exceptional growth of one region relative to others. Findings show that the convergence experienced by a high-income group of States after the 2008 recession is better explained by the neoclassical hypothesis of convergence. This is because the high-income regions experienced slow growth after the recession explained by the diminishing marginal returns on capital and investment. The productivity loss during this period could be explained through neoclassical perspective. The growth models gave rise to models that explain convergence within groups. Explaining the existence of groups of similar regions through the principles of club convergence, this chapter classifies similar regions into groups. Grouping regions helps us find within- and between-group dynamics to illustrate the subtleties of regional inequality. In this respect, the chapter provides important insights on regions that are stagnating or lagging behind.

6.6 Conclusion

This chapter outlines US regional convergence and disparity trends during 1997-2017 at two regional hierarchical levels: State (50) and MSA (383) levels. The use of standard measures of convergence (beta, sigma, and gamma) provide inconclusive findings on convergence. The beta indicator showed convergence for States during 1997-2017. It was accompanied by constant sigma which indicates the dispersion if income is the same over time. The gamma indicator showed downward trend from 2007 indicating the dominance of convergence from 2007. Thus, inconsistency in findings was reported by the three measures of convergence.

To find a conclusive trend on convergence, a detailed pairwise analysis using the X-convergence technique was performed in the chapter. The analysis found the dominance of divergent growth paths for States and MSAs for the majority of years. The findings of divergent growth paths were observed at both levels, thereby highlighting increasing inequality between regions. This finding is demonstrated with the help of an assessment of within and between groups of high-income and low-income States and MSAs. One of the objectives of the chapter was to assess the impact of the 2008 global recession on US States and metros. In this regard, the group analysis of the impact of the 2008 recession on regional convergence and disparity suggests that some of the relatively rich States within the high-income group have experienced slowed growth and hence converged with the rest of the group members. On the other hand, the relatively low-income States within the low-income group has stagnated and experienced divergent growth paths. The findings indicate that post-recession some of the poorest of the poor States have not been able to cope with the recession, such as Mississippi. Thus, stagnating States of the relatively poor-income group need attention from the policymakers. The between group analysis reveals the persistence of high-income and low-income groups, i.e., the high-income States remain rich and low-income States remain poor during the analysis period. The findings on persistence in groups of US regions is in line with Yamamoto (2008), which predicted that the mobility of regions declined from 1990s which established stability. The findings of divergence and persistence are similar to Chinese provincial divergence and persistence trends as discussed in the previous chapter. China and the US are similar in terms of regional convergence dynamics. Both countries are struggling with high income inequality and persistence in groups of high and low-income provinces/States.

Analysing the trends at the MSA level, the findings of divergence are consistent with the literature in this domain (El-Montasser et al., 2016; Yamamoto, 2007). The recent literature on convergence illustrates the presence of divergence among regions in the US. The presence of high percentages of diverging pairs, especially after the 2007/08 global recession, is validated while performing within and between group analyses. The divergent growth paths were found at both State and MSA levels. To identify slow growing MSAs lying within the rich coastal States and poor landlocked States, convergence trends of the bottom 5 MSAs within the coastal and landlocked States was performed. Interestingly, the MSAs lying within rich coastal States have demonstrated diverging behaviour with others, while MSAs lying within the landlocked States showed convergence. This indicates high inequality within the coastal States relative to the landlocked States. It appears that low-income regions lying within the landlocked States are performing better than the low-income regions located within the coastal States in the US, which is also reflected in their 2017 per capita income. The findings are important from a policy perspective because they identify the slow growing/lagging/stagnating regions that are the focus of cohesion policies aiming to promote spatial equality.

The findings of this chapter add to the empirical evidence on regional convergence and disparity in the US. One limitation cited in the chapter is the assumption of uniform coastal effects for all MSAs lying within the coastal States. The assumption implies that all the cities have homogenous growth opportunities brought about by the coastal effects of the coastal States. The assumption may not be true because all MSAs lying within the boundary of coastal States may not be near the coast or shoreline. There could be a few that lie in the interior parts of the coastal States. This issue will be addressed in future studies by considering the MSAs that are geographically located on the coast or shoreline as coastal MSAs and rest as landlocked MSAs.

CHAPTER 7 EUROPEAN UNION

7.1 Introduction

Since 2004, the European Union (EU) has integrated 12 member states (Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria, and Romania) and consequently, increased the scope of free trade, capital, and labour flows. One of the objectives behind the integration process was to ensure economic and social equality for the whole EU. In the light of harmonious development and economic cohesion, the catching-up process (convergence) of regions became an important policy objective. The regional implications of European integration policies have drawn the attention of academics across the globe to understand the pattern and extent of convergence/divergence among European regions (Fingleton, 2013). The barriers to labour, capital, goods, and services mobility have been abated owing to the integration process to facilitate convergence (Sondermann, 2014). To some extent, the objectives of policy initiatives are realised at the national level by catching-up effects of poorer member states (Monastiriotis, 2014; Borsi and Metiu, 2015). However, concentration of economic activities at certain places facilitating agglomeration effects went against the objectives of policy initiatives. Thus, the evidence of remarkable heterogeneity among regions was unanimously accepted in the literature.

The heterogeneity arises from regions with different economic and structural dynamics, and capabilities to adapt to any change in fast moving environments. This heterogeneity gives rise to groups/clusters of similar regions that demonstrate similar growth paths. Consequently, the notion of a “multi-speed” Europe became popular that differentiated the rate of integration process across groups of member states (Califano and Gasperin, 2019; Gaynor and Karakitsos, 2016). The notion of a multi-speed Europe is a consequence of the existence of clubs/clusters/groups of regions, as suggested by the club convergence literature (Iammarino et al., 2019).

In this regard, the cross-country analysis in Chapter 4 provided a reason to perform a convergence analysis within and between similar groups of regions, thereby highlighting the fact that the mix of heterogeneous economies exhibits differential behaviour which could influence the overall convergence in the sample. To validate whether regions lying within the boundary of a country behave in a similar manner owing to institutional similarity, empirical chapters 5 and 6 on China and the US were conducted. The within-country analyses of China and the US reveal great divergence between regions. This indicates that regions lying within a country differ greatly and show varied trends on convergence and inequality over time. Validating this notion of varied regional dynamics demonstrated within the European regions would not be tough, because Europe is a heterogeneous mix of countries with varied geographical size, population, income, etc. However, it would be intuitive to understand whether the regional dynamics of convergence/divergence demonstrated by countries are also followed by sub-national regions.

The importance of assessing sub-national convergence trends has been highlighted by many researchers (Webber et al., 2014; Jeffery, 2000; Bomberg and Peterson, 1998). Convergence trends at national level may not be a true representation of all the regions lying within the boundaries of a country. This is because the aggregate data on countries could be driven by a few selected better performing regions that offset the effects of other slow performing regions. The group trends at national level may not be suitable to apply at the subnational level simply because the aggregate behaviours of countries could differ across regions at a disaggregated level. For instance, Monastiriotis (2011) finds that Central and Eastern Europe are converging at the national level but diverging at the regional level. In the case of Europe, heterogeneities are prevalent not only between countries but also within countries. Therefore, the trend comparison should be between similar regions lying anywhere in Europe rather than all the regions lying within a country. An appropriate comparison could be based on regions with similar growth trajectories anywhere in Europe, e.g., Saarland in Germany should be compared with Milan in Italy if they share similar growth paths. In the light of heterogeneities across Europe, this Chapter is going to assess if the trends of regional dynamics are the same at three hierarchical levels—NUTS0, NUTS1, NUTS2.

One of the important findings of the analysis for US regions in Chapter 6 suggests that the relatively high-income states during the 2008 global recession demonstrated slow growth, which facilitated the convergence of relatively low-income regions with the rest of the States over time. The 2008 global recession had a major impact across the world. As every part of the world, the EU also suffered from the 2008 global recession. Immediately after the 2008 recession, there was the Euro debt crisis in late 2009 that had similar major impacts on European countries. The peak of these two recessions was felt in 2010 when lots of regions experienced job losses, reduced economic growth, etc. As shown in Figure 7.1 the southern European regions lying within Spain, Greece, Italy, and Portugal have still not come back to the pre-crises level of income per capita. On the other hand, the impact of these recessions was less in Central and Eastern Europe (CEE) compared to the southern European regions. It is evident that the impact of the two crises was not uniform across Europe. Therefore, just like the US, it would be insightful to find any change in regional behaviour within and between different groups of regions at three hierarchical levels. The hypothesis of this chapter is derived from the impact of two crises in Europe on regional convergence and disparity. The hypothesis to test is whether similar patterns of regional dynamics exist pre- and post-crises at the aggregate (NUTS0) and disaggregate levels (NUTS1 and NUTS2).

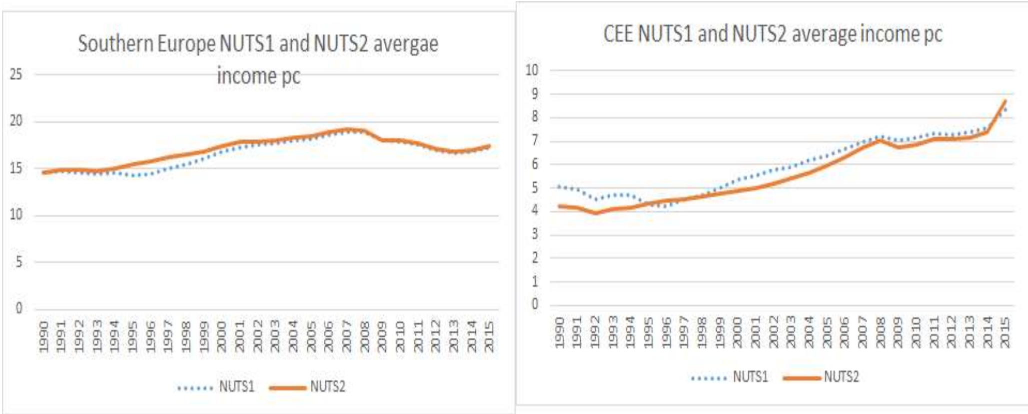


Figure 7. 1: Average income per capita (pc) of NUST1 and NUTS2 regions in southern and eastern Europe

The differential speed of growth of regions across Europe will have different impacts on convergence and disparity. It is also argued that overall convergence across Europe is mostly driven by the catching-up process experienced by the CEE and other regions may not necessarily be converging (Cuaresma et al., 2014). Moreover, Butkus et al., 2018) showed that economic disparities decreased at the country level but not at the regional level. In addition, Paci (1997) found that labour productivity disparities were declining for Europe but per capita income disparities were not. All these arguments indicate differential convergence/disparity findings for different groups of regions, different regional hierarchical levels, and different regional attributes (Borsi and Metiu, 2015). Therefore, a comprehensive pairwise analysis will be conducted at three levels of European regions in this chapter.

Compared to the Chapters on China and the US, this chapter is going to increase the complexity of analysis by analysing regional data during 1991-2015 at three hierarchical levels NUTS0 (28 countries), NUTS1 (86 regions), and NUTS2 (252 regions). This chapter will test whether the convergence trend prevalent at aggregate hierarchical level is also followed by the disaggregate levels, especially after the 2008 global recession and subsequent debt crises. The regions will be divided into groups based on their growth trajectory. Then, the X-convergence technique will help to estimate the dominant trend within- and between-groups and at all three hierarchical levels to discover whether the findings support the prevailing understanding on income convergence or divergence. This chapter is going to add to the previous empirical chapters by arguing that the choice of not only different techniques to measure convergence, but also the hierarchical levels affect the overall outcomes on convergence and disparity trends. Hence, the scale and scope of studies play important roles in the determination of convergence trends.

The major finding in this chapter suggests different outcomes on the convergence trend at aggregate and disaggregate levels. The findings further suggest that relatively high-income regions are diverging within and across groups; middle-income regions are diverging (falling behind) away from the relatively high-income group and converging with the low-income group; and low-income regions are converging within and across groups. Therefore, the findings support the evidence of convergence driven by the low-income group of regions in Europe as indicated by Cuaresma et al. (2014).

The chapter is organised as follows: section 7.2 will give a background on the reasons behind mixed outcomes of convergence trend; section 7.3 gives information on data and its sources; section 7.4 gives findings obtained by different measures of convergence and findings obtained at different hierarchical levels of regions; section 7.5 discusses the findings and relates them to literature; section 7.6 concludes the whole chapter.

7.2 Background

This section provides an overview of the literature that reveals inconsistent outcomes on convergence and divergence trends. As emphasised in the previous chapters, a wide gap in income between regions or the heterogeneity among regions lead to a problem of identifying an appropriate scale to measure convergence. To take account of heterogeneity among regions, identification of clubs of similar regions has been used by many studies. The different behaviours of economies within and between clubs/groups give rise to the mixed outcome of dominant convergence trend analysis. This section will shed light on a few other factors that contribute to the mixed findings on dominant convergence trend including analysing data at different hierarchical levels, measures of convergence, time period, and definition of regions.

One of the reasons behind mixed results of the assessment of convergence, which is highly evident in the European case, is the heterogeneity among economies. Economies differ in a wide range of indicators, such as growth rates, productivity levels, employment rates, inflation rates, etc. For instance, studies on EU regional growth has underlined heterogeneity in regional behaviour with some regions showing exceptional growth while others lag behind (Geppert and Stephan, 2008; Petrakos et al., 2005). The regions of East Anglia, South West and East Midlands of United Kingdom; Bayern and Baden-Wutenberg of Germany; and industrial regions of “Terza Italia” in Italy have been successful regions since the early 1970s. On the other hand, Nord-Pas de Calais in France; Nordrhein Westfalia in Germany; South Yorkshire in the United Kingdom; and Wallonne in Belgium have experienced below European growth averages (Cuadrado-Roura, 2001; Armstrong and Kervenodel, 1997).

The heterogeneity among regions gives rise to the existence of groups of regions with similar behaviours. The implication of the existence of groups could be found in the club convergence literature (Galor, 1996; Durlauf and Quah, 1999). The existence of club convergence in Europe made the explanation of patterns of convergence or divergence among European regions a complicated process. It has been established that regions were converging within a club, but diverging across clubs (Borsi and Metiu, 2015; Ramajo et al., 2008).

For instance, Bartkowska and Riedl (2012) applied Phillips and Sul's (2007, 2009) log *t* test to analyse data from 1990 to 2002 and found that 206 NUTS2 European regions were grouped into six separate clubs based on labour force, capital share, human capital, and income per capita. Similarly, Borsi and Metiu (2015) also applied log *t* test to confirm the existence of convergence clubs based on their geographical region rather than EU membership. Ramajo et al. (2008) used spatial econometric techniques applied to 163 NUTS2 regions across 12 EU countries and found that Ireland, Greece, Portugal and Spain were converging separately and faster than the rest of the Europe. Moreover, Webber et al. (2014) used a group-based trajectory model approach to the EU regions from 1980 to 2007 and found five groups of countries and six groups for NUTS2 regions.

Fagerberg and Verspagen (1996) suggested three different growth clubs in Europe with low, medium and high unemployment levels. Investment and R&D support from the EU appear to play significant roles in regions' growth in a group of low unemployment regions of North Italy and France. A group of high unemployment regions was characterised by low initial productivity, low levels of R&D, and substantial EU investment loans. These regions consist of the northern UK, southern Italy, and most of the Netherlands. Although the study only included regions of very few EU countries for the analysis (Germany, UK, Italy, France, Netherlands, and Belgium), the findings were well supported by many studies in due course (Gill and Raiser, 2012; Alcidi, 2019; Epstein, 2014). Subsequently, the prosperous regions were able to attract new investments and were open to innovation, while the unsuccessful regions were trapped in problems such as economic crisis, industrial revolution, socio-cultural and linguistic barriers, and inefficient technology transfers (Cuadrado-Roura, 2001).

It has been emphasised that regions within a club have similar rates of economic growth and converge to one steady state growth path, while regions across different clubs settle at different steady states.

Regions with similar characteristics in terms of GDP growth, productivity, and employment levels form one group or club (Monfort et al., 2013; Bartkowska and Riedl, 2012). Some researchers underlined that the existence of convergence clubs in Europe partly explains the divergence trend (Geppert and Stephan, 2008; Alcidi et al., 2018). That is, regions within a club might be converging but the distance between two clubs would be increasing, causing an overall or aggregate divergence across regions (Ramajo et al., 2008; Monfort et al., 2013).

The evidence of club convergence is also advocated by the studies that found a multi-speed Europe. With more than one speed across the EU regions, Gaynor and Karakitsos (2016) have identified three groups of member states that are growing at different speeds in “periphery” mainly consisting of countries like Greece and Eastern Europe countries that qualify for deeper integration process; a “median” consisting of countries like Spain that have achieved some level of convergence; and a “core” comprising of countries like France and Germany that have largely achieved convergence. Similarly, the European Commission has identified two categories of lagging regions, namely, low growth regions and low-income regions. Low growth regions are in the southern part of Europe including regions of Italy, Spain, Greece and Portugal. These regions failed to converge with the EU average between 2000 and 2013 and experienced stagnant productivity. Low-income regions are the regions of Central and Eastern Europe (CEE) including parts of Poland, Hungary, Romania, and Bulgaria. These regions had GDP per capita below 50 percent of the EU average in 2013.

The existence of a convergence club is only one of the factors that add to the complications of identifying a robust pattern of convergence/divergence across Europe. There are many other factors that add to the ongoing debate on whether a convergence or divergence trend dominates in Europe. For instance, differences in defining a region, estimation techniques, time period adopted for the study, the way growth is measured, and the influence of national growth on regional growth, all appear to be important (Geppert and Stephan, 2008; Fingleton and López-Bazo, 2006; Rodríguez-Pose, 1999; Paci, 1997).

A dominant conclusive trend can change when the scope of the study changes, for instance, when the size of the geographical areas is changed. For instance, Petrakos et al. (2011) used the beta convergence technique to assess 249 EU NUTS2 regions between 1990 and 2003 and found that a regional divergence trend dominated during the period. Cuadrado-Roura (2001) also used beta convergence and found that the process of convergence lost speed and disparities among regions were established across 109 regions. Cheshire and Magrini (2000) employed Markov chain estimates to 122 Functional Urban Regions (FUR) in Western Europe and found the existence of a divergence process in the pattern of regional growth.

On the other hand, some studies have shown the prevalence of regional convergence instead of divergence. For example, Badinger et al. (2004) analysed 196 NUTS2 regions using generalized method of moments (GMM) estimators and found the prevalence of convergence. Similarly, Cuaresma et al. (2014) employed Bayesian Model Averaging (BMA) to 255 NUTS2 regions and found that the convergence among regions was prevalent and was driven by the CEE regions. Moreover, Geppert and Stephan (2008) used Markov chain analysis and dynamic panel estimation for 207 EU15's NUTS2 and found strong regional convergence prevalent during the 1990s.

Furthermore, the outcome of convergence estimates differs depending on the hierarchical levels of data analysed. For instance, Monastiriotis (2011) employed sigma convergence and a Kuznets curve for 1276 NUTS3 regions from 1990 to 2008. The findings indicated that regional convergence was strongly linked to national development and CEE regions exhibited weaker convergence. Butkus et al. (2018) employed the Theil index to NUTS1,2,3 regions from 1995 to 2014 and found that disparities decreased at the country level but not at the regional level and the speed of convergence varies over time.

The issues related to data discrepancy has been widely recognised in the literature as well. For instance, Eurostat has highlighted the discrepancies could arise from different data sources used in the compilation of data and the lack of synchronised revision practices used by the compilers. Hence, the concurrence of a dominant trend on European convergence/divergence has become difficult to attain not because of one factor but because of several factors.

To conclude, the evidence of mixed outcomes in the convergence literature is supported by many studies. Emphasising the importance of techniques employed and grouping of regions in clubs on revealing mixed outcomes, this chapter is going to identify the convergence/divergence trend by using different techniques and show if the outcome differs across the groups of regions. This chapter tests whether mixed findings are obtained by using different techniques of measuring convergence including beta, sigma, gamma, and X-convergence. In addition, this chapter shows differential trends in convergence at different hierarchical levels, which emphasise the role of selecting the scale and scope of the study. Therefore, to test the inconsistent findings on the convergence trend, this chapter is going to perform two things: first, to show whether differential outcomes are obtained by using different techniques for measuring convergence. Secondly, whether different outcomes are obtained when the data is analysed at different levels of hierarchy, i.e., national and subnational levels.

7.3 Data

The data on income per capita used in this chapter are obtained from the European regional data from the Cambridge Econometrics database from 1991 to 2015. GVA provides a better indication of income than GDP when increases in income of a region are due to higher tax collections and subsidies and not due to actual production. However, both indicators suffer from shortcomings. The indicators ignore the effects of attributes of in-commuters to a region like London, where people commute from far off places to work. Hence, they yield overestimated figures for income of a destination region and underestimated figures for an origin.

After choosing the appropriate indicators of regional performance, the choice of geography for comparing regional performance becomes important. Commuting zones and functional urban areas are important to consider while selecting geographies to analyse. The comparison of different types and sizes of areas becomes important for international comparisons. For instance, the sizes of NUTS2 regions of Paris are bigger than the NUTS2 regions constituting London as they are divided into smaller units. Therefore, if one wants to compare the income and productivity of regions across NUTS levels for different countries, adjustments need to be made for comparing regions with similar sizes in terms of population or any other factor.

The NUTS classification is a geographical classification subdividing the economic territory of the European Union into three (NUTS1, 2, 3) subnational hierarchical levels moving from larger to smaller regions. For instance, NUTS 0 is the country level member state, NUTS 1 is the regional level, NUTS 2 is the sub regional level, and NUTS 3 is the smallest regional level member. The NUTS regions are classified based on the minimum and maximum population range as shown in Table 7.1.

Table 7. 1: NUTS classification based on population range

Level	Minimum	Maximum
NUTS 1	3,000,000	7,000,000
NUTS 2	800,000	3,000,000

The purpose of NUTS classification is to ensure that regions of the same size appear at the same NUTS level. This provides a strong foundation for regional data analysis. Due to its hierarchical nature, it becomes important to use techniques that take account of the hierarchical nature of data for assessment such as multi-level regression modelling, covariance components-modelling and hierarchical linear modelling. Simple regression techniques are insufficient for the data analysis because of their ignorance about the shared variance.

It is evident that for hierarchically structured data it is important to understand the relationship between variables that are nested at different hierarchical levels. For this, European NUTS classification gives strong support to do statistical analysis for Europe. However, there are many issues related to the use of NUTS data. As widely accepted, NUTS levels provide regions of comparable size at the same level but they are not the same in actual terms. For instance, given its relatively small population, Luxembourg, for instance, simultaneously represents NUTS-0, NUTS-1, NUTS-2 and NUTS-3 levels. In Germany, the Federal States Berlin, Hamburg, Mecklenburg-Vorpommern and Saarland function as both NUTS-1 and NUTS-2 regions (Eurostat Web site). In addition, despite the fact that this classification attempts to create comparable regions at all hierarchical levels, the regions at a given level can differ quite significantly with respect to land area, population, economic strength and administrative importance.

Another issue that has been highlighted is that the regions are defined by functional markets instead of administrative boundaries. Few researchers dispute that functional markets provide a better parameter to define a region rather than administrative boundaries (Functional Economic Market Areas - An economic note, 2010; Oberst, 2012). For this a classification known as Functional Economic Market Areas (FEMA) has been developed. FEMAs provide a spatial scale in which the limits cut across traditional local authority boundaries. According to FEMA, regions are divided based on the main drivers of economic activity in an area, using evidence gathered by the Local Economic Assessments. There is no standard approach to define a FEMA, as the trends of economic flow seem to differ depending on the market areas assessed. Some of these markets are labour market areas, housing market areas, consumer market areas, areas with easy transport and connectivity. It has been outlined that commuting flow data representing labour markets best demonstrate information about FEMAs (Berkshire Functional Economic Market Area Study, 2016). Apart from recognising the difficulty in data availability from other market areas like housing and consumer markets, it has been accepted that no single source of data is comprehensive enough for assessing FEMAs (Oberst, 2012). Most approaches in this domain have relied upon the analyses of one single market area. Considering just one type of market, however, overlooks the links between the decisions people make about where they live, work, shop and pursue leisure activities. Therefore, it is recommended that Local Planning Authorities develop a logical ‘best fit’ to encompass those FEMAs that exhibit strong inter-relationships to understand policy needs.

It has been recently established that FEMA holds an important place in local authority policy development and implementation plans. Nevertheless, the significance of administrative boundaries cannot be ignored. It is argued that FEMA could be used as a first step to analyse the key market areas, after that administrative boundaries could be used to implement the required strategies and services. This could help to provide an insight on the performance of the implemented strategies within a region. To resolve the issue of the importance of their boundaries, the ‘best fitting’ FEMA boundaries to local authority administrative boundaries is recommended by some reports (Berkshire Functional Economic Market Area Study, 2016). However, considering the nebulous nature of defining FEMA and the infancy of methodological approaches adopted in classifying FEMA, this chapter is going to use NUTS administrative boundary data for European regional data analysis. Consequently, the European regional data based on NUTS classification is the best form of data that could achieve the goals of studying the evolution of GVA convergence. Since the data is structured hierarchically, it becomes relevant to analyse the convergence pattern for different levels separately.

To conclude, for this chapter GVA per capita data are obtained from the European regional data from the Cambridge Econometrics database. The units of geography considered in this chapter are threefold NUTS0, NUTS1, NUTS2 levels. The data is analysed from 1991 to 2015 for 28 NUTS0, 86 NUTS1, and 252 NUTS2 regions. The time consideration from 1991 onwards provides the best opportunity to include subnational regions from East Germany after the German unification. The GVA data are based on millions of 2005 euros. The total population data are in thousands.

7.4 Findings

The section provides the outcomes of the convergence analysis at the national level among 28 EU countries using the beta, sigma, and gamma convergence techniques. The findings using these techniques will be compared with the findings using the X-convergence technique. The X-convergence technique will be used further to investigate the regional mobility dynamics across regions (overtaking/stagnating) at three hierarchical levels. The differences between the outcomes of traditional and X-convergence analysis will be highlighted in the study.

The descriptive statistics of per capita GVA data for 28 countries for the years 1991, 1997, 2003, 2009, and 2015 are observed in Table 7.2. Figure 7.2 shows the trend of mean per capita income by NUTS0 countries. Mean income is increasing continuously over time. This indicates that the average income of 28 EU countries is increasing continuously throughout. However, the flatter slope during 2003-2009 indicates a slower rate of growth of the average income of the EU. This is evident from an increase of only 1.14 thousand Euros income per capita from 19.18 in 2003 to 20.32 in 2009. The slow growth in per capita income during 2003-2009 could be the result of fall or slow growth in income around 2009 after the global and Eurozone crises.

The maximum and minimum per capita country income values in Figures 7.3 and 7.4 have increased during the years. The maximum earnings appear to be constant from 2003 to 2009 but increased thereafter. This suggests that the richest countries in the EU have experienced stagnation during 2003-09 but experienced growth after 2009. Luxembourg is the richest country in Europe throughout the analysis period and hence maximum values depict Luxembourg's income only. This could be misleading as maximum values based on only one country may not be a good representation for the whole of Europe. The minimum value represents the lowest income in the group of 28 countries. The minimum income trend in Figure 7.4 shows that incomes increased continuously from 2003 for low-income countries. However, the minimum income is represented by Bulgaria which has got the lowest income among all countries across Europe. Therefore, the minimum value is depicted for Bulgaria only which shows an increasing trend from 2003.

Table 7. 2: Descriptive statistics

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Gvapc1991	28	14.51	10.07	1.09	38.94
Gvapc1997	28	16.40	11.66	1.93	44.87
Gvapc2003	28	19.18	13.33	2.33	55.17
Gvapc2009	28	20.32	13.40	3.27	57.06
Gvapc2015	28	22.34	14.65	4.51	64.60

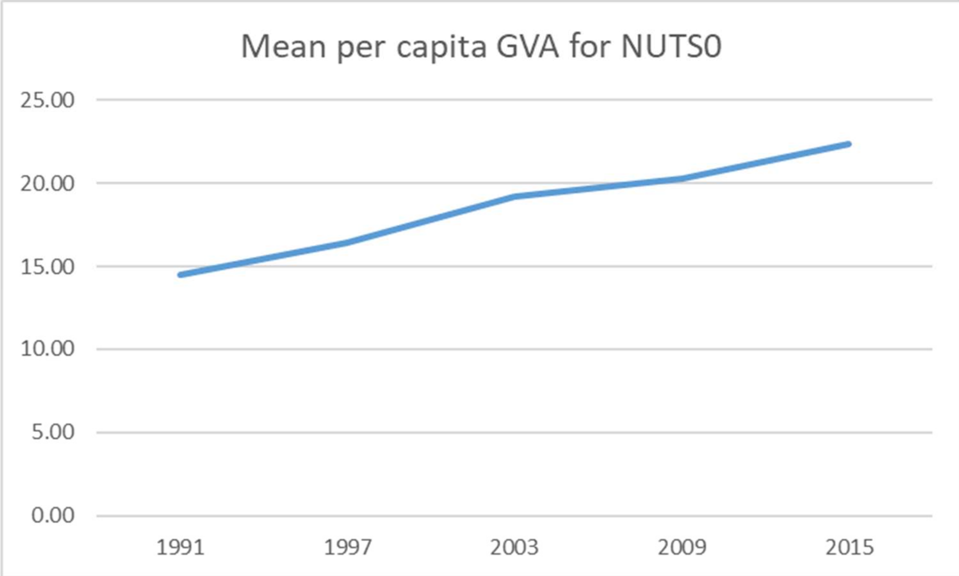
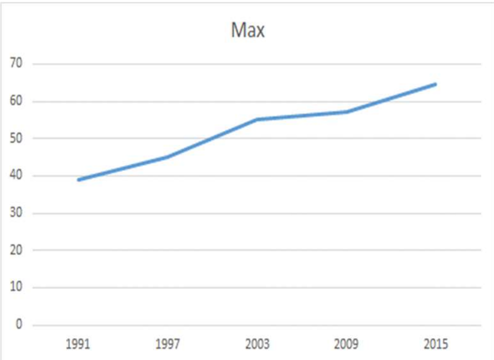


Figure 7. 2: Mean per capita GVA for 28 NUTS0 countries in 1991, 1997, 2003, 2009, and 2015.



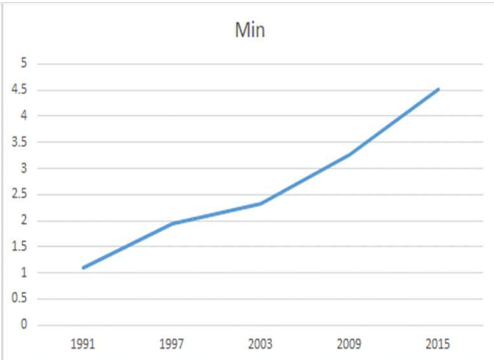


Figure 7. 3: Maximum per capita GVA *Figure 7. 4: Minimum GVA/capita*

7.41 Beta, sigma, and gamma convergence

The unconditional or absolute beta convergence estimation is used to find whether absolute convergence is happening among 28 EU countries as predicted by the neoclassical hypothesis of convergence. The absolute convergence is calculated from 1991 to 2015 using equation (1).

$$(1/T)\log(\frac{y_{it+T}}{y_{it}}) = \alpha + (-\beta)\log(y_{it}) + \in_{it} \quad (14)$$

Or, Dependent variable income growth = constant + βlngdp1991 + error

Dependent variable income growth = 0.0599316 + (-0.0167972) lngdp1991 + error

(0.0048428 *) (0.0020041*)

*Standard error in parenthesis. The *p-value* is 0 indicating a highly significant coefficient.

β coefficient is (-0.0167972)

The negative sign on the beta coefficient provides evidence of convergence among the 28 EU countries from 1991 to 2015. As emphasised in the literature, the beta coefficient value provides the behaviour of an average economy to give a generalised result. Therefore, in general, the capital poor countries in Europe are growing at a faster rate to catch-up with the richer provinces, as suggested by the neoclassical hypothesis of convergence. The value of the absolute unconditional beta coefficient is 1.6 percent. The absolute beta convergence evidence found in this section is in contrast to Petrakos et al. (2011) and Cuadrado-Roura (2001). These studies used the beta convergence indicator and found divergence among European regions.

For sigma convergence, the chapter analyses the coefficient of variation (CV) from 1991-2015, when the lower value of CV indicates lower dispersion of income between a set of economies. Lower dispersion indicates sigma convergence among a group of economies, i.e., the distance between economies reduces and they converge together. Figure 7.5 shows an increase in dispersion from 1991 to 1995 but low dispersion thereafter, suggesting existence of sigma convergence for the group over the entire period. Combining beta and sigma convergence findings, it is evident that European countries started to converge from 1995.

For the gamma convergence, the variation in rank concordance is calculated following Boyle and McCarthy (1997, 1999). The gamma indicator is close to one, which implies less mobility of economies among themselves. In addition, the indicator value close to 1 throughout, indicates low mobility between countries. Figure 7.5 shows an almost constant value of gamma, which is inconclusive about convergence among economies. However, the value of gamma convergence is close to one, which implies that economies have not changed their rank order positions much during 1991-2015. In other words, relatively high-income countries remain rich and low-income countries remain poor.

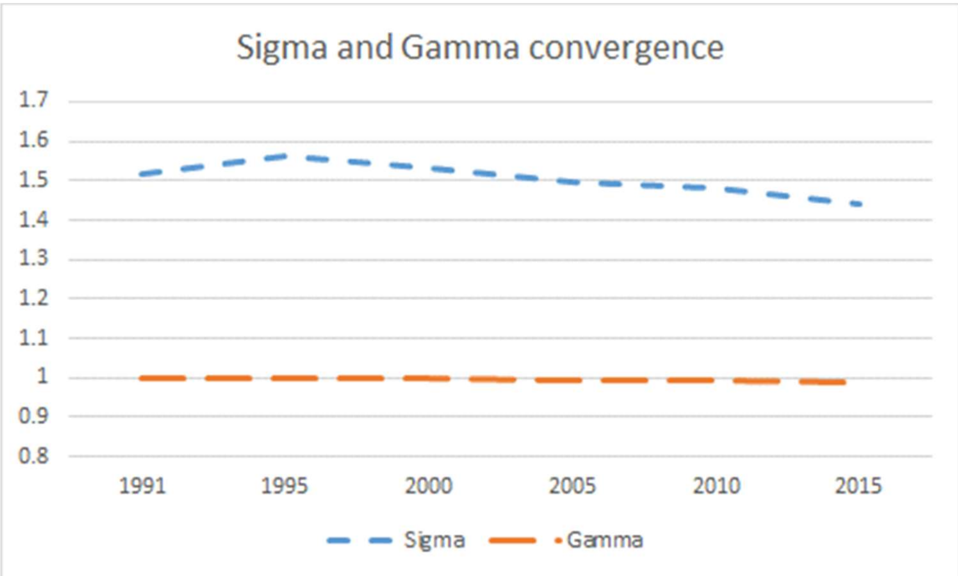


Figure 7. 5: Sigma and Gamma convergence among 28 EU countries

To conclude, beta and sigma indicators suggest the prevalence of convergence among the group of 28 EU countries. However, the gamma indicator does not provide strong information on the prevalence of convergence. Overall, these convergence findings suggest that low-income countries are catching-up with the high-income countries albeit with low mobility as indicated by the gamma convergence indicator. The next step is to validate or challenge the findings on convergence using the X-convergence technique.

7.42 X-convergence

7.421 NUTS0 convergence

GVA data for the 28 EU countries' were analysed annually from 1990 to 2015 to identify the convergence/divergence trend. The relative X-convergence technique is used to identify the convergence trend over these years. X-convergence is divided into four types of behaviours: Type I (divergence without switching), Type II (convergence without switching), Type III (convergence with switching), Type IV (divergence with switching), and Type V[3] (no convergence).

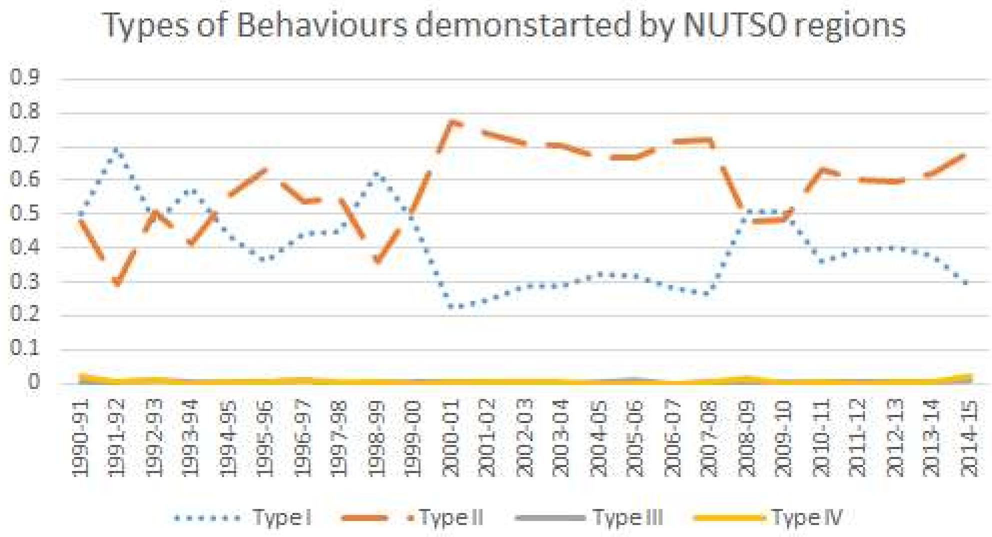


Figure 7. 6: NUTS0-Summary of annual percentages of instances of types of behaviour exhibited by pairwise NUTS0 countries. Type I = Divergence without switching, Type II = Convergence without switching, Type III = Convergence with switching, Type IV = Divergence with switching.

[3] Type V instances are nil throughout, therefore, this type of convergence is omitted from the analysis.

Figure 7.6 indicates the annual percentages of instances of behaviours demonstrated by one country with respect to others. The X-convergence technique suggests higher instances of convergence (Type II) than divergence (Type I) during the analysis period, particularly after 1999. The percentages of diverging pairs are greater in the years 1990/91, 1991/92, 1993/94, 1998/99, 2008/09, and 2009/10. The other periods show convergence among countries. Consequently, the higher evidence of convergence indicates a declining GVA per capita gap between regions, i.e., countries with the lower initial level of per capita income are growing at a faster rate and catching up with their richer counterparts. In addition, the instances of Type III and IV behaviours are very little or close to zero, which signify little mobility of regions across the distribution. The findings support the outcomes found from beta, sigma, and gamma convergence presented in section 7.41.

During the recession of 2008-09, the instances of converging pairs reduced but the percentage is almost the same for the converging and diverging pairs across two time periods. Afterwards, the percentage of convergence is greater than divergence but the percentage is less than the pre-crises period. This indicates that in the post-crises period, the frequency of pairs of converging countries has declined compared to the pre-crises period.

One of the advantages of the X-convergence technique is that we can group the countries to identify within-and between-group patterns of convergence and divergence. This helps to understand convergence and inequality trends within and between groups of similar countries. The next section will use a group-based trajectory model (GBTM) to identify groups of countries that follow similar growth trajectories.

Group analysis

The existing evidence of the presence of clubs/clusters/groups of regions was provided in section 7.2. Hence, it becomes important to group countries first and then find the convergence trend within- and between-groups. In order to classify groups of 28 NUTS0 regions and to support the club convergence literature, Nagin's group based trajectory modelling is applied. The identification of the numbers of groups was more complicated for the European data than for Chinese and American data because of the mix of highly varied regions at different stages of development in Europe.

The algorithm of group based trajectory modelling (GBTM) identified four groups for countries. The trial and error showed that the BIC is highest at -2548.96 for four groups with quadratic growth paths for group members. The other deciding factor is the p-value for every parameter. Table 7.3 shows a significant p-value for every parameter. The group membership for the first group indicates that there is 7.14 percent of total countries lie in group 1. This turns out to be two countries (0.0714*28) in group 1. Similarly, there are 10 countries (0.35*28) in group 2, 8 countries (0.29*28) in group 3, and 8 countries (0.29*28) in group 4. Table 7.3 provides a list of countries in different groups.

Table 7. 3: Group membership for 28 NUTS0 countries

Group	Parameter	Estimate	Prob > |T|
1	Intercept	-11.4337	0
	Linear	0.50842	0
	Quadratic	-0.00446	0
2	Intercept	-8.28545	0
	Linear	0.68685	0
	Quadratic	-0.01039	0
3	Intercept	-3.66946	0
	Linear	1.1259	0
	Quadratic	-0.06465	0
	Cubic	0.00121	0
4	Intercept	1.3973	0
	Linear	0.28367	0
	Quadratic	-0.00978	0.0041
Group	membership		
1	(%)	7.14298	0.1474
2	(%)	35.71424	0.0001
3	(%)	28.57138	0.001
4	(%)	28.5714	0.001

Group 1	**Group 2**	**Group 3**	**Group 4**
Luxembourg	Belgium	Czech	Bulgaria
Norway	Denmark	Greece	Estonia
	Germany	Spain	Latvia
	France	Italy	Lithuania
	Ireland	Cyprus	Hungary
	Netherlands	Malta	Poland
	Austria	Portugal	Romania
	Finland	Slovenia	Slovakia
	Sweden		
	United Kingdom		

As shown in Table 7.3, the groups of countries are mostly classified as follows: Group 1: High income group include Luxembourg and

Norway[4], Group 2: upper-middle income, Group 3: Middle-income, Group 4: Low-income countries.

The X-convergence technique is applied to understand the regional intradistributional properties of convergence, mobility, and persistence within the specified groups. The relative performance of countries with respect to their group members was analysed to examine the within- and between-group behaviours of convergence/divergence. The evidence of high instances/percentages of convergence is considered as countries/economies become more or less equal. The group analysis findings are shown in Figure 7.7.

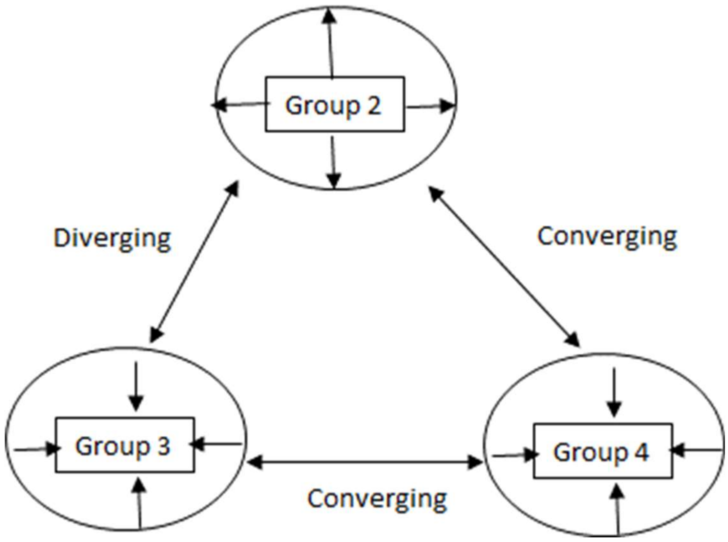


Figure 7. 7: Group behaviour of NUTS0 countries. Inward arrow shows convergence and outward arrow shows divergence within a group.

The percentage of convergence and divergence is calculated for within and between group members. Based on the majority of periods of higher instances of convergence (Type II+III) and divergence (Type I+IV), Figure 7.7 illustrates the overall trend of convergence and

[4] Luxembourg, Estonia, Cyprus, Latvia, Lithuania, and Malta are considered as NUTS2 regions. Also, Norway is not a part of European Union. These countries are dropped from the list for convergence analysis later on.

divergence within and between groups. The Figure 7.7 shows that countries within groups 3 and 4 are having higher instances of converging pairs (shown by inward arrows) but countries within group 2 are having higher percentages of diverging pairs (shown by outward arrows) during 1990-2015. Group 2 is a relatively high-income group of countries that demonstrate higher instances of diverging pairs implying the relatively rich countries within the group are growing at a faster pace or relatively poor countries within the group are falling behind. To check what is happening within this group; within group analysis is done in the next section.

Within group analysis

Group 2 is a group of upper-middle income countries that are showing signs of increasing inequality among themselves. This finding suggests that both the situations are occurring within the group—relatively richer countries within group 2 are growing at a faster rate and relatively poor countries are falling behind. Delving deeper into the behaviours of countries within group 2 reveals convergence and divergence trends without switching from 2000, as shown in Figure 7.8.

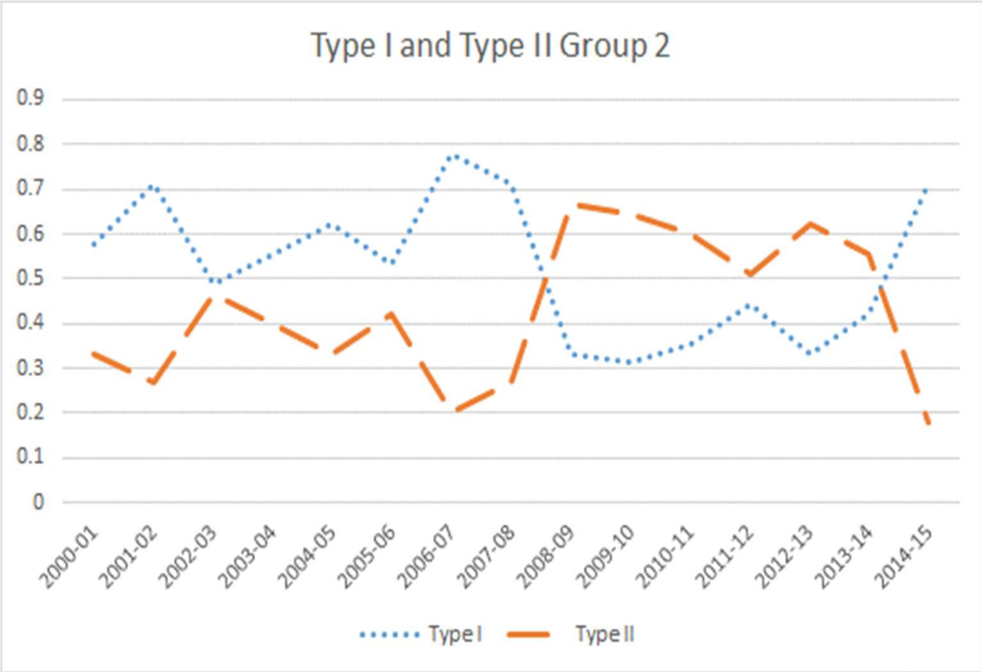


Figure 7. 8: Type I and Type II behaviours trends within upper-middle income countries (group 2) during 2000-2015. Type I indicates divergence without switching and Type II indicates convergence without switching

Figure 7.8 shows that the countries within group 2 are diverging for all periods, except 2008-2014. This behaviour is different from the aggregate behaviour of the whole sample of countries shown in Figure 7.6, which indicates that convergence during the 2000s and divergence during 2008-2010 for the whole sample are not driven by upper-middle income countries.

The economic crises slowed the economy which coincided with higher instances of converging pairs during 2008-2014 across high-income countries. The relatively richer countries slowed down and poor countries grew faster to converge with each other owing to the 2008 global and subsequent debt crises.

Examination of these countries' behaviours individually will indicate which country exhibits a higher number of diverging pairs—if a high-income country demonstrates a higher number of diverging pairs within the group, then it implies that the country is getting richer and diverging away from the rest. Table 7.4 shows the top 3 and bottom 3 countries' instances of converging and diverging pairs within the group from 2010 onwards. Ireland has the highest income during 2015 and it converges with all nine countries during 2010-11 and diverges with all nine countries in 2013-14 and 2014-15. During 2010-2012, Ireland demonstrates higher instances of convergence with the rest of the group members which suggest it was growing faster than the rest while coping with the crises during 2008-09. After 2012, it grew faster and diverged away from the rest. Thus, as a relatively richer country, Ireland, grew faster than the rest in the group and diverged away from the rest in recent years. Similarly, Denmark and Sweden being relatively richer countries within the group, diverged away from the rest after 2012 suggesting that they grew relatively faster than the rest during 2013-2015. However, Denmark and Ireland being small countries with less population make their GVA per capita more responsive to global pressure.

For the bottom three countries, Finland, France, and the United Kingdom (UK) grew relatively slower than the rest during 2012-2015 and diverged away from the rest of the group members. Therefore, higher instances of diverging pairs after 2013/14 in Figure 7.8 is explained by the higher growth rates of relatively rich countries and slower growth of these three relatively poor countries. There have been very few switching instances that suggest the persistence of high- and low-income groups of countries within the group.

Table 7. 4: Top 3 and bottom 3 countries based on 2015 income per capita within group 2

		2015 Top 3 countries			2015 Bottom 3 countries		
		Ireland	Denmark	Sweden	Finland	France	UK
2010-11	Divergence	0	1	5	5	3	3
	Convergence	9	8	4	4	6	6
2011-12	Divergence	2	5	3	7	3	4
	Convergence	7	4	6	2	6	5
2012-13	Divergence	8	7	8	8	5	6
	Convergence	1	2	1	1	4	3
2013-14	Divergence	9	6	7	8	7	6
	Convergence	0	3	2	1	2	3
2014-15	Divergence	9	9	9	5	7	7
	Convergence	0	0	0	4	2	2

Within group 3 and 4 the countries demonstrate higher instances of converging pairs than diverging pairs. Figure 7.9 shows that group 3 members are converging with their group members and group 4 members show erratic behaviour of convergence and divergence.

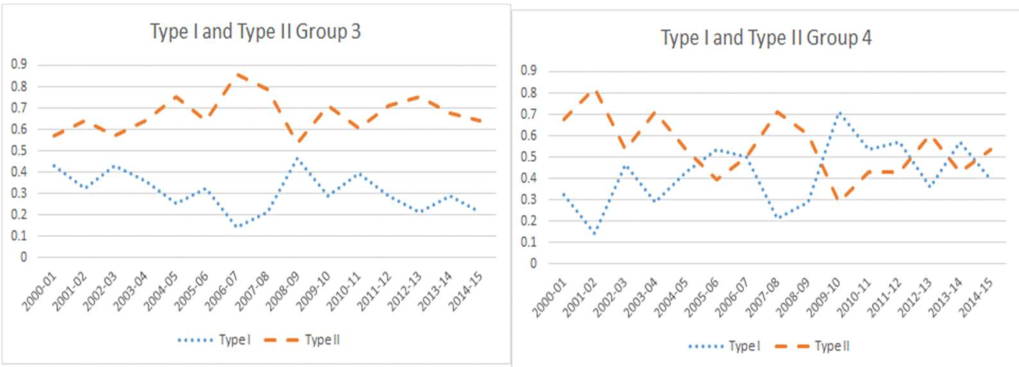


Figure 7. 9: Type I and Type II behaviours trends within group 3 and 4 during 2000-2015

Assessing the average income of countries within group 3 and 4, the average income per capita declines for a longer period for group 3 members than for group 4. This suggests that the countries within group 3 suffered more from the two crises for a longer period when compared to group 4 countries. Group 3 consists of countries that are categorised as low-growth by the European Commission and group 4 consists of countries that are categorised as low-income countries.

Countries in group 3 experienced ups and downs in their income per capita after 2008 and there is no consistent pattern. Only Malta showed a relatively consistent increase in income from 2009 to 2015. Therefore, it would be unrealistic to conclude if any country is growing constantly faster or slower within the group after the crises.

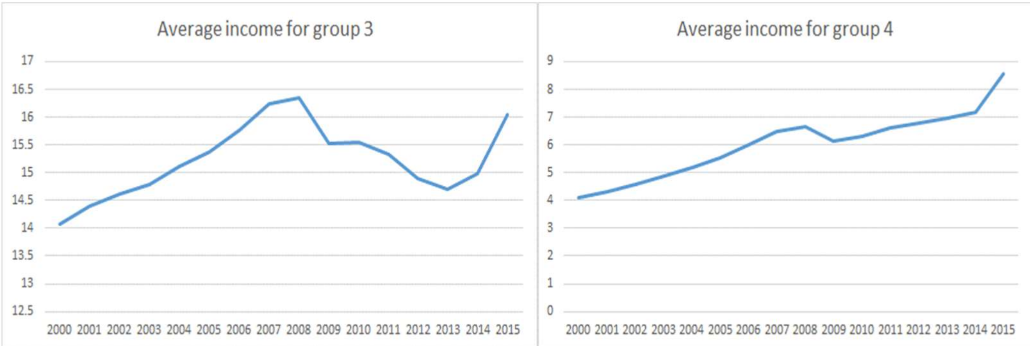


Figure 7. 10: Type I and Type II behaviour trends within group 3 and 4 during 2000-2015

Group 4 countries are a part of a low-income countries group categorised by the European Commission. They showed signs of improved performance from 2009. All countries showed signs of growth but one country grew faster in one period and another country grows faster in another period. There is no pattern of consistent growth demonstrated by individual countries relative to one another. Therefore, there is an erratic pattern of convergence after the crises.

Between group analysis

As shown in Figure 7.7, group 2 consists of upper-middle income countries that have higher instances of diverging pairs with members of group 3 and are converging with group 4. Group 3 and 4 seem to converge with each other. This indicates that group 2 members are becoming richer relative to members of group 3 and 4 and there is persistence in groups of relatively high- and low-income countries.

Therefore, the relatively richer nations remain rich and poor nations remain poor. In addition, group 4 members are catching-up with group 2 and 3 members. Group 4 countries are converging and reducing their disparities with the rest of the countries in group 2 and 3. Group 3 members have diverged compared to group 2 members that are relatively richer. This indicates that there is a need for members of group 3 to grow faster to catch-up with group 2 members.

To conclude, we can see that application of the X-convergence technique provides a deeper understanding of the convergence trend than using standard measures of convergence at NUTS0 level. The aggregate findings are similar using all the different techniques, however, the group analysis offer opportunities to provide better insights into groups of countries' regional dynamics. The findings suggest that the upper-middle income group of countries higher instances of diverging pairs exist, suggesting an increasing gap between the relatively rich and poor countries. Group 3 and 4 show higher instances of convergence or reduction in income disparity within group members. The negative effects of crises in terms of generating a lower average per capita income is evident for group 3 (consisting of southern European countries). By establishing the fact about promising outcomes obtained by X-convergence technique, the study will explore the convergence trend at NUTS1 and NUTS2 levels in the next sections.

7.422 NUTS1 convergence

There are 86 NUTS1 regions analysed pairwise for identifying the convergence/divergence trend annually from 1990 to 2015. Overall, there are more episodes of convergence than divergence for NUTS1 regions, as shown in Figure 7.11. There has been the continuous occurrence of convergence from 1994 to 2009. The year 2009/10 has experienced the highest percentage of diverging pairs of economies:

60 percent approx. Later, for three years from 2009 to 2012, income per capita diverged between many regions implying an increasing gap between the better off and worse off regions. The difference between the frequencies of convergence and divergence was high between 2009-2012, which indicates an impact of the lagged recessionary events of the 2008 global and European debt crises of late 2009. Compared to the aggregate level country analysis, the impact of the crises seem to be more intense for NUTS1 level regions than for NUTS0 countries.

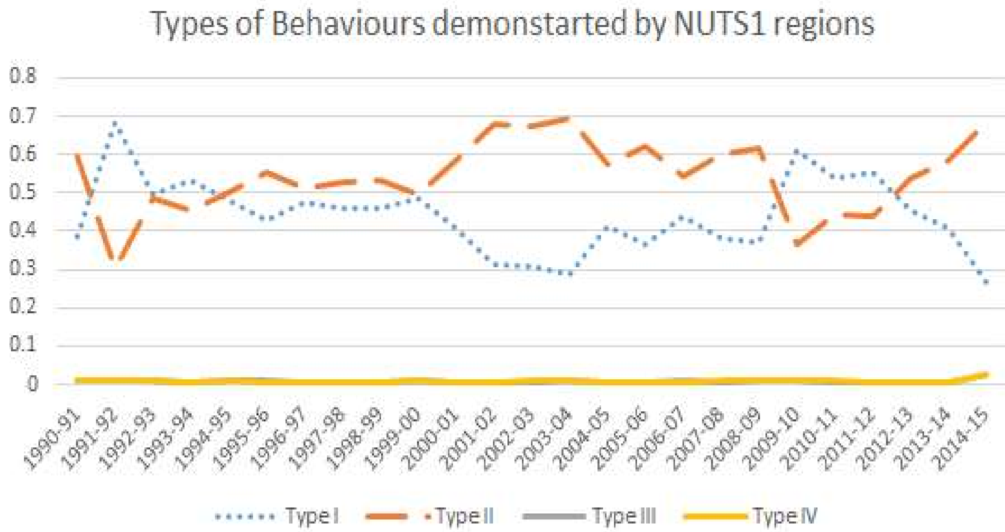


Figure 7. 11: NUTS1-Summary of annual percentages of instances of types of behaviour exhibited by pairwise regions

The intradistributional dynamics during the 2008/09 period for the top 10 and bottom 10 NUTS2 regions in Table 7.5 indicate that the richer regions of Germany (de5, de6, de7), France (fr1), and the UK (uki, ukj) are experiencing more instances of convergence (Type II+III) than divergence (Type I+IV), while richer regions of Belgium (be1), Netherlands (nl3), Finland (fi2), and Sweden (se1) are more frequently diverging than converging with other NUTS1 regions. That is, the impact of the 2008/09 events had a smaller effect on the rich regions of Belgium, Netherlands, Finland, and Sweden than in comparison to Germany, France, and UK regions. The former group of four countries experienced a slowdown but not as much as the latter three countries and, therefore, these countries' rich regions continued to diverge with the others and maintained their top-rank positions.

Looking at the bottom 10 regions, regions of Hungary (hu2 and hu3) and Romania (ro3 and ro4) deteriorated more than others by exhibiting high percentage of divergence with other regions. These regions experienced much slower growth rates and were left behind with an increased economic gap between themselves and others.

The years following 2009 saw a gradual decrease in diverging pairs of economies until 2012 and the economies started to converge until 2015. The intra-distributional analysis of the bottom 10 NUTS2 regions in year 2015, presented in Table 7.5 reveals the same bottom 10 regions as in 2009, except the ro3 region of Romania which improved and left the group. The PTl4 region of Poland was a new addition to the bottom group of 10 regions. Each region exhibited high percentage of Type II behaviour, suggesting convergence with other regions. Moreover, the top 10 regions have mostly converged with the other 85 regions barring se1 region of Sweden. Therefore, evidence suggests there was a higher rate of growth for poorer regions, suggesting an eventual decline in regional economic disparities with the richer regions.

Table 7. 5: 2009 and 2015 top and bottom 10 NUTS1 regions demonstrating types of behaviours

2009 Top 10		Type I	Type II	Type III	Type IV
be1	Brussels (Belgium)	0.747	0.241	0	0.013
de5	Bremen (Germany)	0.076	0.899	0	0.025
de6	Hamburg (Germany)	0.266	0.734	0	0
de7	Hesse (Germany)	0.241	0.747	0.013	0
fr1	Île de France (France)	0.468	0.532	0	0
nl3	Western Netherlands	0.608	0.38	0	0.013
fi2	Åland (Finland)	0.823	0.152	0.025	0
se1	East Sweden	0.62	0.367	0	0.013
uki	London (UK)	0.392	0.595	0	0.013
ukj	South East England (UK)	0.278	0.709	0.013	0
2009 Bottom 10					
bg3	Northern and Eastern Bulgaria	0.152	0.848	0	0
bg4	South-Western and South-Central Bulgaria	0.139	0.861	0	0
hu2	Transdanubia (Hungary)	0.835	0.127	0	0.038
hu3	Great Plain and North (Hungary)	0.709	0.278	0.013	0
pl3	Region Wschodni (Poland)	0.139	0.848	0.013	0
pl6	REGION PÓŁNOCNY (Poland)	0.101	0.899	0	0
ro1	Macroregion one (Romania)	0.342	0.658	0	0
ro2	Macroregion two (Romania)	0.367	0.633	0	0
ro3	Macroregion three (Romania)	0.81	0.19	0	0
ro4	Macroregion four (Romania)	0.506	0.494	0	0

2015 Top 10		Type I	Type II	Type III	Type IV
be1	Brussels (Belgium)	0.34	0.65	0.01	0.00
de5	Bremen (Germany)	0.32	0.66	0.01	0.01
de6	Hamburg (Germany)	0.16	0.81	0.03	0.00
de7	Hesse (Germany)	0.25	0.72	0.01	0.01
de1	Baden-Württemberg (Germany)	0.25	0.71	0.01	0.03
de2	Bavaria (Germany)	0.25	0.75	0.00	0.00
fr1	Île de France (France)	0.30	0.70	0.00	0.00
nl3	Western Netherlands	0.37	0.63	0.00	0.00
se1	East Sweden	0.59	0.41	0.00	0.00
uki	London (UK)	0.00	0.97	0.03	0.00
2015 Bottom 10					
bg3	Northern and Eastern Bulgaria	0.06	0.94	0.00	0.00
bg4	South-Western and South-Central Bulgaria	0.04	0.96	0.00	0.00
hu2	Transdanubia (Hungary)	0.06	0.92	0.00	0.01
hu3	Great Plain and North (Hungary)	0.19	0.81	0.00	0.00
pl3	REGION WSCHODNI (Poland)	0.09	0.91	0.00	0.00
pl4	REGION PÓŁNOCNO-ZACHODNI (Poland)	0.05	0.94	0.01	0.00
pl6	REGION PÓŁNOCNY (Poland)	0.05	0.94	0.00	0.01
ro1	Macroregion one (Romania)	0.05	0.95	0.00	0.00
ro2	Macroregion two (Romania)	0.06	0.94	0.00	0.00
ro4	Macroregion four (Romania)	0.05	0.95	0.00	0.00

Next step is to group the regions using the GBTM procedure to undertake within- and between group regional dynamic trend analyse.

The algorithm of group based trajectory modelling (GBTM) identified four groups for NUTS1 regions. The trial and error showed that the BIC is highest at -7791.73 for four groups with mixed growth paths for group members. The other deciding factor is the p-value for every parameter. Table 7.6 shows a significant p-value for every parameter. The group membership for the first group indicates that there is 13.95 percent of total NUTS1 regions lie in group 1. This turns out to be 12 NUTS1 regions (0.1395*86) in group 1. Similarly, there are 16 NUTS1 regions (0.186*86) in group 2, 25 NUTS1 regions (0.3023*86) in group 3, and 32 NUTS1 regions (0.372*86) in group 4. Table 7.6 also provides a list of NUTS1 regions in different groups.

Table 7. 6: Group membership for 86 NUTS1 regions

Group	Parameter	Estimate	Prob > |T|
1	Intercept	-3.77268	0
	Linear	0.31512	0
	Quadratic	-0.00371	0
2	Intercept	6.65887	0.0185
	Linear	-1.41707	0.0582
	Quadratic	0.10015	0.0065
	Cubic	-0.00198	0.0009
3	Intercept	-12.50952	0
	Linear	1.06078	0
	Quadratic	-0.01815	0
4	Intercept	1.49238	0
	Linear	0.39168	0
	Quadratic	-0.04076	0
	Cubic	0.00129	0
Group	membership		
1	(%)	13.95348	0.0002
2	(%)	18.59801	0
3	(%)	30.23913	0
4	(%)	37.20938	0

Group 1	Group 2	Group 3	Group 4
be1	be3	be2	bg3
de1	def	de9	bg4
de2	el3	dea	el5
de5	es2	deb	el6
de6	es5	dec	el4
de7	fr2	es3	es1
fr1	fr3	fr7	es4
nl3	fr4	itc	es6
fi2	fr5	ith	es7
se1	fr6	iti	fra
uki	fr8	nl1	itf
ukj	ukc	nl2	itg
	uke	nl4	hu1
	ukl	at1	hu2
	ukn	at2	hu3
	ded	at3	pl1
		fi1	pl2
		se2	pl3
		se3	pl4
		ukd	pl5
		ukf	pl6
		ukg	pt1
		ukh	pt2
		ukk	pt3
		ukm	ro1
		de3	ro2
			ro3
			ro4
			de4
			de8
			dee
			deg

Group 1 consists of 12 relatively high-income regions with an average income of 37.58 dollars in 2015.

Group 2 consists of 16 middle-income regions with an average income of 20.94 dollars in 2015.

Group 3 consists of 25 upper-middle income regions with an average income of 26.21 dollars in 2015.

Group 4 consists of 32 relatively low-income regions with an average income of 11.60 dollars in 2015.

Figure 7.12 shows that overall regions within group 1, 2, and 4 are having higher instances of converging pairs but regions within group 3 are having higher percentages of diverging pairs. Groups 2, 3 and 4 are catching-up and becoming more similar to each other. Group 3 consist of upper-middle income regions and seems to show higher instances of divergence than convergence, implying relatively high income regions within the group are growing at a faster rate than the poorer ones. In other words, relatively rich regions remain rich and poor regions remain poor.

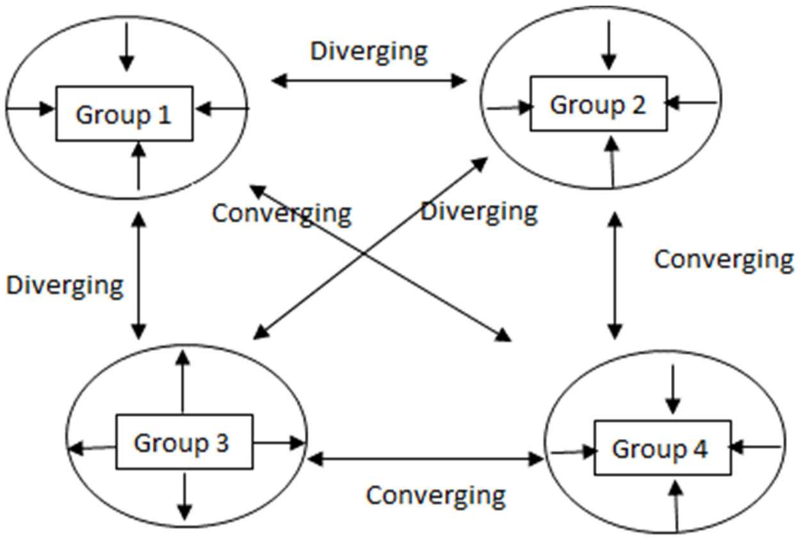


Figure 7. 12: Group behaviour of NUTS1 regions

<u>*Within group 3 analysis*</u>

Delving deeper within group 3 in which regions are diverging among themselves, the Types I and II of behaviours are shown in Figure 7.13.

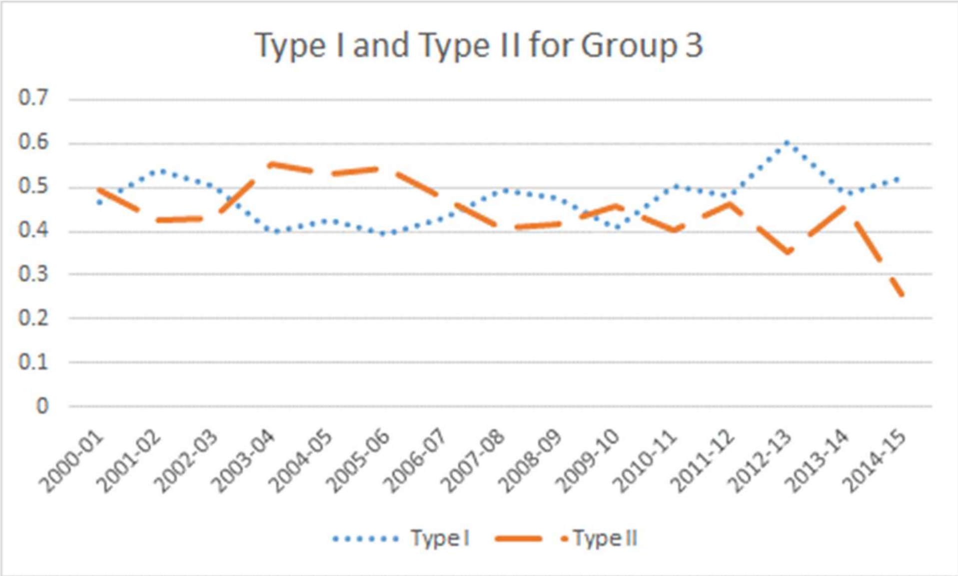


Figure 7. 13: Type I and Type II behaviours trends within upper-middle income countries (group 2) during 2000-2015. Type I indicates divergence without switching and Type II indicates convergence without switching

The figure shows that the higher instances of divergence within group 3 started from almost 2006 and continued until 2015. There are 26 regions in group 3 and the top NUTS1 regions are growing at a faster rate. It is demonstrated in Table 7.7, that the top 3 regions exhibit higher numbers of diverging pairs than converging pairs in almost every period. These regions are growing faster and diverging away from the rest securing their top positions. Table 7.7 shows that among the bottom regions, iti (central region of Italy) had a higher instances of diverging pairs, suggesting that the region is stagnating or lagging behind the rest in recent years. The bottom regions of South-West UK (ukk) had higher instances of diverging pairs in almost every period, suggesting the region is lagging behind. Other regions of the UK, including ukf (East Midlands), ukd (North West), and ukg (West Midlands) are demonstrating higher instances of diverging pairs in 2010-11 and 2014-15. For other periods they were converging more than diverging, indicating that their income has grown at a faster rate than others during these periods. The regions of the UK recorded higher instances of Type III and IV behaviours, i.e., they exchanged places with the rest of 25 regions.

Table 7. 7: 2015 Bottom 5 and Top 3 regions demonstrating convergence and divergence during 2010-2015

		2015 Bottom 5 regions group 3					2015 Top 3 regions		
		iti	**ukk**	**ukf**	**ukd**	**ukg**	**be2**	**at3**	**nl4**
2010-11	Divergence	20	14	17	17	17	14	20	19
	Convergence	5	11	8	8	8	11	5	6
2011-12	Divergence	24	12	11	10	4	13	24	7
	Convergence	1	13	14	15	21	12	1	18
2012-13	Divergence	25	15	7	9	11	17	17	15
	Convergence	0	10	18	16	14	8	8	10
2013-14	Divergence	24	16	7	13	4	16	5	19
	Convergence	1	9	18	12	21	9	25	6
2014-15	Divergence	13	19	22	21	23	21	20	22
	Convergence	12	6	3	4	2	4	5	3

Figure 7. 14: Type I and Type II behaviours of Group 1,3,4 to demonstrate higher instances of converging pairs post-crises with respective group members.

<u>Between groups analysis</u>

The between-group analysis, as shown in Figure 7.12, suggests that between group 1 and group 2 there are more diverging pairs of regions than converging. Similarly, group 1 and group 3 have higher instances of diverging pairs between the regions. Groups 3 and 2 have higher instances of diverging pairs too. The higher instances of diverging pairs between groups 1, 2 and 3 suggest that some of the high income regions in group 1 are growing faster and diverging away from the rest. Similarly, some of the high income regions of group 3 are growing faster than the group 2 regions and diverging away from the group. Note that in terms of income per capita, group 1 has the highest income regions, group 3 has second highest regions, and group 2 has the third highest income regions. In other words, income of group 1>group 3> group 2. Therefore, group 2 regions are lagging behind the regions in group 1 and 3.

Group 4 is a group of regions with the lowest incomes. This group has more instance of converging pairs with rest of the groups. In terms of persistence, there are lower instances of Type III and IV behaviours between groups compared to within groups. This suggest that there is persistence in groups among NUTS1 regions.

To conclude, the high-income regions of NUTS1 (be1, nl3, se1, fi2) are growing at a faster rate and diverging away from the rest in 2009 but all top 10 regions in 2015 were converging with the rest suggesting more equality among regions in recent years. The upper-middle income group of regions exhibits divergence among themselves, indicating increasing disparities within the group. The group of relatively low-income regions are showing higher instances of converging pairs within as well as between groups depicting a catching-up process. This is because they are growing at a faster rate than others.

7.423 NUTS2 convergence

There are 252 NUTS2 regions analysed pairwise across Europe for this section. Figure 7.15 shows an erratic trend of convergence and divergence until 2000 and a continuous trend of convergence from

2000 to 2009. The period from 2009 to 2013 is the period of higher instances of diverging pairs of economies showing high regional disparities between the well off and worse off regions. This could be the effect of two crises during this time when many regions were showing low-income growth. Type III and Type IV behaviours are close to zero, which indicate that the mobility of NUTS2 regions.

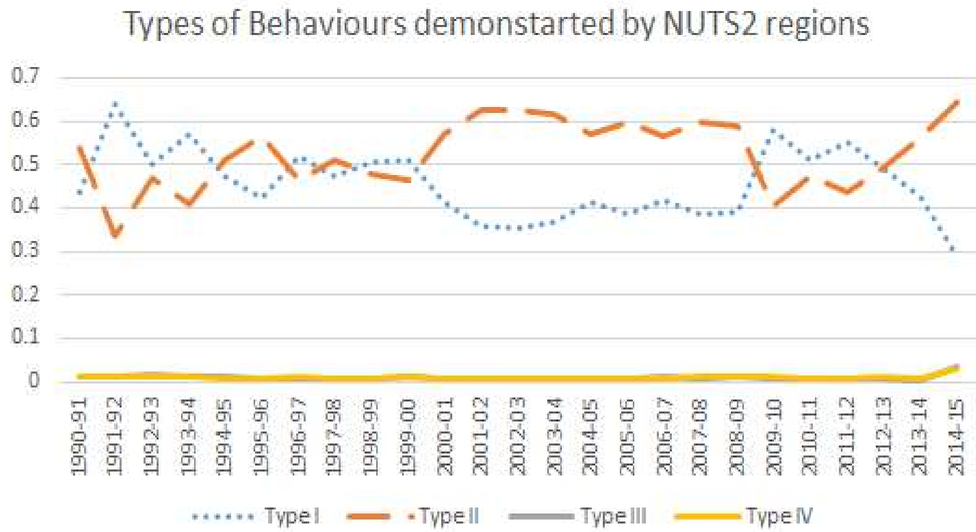


Figure 7. 15: NUTS2-Summary of annual percentages of instances of types of behaviour exhibited by pairwise regions

Considering the top 10 NUTS2 regions based on their 2009 GVA per capita, as shown in Table 7.8, regions dk01, se11, uki3, ukj1 and no6 were diverging (Type I+IV) with 251 other regions during 2009/10. The regions of uki4, ukm5, no1, no4, and no5 are converging (Type II+III) with the rest. The former group of regions were growing at a faster rate than others and moving to the top. On the other hand, although the latter group of regions were among the top regions, they were not growing as fast as the former group of regions and converged with the rest. Compared to 2009, in 2015 a few new regions from Norway and Ireland were added to the top 10 category and certain regions from the UK had been dropped from the category. All the regions in 2015 (except uki3) are demonstrating higher instances of diverging pairs with the rest suggesting high-income growth for them.

Looking at the bottom 10 trend in year 2009, all of the regions have shown greater evidence of divergence, except bg42 and ro22 regions. This indicates that the poorer regions are falling behind due to their slow growth rate and the gap between them and the well-off regions was increasing. The increasing disparity suggests a noticeable impact of the crises on lagging regions until 2012 and afterwards regions showed continuous episodes of convergence. When the intra-distributional properties of the bottom 10 regions were analysed for 2015, all of the bottom regions were the same as in 2009 except ro22 which was replaced by hu32. Hence, the position of poor regions has not changed much and they are still in the poor category. On a positive note, all of the 2015 bottom 10 regions are converging, implying that the regions are growing at a faster rate than some well off regions.

Table 7. 8: 2009 and 2015 top and bottom 10 NUTS2 regions demonstrating types of behaviours

2009 Top 10		Type I	Type II	Type III	Type IV
dk01	Hovedstaden (Denmark)	0.83	0.16	0.00	0.00
se11	Stockholm (Sweden)	0.54	0.46	0.00	0.00
uki3	Inner London - West (UK)	0.71	0.29	0.00	0.00
uki4	Inner London - East (UK)	0.31	0.69	0.00	0.00
ukj1	Berkshire, Buckinghamshire, and Oxfordshire (UK)	0.63	0.37	0.00	0.00
ukm5	North Eastern Scotland (UK)	0.41	0.58	0.00	0.00
no1	Oslo og Akershus (Norway)	0.34	0.66	0.00	0.00
no4	Agder og Rogaland (Norway)	0.24	0.76	0.00	0.00
no5	Vestlandet (Norway)	0.08	0.92	0.00	0.00
no6	Trøndelag (Norway)	0.61	0.39	0.00	0.00
2009 Bottom 10					
bg31	Northwestern Bulgaria	0.83	0.17	0.00	0.00
bg32	Northern Central Bulgaria	0.80	0.20	0.00	0.00
bg33	Northeastern Bulgaria	0.61	0.39	0.00	0.00
bg34	Southeastern Bulgaria	0.68	0.32	0.00	0.00
bg42	Southern Central Bulgaria	0.30	0.70	0.00	0.00
ro11	Nord-Vest (Romania)	0.92	0.08	0.00	0.00
ro21	Nord-Est (Romania)	0.87	0.13	0.00	0.00
ro22	Sud-Est (Romania)	0.45	0.55	0.00	0.00
ro31	Sud-Muntenia (Romania)	0.93	0.07	0.00	0.00
ro41	Sud-Vest Oltenia (Romania)	0.68	0.32	0.00	0.00

2015 Top 10		Type I	Type II	Type III	Type IV
dk01	Hovedstaden (Denmark)	0.69	0.29	0.01	0.01
se11	Stockholm (Sweden)	0.54	0.45	0.01	0.01
uki3	Inner London - West (UK)	0.00	1.00	0.00	0.00
no1	Oslo og Akershus (Norway)	0.85	0.15	0.00	0.00
no03	Sør-Østlandet (Norway)	0.83	0.12	0.02	0.03
no4	Agder og Rogaland (Norway)	0.93	0.06	0.00	0.01
no5	Vestlandet (Norway)	0.87	0.12	0.00	0.01
no6	Trøndelag (Norway)	0.85	0.13	0.01	0.01
no07	Nord-Norge (Norway)	0.83	0.14	0.01	0.02
ie02	Southern and Eastern Ireland	0.84	0.12	0.01	0.02
2015 Bottom 10					
bg31	Northwestern Bulgaria	0.08	0.92	0.00	0.00
bg32	Northern Central Bulgaria	0.07	0.92	0.00	0.00
bg33	Northeastern Bulgaria	0.06	0.94	0.00	0.00
bg34	Southeastern Bulgaria	0.06	0.94	0.00	0.00
bg42	Southern Central Bulgaria	0.02	0.98	0.00	0.00
ro11	Nord-Vest (Romania)	0.05	0.95	0.00	0.00
ro21	Nord-Est (Romania)	0.06	0.94	0.00	0.00
hu32	Northern Great Plain (Hungary	0.32	0.66	0.01	0.00
ro31	Sud-Muntenia (Romania)	0.03	0.97	0.00	0.00
ro41	Sud-Vest Oltenia (Romania)	0.06	0.94	0.00	0.00

Group Analysis

The next step is to group the regions using the GBTM approach to understand within- and between-group regional dynamic trend analysis.

The algorithm of group based trajectory modelling (GBTM) identified four groups for NUTS2 regions. The trial and error showed that the BIC is highest at - 38103.91 for four groups with mixed growth paths for group members. The other deciding factor is the p-value for every parameter. Table 7.9 shows a significant p-value for every parameter. The group membership for the first group indicates that there is 9.12 percent of total NUTS2 regions lie in group 1. This turns out to be 23 NUTS2 regions (0.0912*252) in group 1. Similarly, there are 229 NUTS2 regions (0.9088*252) in group 2. Table 7.9 also provides a list of NUTS1 regions in different groups.

Two groups of regions were identified. Group 1 consists of 23 relatively high-income regions with an average income of 46.71 units in 2015. Group 2 consists of 229 relatively low-income regions with an average income of 19.31 units in 2015.

Table 7. 9: Group membership for 252 NUTS2 regions

Group	Parameter	Estimate	Prob > |T|
1	Intercept	0.70495	0
	Linear	0.0368	0
	Quadratic	-0.00013	0
2	Intercept	1.09438	0
	Linear	0.06896	0
Group	membership		
1	(%)	9.12698	0
2	(%)	90.87301	0

Group 1		Group 2							
dk01		be21	de12	el63	fr41	itg1	at22	ro22	uke2
de11		be22	de13	el64	fr42	itg2	at31	ro31	uke3
de21		be23	de14	el65	fr43	ith1	at32	ro32	uke4
de71		be24	de22	el41	fr51	ith2	at33	ro41	ukf1
fra5		be25	de23	el42	fr52	ith3	at34	ro42	ukf2
ie02		be31	de24	el43	fr53	ith4	pl11	si03	ukf3
nl11		be32	de25	es11	fr61	ith5	pl12	si04	ukg1
nl31		be33	de26	es12	fr62	iti1	pl21	sk01	ukg2
nl32		be34	de27	es13	fr63	iti2	pl22	sk02	ukg3
at13		be35	de72	es21	fr71	iti3	pl31	sk03	ukh1
fi1b		bg31	de73	es22	fr72	iti4	pl32	sk04	ukh2
se11		bg32	de91	es23	fr81	hu21	pl33	fi19	ukh3
uki3		bg33	de92	es24	fr82	hu22	pl34	fi1c	uki5
uki4		bg34	de93	es41	fr83	hu23	pl41	fi1d	uki6
ukj1		bg41	de94	es42	fra1	hu31	pl42	se12	uki7
ukm5		bg42	dea1	es43	fra2	hu32	pl43	se21	ukj2
no01		cz01	dea2	es51	fra3	hu33	pl51	se22	ukj3
no02		cz02	dea3	es52	fra4	nl12	pl52	se23	ukj4
no03		cz03	dea4	es53	ie01	nl13	pl61	se31	ukk1
no04		cz04	dea5	es61	itc1	nl21	pl62	se32	ukk2
no05		cz05	deb1	es62	itc2	nl22	pl63	se33	ukk3
no06		cz06	deb2	es63	itc3	nl23	pt11	ukc1	ukk4
no07		cz07	deb3	es64	itc4	nl33	pt15	ukc2	ukl1
		cz08	el51	fr21	itf1	nl34	pt16	ukd1	ukl2
		dk02	el52	fr22	itf2	nl41	pt17	ukd3	ukm2
		dk03	el53	fr23	itf3	nl42	pt18	ukd4	ukm3
		dk04	el54	fr24	itf4	at11	ro11	ukd6	ukm6
		dk05	el61	fr25	itf5	at12	ro12	ukd7	
			el62	fr26	itf6	at21	ro21	uke1	

Figure 7. 16: Group behaviour of NUTS2 regions

Figure 7.17 shows group 1 regions demonstrating higher instances of diverging pairs after 2010 indicating increasing disparity among regions within the group. Group 1 consists of relatively high-income regions exhibiting higher instances of diverging pairs, thereby suggesting regions with relatively high-incomes are growing faster and diverging away from the rest as shown in Table 7.8. Group 2 regions demonstrate higher instances of diverging pairs between 2009 and 2013. Group 2 regions exhibit more instances of convergence than divergence throughout the entire time period which suggests that the relatively low-income regions are growing at a faster rate. The regional convergence trend analysis for top 5 and bottom 5 regions within group 2 may not provide a relevant outcome as the total number of regions in this group is much high (229 regions). Thus, the convergence behaviours for top 5 and bottom 5 regions are omitted in this section.

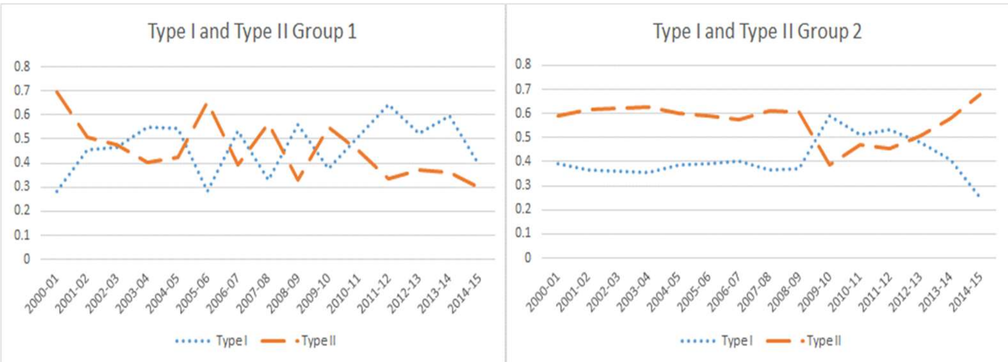


Figure 7. 17: Type I and Type II behaviours trends group 1 and group 2 during 2000-2015. Type I indicates divergence without switching and Type II indicates convergence without switching

The between group analysis, as shown in Figure 7.16 for NUTS2 regions, demonstrates higher instances of divergence between high-income and low-income groups. This implies that low-income regions are not able to catch-up with relatively high-income regions, probably because high-income regions are growing faster and diverging away from the group. The findings also suggest persistence in groups of high- and low-income regions.

To conclude, the low-income NUTS2regions are converging among themselves reducing regional disparity within the group. However, the high-income regions are diverging away from the rest and increasing the income gap within the group of similar regions as well as between the groups.

7.5 Discussion

This section will provide an overview of theoretical underpinnings that could explain the changing trends of convergence and divergence for European regions during 1991-2015. The findings suggest a dynamic trend of convergence which differed based on groups of regions and time periods. The explanation of changing trends could follow different principles of convergence and divergence.

7.51 Coexistence of regional convergence and divergence

The findings on convergence at the aggregate level in Europe since 2000 from this study are in line with many existing studies (Badinger et al., 2004; Cuaresma et al., 2014; Butkus et al., 2018). The convergence at national level is driven by CEE countries, which is supported by Cuaresma et al. (2014) and Monastiriotis (2011). According to the neoclassical hypothesis of convergence, this is predicted to reduce the income gap between high-income and low-income countries, eventually. The national level data follow the principles of convergence via high-growth rate experienced by the low-income countries.

However, when the regions were grouped based on their growth trajectories, the findings revealed divergent growth paths experienced within high-income group of countries (as shown in Figure 7.8) until 2008, followed by convergence from 2008-2013 and the resumption of divergence afterwards. The recent analysis of convergent and divergent pairs revealed that relatively high-income countries including Ireland, Sweden, and Denmark demonstrated higher instances of diverging pairs with the rest of the group members from 2012 onwards. This implies that they grew at a faster rate and diverged away from the rest, which is advocated by the proponents of new growth theory or new economic geography. This is not surprising, as these countries have low populations and any increase in income would look big in terms of income per capita. Neverthless, these countries are important parts of Europe and we cannot ignore them. Hence, the findings of studies could be distorted in some respect. Looking at the relatively low-income countries in the high-income group, France, Finland, and the UK demonstrated higher instances of diverging pairs with the rest of the group members from 2012 to 2015. Their stagnation or lagging behind during this period could be potentially attributed to their slow growth. Therefore, the divergence within the high-income group of countries indicate increasing disparity among themselves.

Countries within Europe are at different stages of development, Iammarino et al. (2019) emphasised the need to group countries to solve the problem of comparing countries at the same development levels. There have been a lot of studies that identified groups of regions in Europe such as Gaynor and Karakitsos (2016) and Bartkowska and Riedl (2012), however, they do not determine what is happening within and between groups of regions in detail.

In an attempt to provide insights on whether regions within a group are converging towards each other, this study identified groups of regions and divided them into high-income, middle-income, and low-income categories for all three levels of regional data. The trends show that divergent growth paths between relatively rich and poor regions. On the other hand, the low-income group is converging among themselves as well as with other groups. This implies, that this group is catching-up with the rest of the regions. Therefore, Europe has the simultaneous presence of convergence and divergence trends, which makes it difficult to identify a dominant trend for the whole of Europe. A clear dominant convergence trend among regions is complex to find which contribute to the "convergence puzzle" in Europe (Califano and Gasperin, 2019).

Middle-income group

The findings of this study further suggest that the middle-income group is diverging away (falling behind) from the relatively high-income group at the national level. The national level groups of middle-income countries apart from the Czech Republic, Malta, Cyprus, and Slovenia, also include low-growth countries—Spain, Greece, Portugal, Italy. The regions of Italy and Greece suffer from problems such as geographical remoteness aggravated by a lack of infrastructure development, large-scale debt hindering government expenditure, restricted employment, large share of public sector employment, lack of competitiveness of their service sector, dependence on domestic demand, and irregular jobs, among others (Bonatti and Fracasso, 2019). Likewise, Spain suffers from low human capital investment and Portugal suffers from low labour productivity. The finding of divergent growth paths followed by the middle-income group with respect to the relatively high-income group is consistent with Kashnitsky (2017) that indicated that southern Europe's economic output was converging to some extent with the rest since 2003, but soon after the crises of 2008/09 the trend started to reverse.

Iammarino et al. (2019) has highlighted that the low-growth countries of southern Europe are transition economies that have not been able to converge to the EU average between 2000 and 2013. Even though these countries have better infrastructure, the lack of a skilled workforce and low capabilities to produce and assimilate innovative activities hamper the growth of these countries. Gill and Raiser (2012) stated that from 2002 to 2008 Southern European countries—Greece, Italy, Portugal and Spain recorded falling labour productivity. They have created jobs in sectors like construction (mostly cyclical) or in less productive micro/family enterprises. Particularly for some of these countries, higher taxes and poorly administered regulations were also blamed for their poor performances.

The finding of falling behind of the middle-income group compared to the high-income group was severe post-crises. During the financial crises of 2008/09, the slow growing southern Europe suffered the greatest setback. Their already struggling regions had to go through many structural and policy changes that made the situation worse (Grela et al., 2017; Colak 2015; Próchniak, 2017; Archibugi and Filippetti, 2011). For instance, high taxes, low government expenditure, low productivity, and high compensation exacerbated the economic problems. The tendency to invest became unattractive and exports became uncompetitive due to the prevailing economic environment in these regions. The lagging regions of the south exhibited certain amount of public expenditure on human capital and innovation but due to the onset of economic crisis of 2008/09 the expenditure started to fall. Thus, the disparity between the southern regions and core regions started to increase after the crises.

High-income group

The findings about the relatively high-income group reveal divergence within their group as well as diverging away from the middle-income group. These results are in line with the principles of endogenous growth theory and new economic geography. These principles predict higher growth for high-income countries that help them grow faster and diverge away from the rest. In the case of Europe, these principles are applicable not only at the national level but also at the subnational levels as evident from this chapter. NUTS1 regions in the mostly high-income group (richest/leading regions) were converging within their group in recent years but were diverging away from the second and third highest income groups. In addition, the second highest income group was diverging within group and also diverging away from the third high-income group. Similarly, NUTS2 regions were grouped in to relatively high-income regions that were diverging within their group as well as from relatively low-income groups.

Divergent growth paths experienced by relatively rich regions owing to the faster growth of high-income regions is in line with the literature (Geppert and Stephan, 2008; Alcidi et al., 2018). For instance, Cuadrado-Roura (2001) argues that prosperous regions attract new investments and get benefits from open innovation that help them perform better. Geppert and Stephan (2008) argue that forces of agglomeration of economic activities at certain locations tend to increase disparities within EU member States. Furthermore, Gräbner et al. (2019) highlight that high growth experiences of export-oriented core European regions and debt-driven periphery regions (e.g., regions of Greece and Portugal) are related to the regional technological gaps and differential firms' performances located within core and periphery regions. These determinants of growth are explained by the new growth theories that highlight increasing returns to factors of production, agglomeration of economic activities, spillover effects, etc.

Divergent growth paths are followed not only by rich countries but also by regions within rich countries. This gives rise to regional disparity within rich countries. It is evident that every region within a country is not growing at the same speed. For example, in the UK some NUTS2 regions lie in a relatively high-income group and some lie in relatively low-income groups as shown in Table 7.9. For within country disparity, Giannetti (2002) highlights that due to increased international interactions, regions with differential capability and specialisation do not benefit evenly from knowledge exchange. Regions specialised in the advanced sector converge towards each other, while regions specialised in the traditional sector lag behind.

In terms of the increasing international competitiveness of industries, the traditional and new growth theories inspired by Schumpeterian research indicate that in the long run, the international competitiveness of industries is related to their own innovative activities and relatively fluid inter-sectoral knowledge diffusion (Castellacci, 2008). The sector-specific differences in R&D activities of private firms and their spillover effects have been studied by researchers from different strands of the literature (Bottazzi and Peri, 2003; Greunz, 2003). The traditional theorists emphasise a market-driven approach for gaining inter-sectoral advantages from R&D spillovers, while the new growth theorists highlight the idea that institutional arrangements and policy interventions play an important role for influencing the innovative activities on industrial competitiveness (Castellacci, 2008). Therefore, both principles acknowledge the significance of inter-sectoral or inter-industrial knowledge spillover for increased growth of regions but the approach to gain those advantages differ between the two perspectives. Knowledge spillover and diffusion are important and can explain the divergent growth paths followed by a few relatively rich regions.

Low-income group

The findings in this chapter highlight the catching-up experiences by low-income Central and Eastern Europe at the national as well as regional levels. Low income regions are the regions of Central and Eastern Europe including parts of Poland, Hungary, Romania, and Bulgaria. These regions had GDP per capita values below 50 percent of the EU average in 2013. However, these regions are driven by easy access to credit to the household and private sector, although to different extent across countries (Kiss et al., 2006; Bethlendi, 2011). The financial sector of these countries are highly dependent on western European banks and foreign capital inflows (Árvai, 2009).

Moreover, the findings suggest that the convergence of eastern European regions among themselves and with relatively high-income regions is happening. However, it is argued that this convergence is only driven by a few capital or urban centres rather than the uniform growth of all regions. Monastiriotis (2011) emphasises that in spite of national level convergence exhibited by CEE countries, regions are following divergence growth paths and showing signs of club formation. For instance, Constanta has been developed as an urban centre, situated on Romania's Black Sea coast and reported to have higher GDP than CEE region. Similarly, the capital cities (Budapest, Bucharest, Warsaw, and Sofia) are developing at a similar pace as the Western cities and the southern European cities. Even though few capital/urban cities are developing very fast, the economic gap between them and other interior regions is increasing at a fast rate. Regional inequality in Slovakia is highest owing to low economic growth, job creation, and labour mobility of low-skilled workers in eastern and central Slovakia (Demmou et al., 2015). Most of the CEE countries are suffering from under-investment in infrastructure, low innovation, and low levels of educational attainment, among others (Demmou et al., 2015).

According to a World Bank (2018) report, the lagging regions of south and east Europe lack exposure to adequate opportunities due to being distant from the economically developed core regions. However, the report also identified that the CEE regions are closer to the core of Europe which is giving them an advantage over the southern part in terms of trade and investment flows. The report also highlighted that if this trend continues then the lagging regions of the east could surpass the regions of the south in terms of GDP per capita and purchasing power standards perhaps that is the reason for low-income CEE regions to show convergence with relatively high-income groups of regions.

This chapter provided empirical evidence of the simultaneous occurrence of divergence and convergence between regions of Europe. The evidence is in line with Dunford and Smith (2000) that underlines the simultaneous presence of falling behind (divergence) and catching up (convergence) regions in Europe. Their study found differential development and backwardness within Western Europe and differential growth for the capital cities (high growth) with the rest of the country (low growth) for Eastern Europe.

Core/central European countries have attracted labour, and peripheral southern and eastern countries have attracted capital investments. This could lead to factor price equalisation according to the neoclassical growth theories and hence, to the convergence of economic growth. The evidence of convergence has been highlighted in many studies at regional and aggregate levels across Europe (Geppert and Stephan, 2008; Badinger et al., 2004; Borsi and Metiu, 2015). Alcidi (2019) highlighted that convergence has been considered as one of the important mechanisms through which cohesion and integration are attained in European regions, however, it should also be considered that economic integration does not always lead to convergence. Owing to the fact that the free movement of people, capital, goods and services have the capability to foster an uneven distribution of income and economic activity as per the agglomeration and concentration forces proposed by new growth theories. This is evident in many cities that outperform other regions due to the uneven concentration of factors, such as human capital (Duranton and Puga, 2014). This causes a drift in the level of income and economic activity across Europe and became a cause of income divergence among regions (Cheshire and Magrini, 2000; Petrakos et al., 2011). Thus, the debate on finding a dominant trend on convergence or divergence across Europe is strengthened.

7.52 Persistent gap

The findings of this chapter and evidence in the literature suggest that the divide between Europe has increased during the 2000s. The between group analysis reveal that relatively high-income group of regions are diverging away (growing fast) from the relatively poor ones. At the same time, within group analysis reveal that within relatively high income group, the regions are following divergent paths which could lead to two situations: first, some of the rich regions are growing at an exceptional rate which is not matched by other group members, secondly, some of the rich regions are stagnating or lagging behind compared to their peers in recent year after the crises. This could raise concerns of an increasing divide within relatively rich regions. Some of the regions in the UK (ukk, ukf, ukd, ukg), France (fr7), Italy (iti, ith), and Spain (es3) are parts of upper-middle or relatively high-income group that have shown dismal performance after the crises. Owing to their dismal performance these regions are diverging away (falling behind) from their group members. This finding is supported by Bartlett and Prica (2016) that argues that the European core is highly dependent on the exports to the periphery Europe. However, because the periphery of Europe is cutting down on imports to rebalance their balance of payments post crises, the core European regions may be vulnerable to stagnation.

The low-income group of Eastern Europe demonstrated higher instances of convergence with both the high-income group and the middle-income group, suggesting that they are successfully closing the gap with relatively advanced regions in Europe. However, this closing of the gap could raise questions. This is because relatively rich regions are growing at a faster rate owing to the agglomeration effects and diverging away (upwards) from the rest of Europe. And low-income regions are converging (upwards) with relatively high-income regions due to faster growth. The net effect of these two processes could keep the gap intact or in some cases even increasing. Therefore, there will be the persistence of regions in groups, i.e., relatively rich regions will remain rich and poor regions will remain poor.

The middle-income group consisting of the low-growth regions of southern Europe demonstrates divergent growth paths from the relatively rich group. This indicates falling behind of this group compared to relatively rich regions. The falling behind of the middle-income group could be alarming because of their lagging behaviour.

Barriers to the diffusion of knowledge have been considered a major cause of the slow growth of lagging regions in Europe (Iammarino et al., 2019). Although empirical evidence provides mixed outcomes on the mechanisms of knowledge flows, Iammarino et al. (2019) showed that the effect of knowledge diffusion was weaker than the effects of concentration during the last decade. The proximity of regions does not automatically facilitate knowledge diffusion, rather there is the need for special conditions which range from strong organisation networks to a skilled workforce (Breschi and Lissoni, 2001). Autant-Bernard et al. (2013) emphasise the need to identify these special conditions to reap the benefits of knowledge flows. This comes from the fact that all regions are not homogenous and there are different regions with different capabilities and capacities to adapt to changes in the global environment (Califano and Gasperin, 2019).

Many studies provide insights on policy implications of differential growth developments and increasing disparity in Europe (Gräbner et al., 2019; Kapeller et al., 2019). The studies relate the rising disparity among European regions to various factors, including structural polarisation and differential institutional set-ups and regulatory framework. Moreover, increases in trade competitiveness to become an export-oriented economy is highlighted as one of the remedies to reverse the slow growth rate (Gilbert and Muchová, 2018; Allard, 2009). Kapeller et al. (2019) highlight the need for coordinated and cooperative intervention by policymakers.

The challenges that the east and south regions face are mostly the same that constrain their future growth prospects. Except for a few growing capital/urban cities, the laggard regions are struggling to keep up with the skills requirements, infrastructure support for technology-oriented businesses, and the creation of job opportunities. The differential development across Europe is a cause of concern for economists and policymakers who are constantly working on promoting regional cohesion and prosperity. The EU Cohesion Policies aim to support the harmonious development of member states by reducing disparity in the levels of development. It seems to facilitate income equality and convergence, a multi-pronged approach is required to strengthen the upskilling of the workforce, innovation, and educational policies (Demmou et al., 2015; OECD, 2017). In this context, Iammarino et al. (2019) argue that people-based and place-based approaches should be more tailored to 'place-sensitive' approaches based on considering micro (individual) and meso (territorial) causes of coping with diverse growth trajectories.

To conclude, this section provided an overview of convergence and disparity trends demonstrated by middle-income, high-income, and low-income groups of regions in Europe. The findings highlight a simultaneous existence of convergence and divergence that has been supported by literature and explained by theories.

7.6 Conclusion

This chapter outlined European regional convergence and disparity trends between 1991 and 2015. This chapter increases the complexity of analysis by analysing data at three regional hierarchical levels—NUTS0 (28 countries), NUTS1 (86 regions), and NUTS2 (252 regions). The convergence trend has been identified and compared at national and subnational levels to enhance the understanding of the effects of the 2008 global and subsequent debt crises.

The convergence outcome obtained by the beta convergence estimate for aggregate NUTS0 countries revealed that the countries converge to their group average between 1991 and 2015. In other words, the capital poor countries catch-up with capital rich countries by growing at a faster rate. Similarly, the sigma convergence findings revealed that the dispersion between European countries reduced from 1995 to 2015. The gamma convergence estimate provided an inconclusive finding on convergence, however the value was close to 1, indicating less mobility among countries during the period of analysis. In other words, there is less variation in countries' rank during the assessment period. Combining the findings from the three standard measures of convergence, it is evident that the countries are converging with less mobility after 1995.

The convergence trend obtained from employing the X-convergence approach shows many ups and downs in the convergence process during the 1990s but a continuous convergence trend from 2000 to 2008 at the aggregate level of NUTS0 and disaggregate levels of NUTS1 and NUTS2. The events of the 2008 global recession and the subsequent Euro debt crisis of 2009 had great impacts on income per capita of economies across Europe. As a result, some regions suffered slow growth and diverged away from others. The disaggregated levels of NUTS1 and NUTS2 exhibited higher instances of diverging pairs from 2009 to 2011/12, indicating greater impacts of the two crises. However, the effect of crisis seems to be negligible at the NUTS0 level as the numbers of diverging pairs marginally increased converging pairs for only two periods (2008/09 to 2009/10) and a number of converging pairs increased thereafter. Therefore, the effect of crises was felt most at the subnational level rather than at the national level.

To further investigate the intradistributional dynamics of regional behaviour, regional convergence trends within and between groups were analysed. The group trajectory modelling identified countries as high-income, upper-middle income, middle-income and low-income categories. The low-income regions have higher percentages of converging pairs within- and between-groups. This indicates that these regions are catching-up with relatively richer regions. This evidence has been supported in the literature as low-income regions of Central and Eastern European regions are converging with their peers (Cuaresma et al., 2014; Franks et al., 2018). On the other hand, high-income groups have higher percentages of diverging pairs within groups suggesting that divergence in income per capita is driven by relatively richer regions. This indicates that disparity is rising within the high-income group of regions due to the stagnation of some of the richer regions post 2008/09 crises. Therefore, analysing group dynamics provide very important and distinct insight on the disparity that is rising among regions that are considered richer or upper-middle income, mainly, due to the slowing or stagnation in growth.

Moreover, at all three levels relatively better off regions tend to diverge among themselves, which could mean slow growth of some rich regions after the crises. This finding has been supported by the literature that discusses the stagnation of Core Europe. This implies that the disparity among rich regions could increase should the divergence persist for long. Compared to the middle-income group regions of southern Europe, the high-income group of regions demonstrated higher instances of divergence, suggesting increasing disparity between them. This could be because southern regions have been hit hard by the crises and they struggle to grow at a decent speed. The low-income group consisting of mostly CEE regions tend to converge among themselves reducing disparity among themselves. In addition, they demonstrate higher instances of convergence with the rest of the groups at NUTS0 and NUTS1 levels but exhibited higher instances of divergence at the NUTS2 level. At NUTS2 regional level, group behaviour demonstrated that relatively low-income regions were diverging away from high-income regions, indicating low-income regions are not able to catch up with some of the well-off regions. This finding suggests that the differences between the relatively rich and the poor regions at the NUTS2 level are very high.

Another important finding of the chapter reveals that there is a persistence in the group of regions or less mobility between groups, i.e., the relatively high-income region remained rich and low-income region remained poor. Combining the findings at all three levels it is concluded that relatively low-income regions promote convergence within and between groups and high-income regions exhibit divergence within their groups.

The chapter analyses regions across Europe instead of doing a countrywide analysis because the thesis aims to analyse the convergence behaviour of European regions as a whole. While comparing regions that behave in a similar manner the national boundaries do not influence the findings on whether regions are catching up or not. This implies that the regions that are similar in their performance are compared together and with respect to others. For example, all areas that are similar performing are considered as equal across the UK, France, Germany, etc. In future studies, the research will carry out country-wise comparisons.

CHAPTER 8 DISCUSSION AND CONCLUSIONS

8.1 Introduction

The convergence experience of low per capita income economies is an important phenomenon that policymakers, researchers, and economists are after. To promote regional equality, the focus is on enhancing the convergence experience of less developed regions. However, in the real world, there is a simultaneous presence of convergence that is demonstrated by relatively low-income economies (as per the neoclassical views) and divergence that is demonstrated by relatively high-income economies (as per the new growth theories). Hence the income gap between the two types of economies depends on the extent of convergence and divergence experienced by the two types of economies. In cross-country analyses, divergence could be alarming when poor economies are not able to grow faster or when they lag behind the relatively rich economies and the income gap between them widens. This raises the importance of identifying and explaining the convergence behaviour of lagging and stagnating economies for optimal allocation of resources.

The aim of the thesis is to examine the year-over-year evolution of convergence patterns across geographies that have highly heterogeneous economies (Worldwide, China, US and EU). There are many studies that identify convergence behaviour between countries and within countries (Petrakos et al., 2011; Zhang and Zou, 2012; Young et al., 2008). At the same time, many studies have also highlighted the problem of inconsistencies in findings obtained on convergence/divergence trends (Senger and Mulquin, 2012). There are many factors underlined by studies that contribute to the inconsistencies in findings, including the development of new conceptual underpinnings, advancements in measuring techniques, better availability of regional data, longer time frame of studies, geographical levels of studies, etc. These factors increase the ability to identify and explain regional convergence trends. This thesis highlights the problem of inconsistencies in the outcomes obtained on convergence and divergence trends resulting from the adoption of different measures of convergence and different scales and scopes of the studies.

The traditional measures of convergence that have been adopted by the majority of studies are beta, sigma, and gamma convergence. These measures provide an assessment of aggregate economies' convergence towards each other within a group of regions. For instance, beta convergence uses a regression equation to reveal the behaviour of economies within a group that are converging to a representative/benchmark economy (Margini, 2004). Whereas sigma convergence provides an understanding of the narrowing (convergence) or widening (divergence) of the cross-country income distribution for a set of economies. Similarly, gamma convergence provides an understanding of variations in rank order positions for a set of economies. It is evident that these measures identify the aggregate convergence behaviour for a group of economies. These measures were criticised for ignoring the individual behaviour of outlier economies, i.e., some of the economies may not be behaving like a representative/benchmark economy and may be an outlier. Therefore, in addition to understanding the aggregate behaviour of a group of economies, it is also important to assess the behaviour of every individual economy to understand convergence/divergence and hence equality/inequality across regions.

To address the issues highlighted in aggregate, this thesis analyses pairs of regions using X-convergence, a technique which is based on concordance and discordance of regional performance. For this, the empirical chapters compare the findings obtained by the traditional measures of convergence with each other and with the X-convergence technique. This comparison of findings supports the literature that highlights inconsistencies in convergence findings because of the employment of different measures of convergence. The X-convergence technique has been used to identify a conclusive convergence trend across the three selected geographical locations which provide an in-depth analysis of the performance of pairs of regions on a year-over-year basis. One of the advantages of the pairwise approach is that there is no need to choose a base or representative region. It provides an extensive analysis of every single region with respect to another and hence has the potential to offer a detailed view of any particular region's behaviour.

Apart from convergence and divergence trends, the X-convergence indicator helps to unravel many important insights on regional dynamics. The most important dynamic is the mobility behaviour of one region with respect to another. The change in rank order positions of pairwise regions within the income distribution of all regions is considered to assess the mobility/switching behaviour of regions. In other words, the degree to which any region moves within the income distribution is referred to as mobility. The mobility assessment is essential to understand the dynamic change in relative behaviour of regions as it allows for a number of possibilities such as overtaking, lagging behind, and stagnating. When the mobility of regions is assessed between two income groups, it provides insights into the persistence of income differences between groups of regions. Thus, the mobility behaviour can be easily performed within- and between-groups. An understanding of these behaviours is significant to examine the intricacies of differences between the relative behaviour of regions.

This addresses a gap in the current literature; the mobility behaviour of regions has not, thus far, been studied in such detail. To some extent, transition matrices have been used to understand the mobility of regions but the interpretation of findings is not straightforward using this approach. The mobility dynamics assessment conducted in a pairwise setting gives a detailed outlook of which region is overtaking, lagging or stagnating with respect to another region. To get insights on regions that are lagging behind or stagnating, it is important to perform a thorough study on their behaviours with regard to others. This is done by identifying the mobility pattern within and between groups of similar regions. The assessment of mobility between groups is important to gain insights on the persistence of income groups, i.e., rich regions remaining rich and the poor remaining poor. It is important to get a holistic picture of regional inequality by identifying lagging regions that need help from the government authorities. Therefore, this thesis will empirically contribute to the assessment of regional dynamics of convergence, divergence, mobility and persistence which is interpreted to uncover differences in regional economic growth.

Another important reason for mixed findings on convergence trends that are not explicitly discussed in the literature is related to the scale and scope of the study. This thesis uses different geographical scales/levels to show the variation of findings at the aggregate and disaggregate hierarchal levels. The scope of the study entails geographical locations that have wide heterogeneity in regional growth. The three geographical locations are selected on the basis of two criteria—first, they have high regional heterogeneity and second, they have enough administrative geographical units to perform group analysis. For instance, in China 31 provinces have been analysed; for the US 50 States and 383 MSAs have been analysed; and for the EU 28 countries, 86 NUTS1, and 281 NUTS2 regions are analysed. To analyse similar regions, the sample is grouped into clubs of similar regions using a GBTM grouping algorithm. The grouping identifies differential behaviours of regions within- and between-income groups that is an important part of this PhD study. In addition, the scope of the study also includes varying time periods for analysis which also contributes to the inconsistent findings on convergence trends. The time periods analysed in this thesis allow a better understanding of the impact of the 2008 global crisis on each location’s convergence trends.

To conclude, the cross-comparisons of findings on the evolution of regional convergence and inequality trends obtained from within China, the US, and Europe, the impact of the global crisis on the convergence/divergence behaviour, and the mobility patterns of regions within and between groups of regions defined by their regional incomes provide interesting insights to address the research questions and objectives laid out in chapter 1. The chapter is organised as follows: section 8.2 provides a background on the gaps in the literature. Section 8.3 compares the mixed outcomes obtained on convergence trends using traditional measures of convergence and the X-convergence technique. Section 8.4 compares the convergence and divergence trends across the three geographical locations. Section 8.5 demonstrates the recessionary effects on convergence. Section 8.6 provides insights on regional income mobility. Section 8.7 provides insights on the research contributions of the study. Section 8.8 provides policy implications of the study and section 8.9 summarises limitations and future research directions.

8.2 Background

An understanding of the regional convergence hypothesis has been constantly refined by explaining the process with the help of growth determinants such as human capital, technological progress, agglomeration economies, and spillover effects, among others. Different strands of the literature explain the process of convergence/divergence through different mechanisms. For instance, the neoclassical convergence hypothesis advocates the mechanism of gradual faster growth for capital poor economies due to higher investment opportunities by rich economies. Capital poor economies provide good opportunities for higher returns on capital for investors from capital rich economies. This is because of the neoclassical assumption of diminishing marginal returns on capital. As a result, investors from rich economies gain higher returns from investing in poor economies rather than rich economies. This helps the poor economies grow faster and eventually catch-up with the richer economies, mitigating the income gap between the two (Mankiw et al., 1992; Barro, 1991; Barro and Sala-i-Martin, 1992; Barro, 2015).

On the contrary, the evidence of growing inequality among regions certainly fails to reflect the prevalence of the convergence process. In this regard, another strand of literature criticises the diminishing marginal returns assumption of neoclassical theorists. This strand of literature is supported by the new growth theorists. They argue that the capital rich economies earn increasing/constant marginal returns to capital as opposed to diminishing marginal returns. Increasing returns are earned by investors while investing in rich regions because of innovation, agglomeration economies, and spillover effects, among others (Acemoglu and Restrepo, 2016; Anzoategui et al., 2016; Dosi et al., 2017). The increasing returns help the capital rich economies grow faster and diverge their growth paths away from the rest, increasing the inequality between the rich and the poor. Therefore, the growth theories provide mechanisms or determinants that explain why economies converge or diverge.

Subsequently, the literature reveals many possibilities of regional dynamics apart from standalone convergence and divergence. Some of these dynamics are polarisation, mobility, and persistence among regions. In this regard, Quah in a series of papers (1993a, 1993b, 1996a, 1996b, 1997; Durlauf and Quah, 1999) underlines the importance of assessing these regional dynamics to unravel the subtleties of regional disparities. Quah (1997) argues that economies/regions are constantly interacting with each other through trade, capital and labour flows, and technology transfers, among others, that constantly changes the relative behaviours of regions in a dynamic process. Through the analysis of income distribution dynamics, Quah (1997) finds the transitory nature of changing positions of economies within the distribution reflect changes in the process of convergence/divergence. As a result, the significance of churning/mobility of economies within the distribution is established.

Moreover, one of the major findings of Quah (1996a, 1996b) suggests that the distribution may evolve into one characterised by twin peaks, meaning the existence of stratified countries into groups of high and low income regions. Many studies support the multiple regimes of growth paths, implying that economies categorise into different clubs/groups according to their identical behaviours and demonstrate different convergence properties (Kharas and Kohli, 2011; Flaaen, 2013; Paap et al., 2005; Acemoglu and Ventura, 2002; Kerekes, 2012).

Economies forming groups/clubs/clusters indicate the presence of multiple regimes of growth patterns followed by world economies instead of a common linear growth paths for every economy to follow, as suggested by neoclassical theory. Similarly, as mentioned earlier, the evidence of prevalence of divergence among regions was contrary to the prediction of convergence by the neoclassical theory. The evidence has suggested a disconnect between theoretical constructs and empirical evidence (Durlauf et al., 2005; Webber and White, 2009; Temple, 1999). Researchers have scrutinised disconnects between theory and evidence and found a variety of regional growth dynamics of convergence, divergence, mobility, polarisation, persistence, etc.

The empirical findings on regional dynamics made the assessment of patterns of convergence a complex process. The simple traditional measures of convergence (beta, sigma, gamma convergence) were criticised for not being able to observe the various regional dynamics highlighted by the empirical studies. As a result, the focus of convergence literature changed to approaches such as kernel density estimates, transition matrices, and other distribution dynamics approaches. These approaches assist in analysing the intradistributional properties of distribution dynamics. Some inequality measures, such as the Gini coefficient, Theil index, and Atkinson index are widely used in distribution dynamic approaches. One of the shortcomings of the Gini coefficient is that it is not easy to decompose, whereas, Theil and Atkinson indices could be decomposed to within and between-group inequality. However, Novotný (2011) highlighted that the interpretation of findings is not easy while using these approaches and the chances of misleading interpretations of findings are high. The variation in interpretation of findings is one of the reasons why studies get controversial outcomes on the convergence trends.

The dearth of convergence measures/indicators that could simply uncover all regional dynamics was highlighted by many researchers (Novotný, 2011; Castro, 2003; Gluschenko, 2012; Monfort, 2008). In this regard, Webber and White (2003, 2009) and Webber et al., (2005) proposed a method (X-convergence technique) based on the concordance and discordance estimates that examines important regional dynamics of convergence, divergence, switching, persistence, polarisation, and mobility of economies, all at the same time. The X-convergence technique is a comparison of two regions' growth at two time periods, thus, making it easy to interpret the findings. This thesis validates the advantages of the X-convergence technique to identify a conclusive convergence trend.

The contribution of this thesis to the regional convergence and disparity literature is underlined by performing an extensive study on behaviours of pairs of regions exhibiting regional dynamics of convergence, mobility, and persistence. The empirical findings on the regional dynamics reveal important insights on rising regional inequality not only between high- and low-income groups of regions but also within these groups. The thesis documents rising regional disparity through mobility of regions by identifying the number of overtaking, lagging behind, and stagnating regions. The framework to assess mobility and persistence of regions has been adopted from Webber and White's (2003, 2009) relative X-convergence indicator. The simultaneous assessments of regional dynamics such as convergence, divergence, mobility and persistence has not been investigated earlier. This thesis provides a new perspective on the identification of regional convergence and disparity patterns using a comprehensive set of mobility dynamics (overtaking, lagging behind, and stagnating regions) assessment which hitherto have not been thoroughly documented in the field.

The empirical chapters have categorised the regions into similar performing regions. This helped in conducting within-and between-group convergence analysis. The group analysis provides insights on the proportion of converging and diverging pairs and hence helps in the assessment of regional economic equality or inequality. One important insight that empirical chapters have provided is on the assessment of convergence/divergence behaviour taking the intradistributional properties into consideration. The intradistributional properties have considered a change in rank order positions of economies within their income distribution which has an additional benefit in economic mobility assessment. The mobility assessment help identify regions that are overtaking and lagging behind others. Hence, the study has highlighted the need to understand convergence in more than just evenly distribute income within the income distribution.

The uneven income distribution across regions drive the convergence policy initiatives. For fulfilling the convergence objective, low-performing regions need the promotion of growth-enhancing conditions/policies that help them catch up with peers. Economic policies have spillover effects that countries do not take into account and that has the potential to sub optimise the final benefits of policy implementation[5]. Single Market cooperative policy in a specific area like European Union can adopt a common policy and benefit from economic integration. For the EU the integration has worked well for the Central and Eastern European (CEE) countries that have shown the tendency of catching-up with the core Europe. However, the benefits are not optimised evenly when the convergence between North and South European countries is scrutinised as the gap between their per capita income has widened. This suggests that the country-

[5] https://www.cesifo.org/DocDL/eeag-2018-its-ok-to-be-different-policy-coordination-and-economic-convergence.pdf

specific factors play important roles in reaping the benefits of integration.

8.3 Mixed outcomes obtained on convergence trends using different techniques

There are variations in the identification of convergence and divergence trends, perhaps due to ignorance of accounting for the dynamic nature of growth and interactions between sample countries. Highlighting the dynamic nature of growth and interactions across countries, Quah (1993a, 1996a, 1996b, 1997) criticised the convergence findings obtained by growth regression equations through beta coefficients that measure the behaviour of a benchmark/representative economy. The representative economy could be very different from others within a sample and hence the difference could be important to analyse.

The first objective of the thesis was to show that employing different measures of convergence could yield discrepancies in the outcomes on a dominant convergence/divergence trend. Regarding the beta convergence value, the negative beta was evident for the whole sample analysed in the study. Findings suggest that the economies are converging towards each other. The beta convergence approach has received widespread criticism in the literature. Quah (1993a) and Friedman (1992) began to argue that the negative relation between subsequent growth and initial income does not necessarily imply a reduction in the dispersion of income per capita and inferences about income distribution dynamics cannot be made with the cross-section regression. This seems to be true because the findings obtained in all empirical chapters show a negative relationship between growth and initial income but inference on the narrowing of the distribution is not clear.

Sigma and gamma convergence measures provide year on year details on convergence but they also vary for many periods which makes convergence invalid for those periods. For the world economies, sigma and gamma convergence are present for the period 1970-1980 and 2000-2010. The findings of X-convergence for world economies show divergence for almost two decades from 1980 to 2000. Afterwards, from 2000 to 2007 there are great variations in convergence and divergence trends. Finally, from 2007 onwards there is a prevalence of convergence which reflects the impact of the 2008 global recession on countries growth and hence convergence. Therefore, it is evident that the employment of different convergence measures could lead to different convergence trends.

The agreement of beta, sigma, and gamma convergence for Chinese provinces indicate the prevalence of convergence from 2000 onwards. However, the X-convergence technique suggests convergence between provinces started only from 2005 onwards. For the US States, the sigma convergence value is almost constant, suggesting that the dispersion has remained the same between US states throughout the period. While the X-convergence indicator shows a higher number of time periods of divergence between states, discrepancies between findings of indicators are present for the EU countries as well. Beta and sigma convergence estimates indicate a prevalence of convergence from 1995, but the gamma convergence values are constantly making the inferences questionable. On the other hand, the X-convergence findings indicate almost a consistent prevalence of convergence from 2000 between EU countries.

To conclude, the findings from different techniques make the assessment of a dominant convergence trend inconsistent by yielding mixed/inconsistent outcomes. This is evident from the findings from different empirical chapters of this thesis. Hence the findings address the first objective (RO1) of the thesis. Different measures use different conceptual underpinnings so what they measure would be different. However, there is a need to identify a conclusive dominant trend which could be supported by the X-convergence technique by conducting a comprehensive pairwise regional analysis on a year-on-year basis.

8.4 Convergence and divergence trends

Convergence and divergence trends exhibit important implications for disparities in income per capita between regions. Convergence suggests a reduction in disparities and divergence indicates increasing disparities between regions. In this regard, the first research question (RQ1) on the evolution of regional dynamics in the selected geographical location is addressed.

In light of the findings from this study, Chinese and US regions are similar with respect to divergence trends. The disparity in income per capita between the high- and low-income groups of regions within the two countries is high.

In China, the high-income regions are located near the coast or mineral-rich locations and as predicted by the principles of new economic geography, they grow faster and diverge away from the rest. For Chinese provinces, within the high-income group, provinces were converging and becoming more similar to each other. On the other hand, within the low-income group, provinces diverged until 2008. This indicates that the poorest of the poor provinces were far behind others until 2008. Afterwards, low-income provinces started to converge within the group, indicating better growth performance of poor regions. This could be the implication of “go west” policy initiatives undertaken by the government during the 2000s to promote regional equality.

For the US States and MSAs, the trend of divergence was not only prevalent between high-income and low-income regions but also within groups. This implies that the richest of the rich regions are growing at a fast speed and the poorest of the poor regions are growing very slowly. This makes the gap between the richest and poorest regions very large, increasing the income disparity. Furthermore, considering the disparity within the high-income and low-income groups, disparities within rich and poor groups of regions are prominent from the findings (details in section 6.4). The findings suggest that differences exist within rich regions and poor regions as well. Therefore, differences across US regions are not only between high-income and low-income groups of regions but also within high-income and low-income groups.

On the other hand, the findings for European regions demonstrate that there are different outcomes at the national and sub-national levels. The aggregate national level data indicate convergence across countries and subnational levels driven by low-income regions of CEE, particularly during the pre-2008 crisis period. However, within the high-income group of regions that includes Core Europe, findings suggest a wide dispersion among rich regions. Just like the US regions, in Europe, some of the affluent advanced regions outperform other regions within the same group (details in section 7.4). In addition, the middle-income group of regions consisting of low-growth countries of Southern Europe is falling behind and not able to catch-up with the high-income group, particularly after the 2008/2009 crisis. Lastly, the low-income group of CEE countries is growing at a faster rate than the high-income and middle-income group and converging with the two groups. In this regard, Halmai and Vásáry (2012) state that the growth rate of a low-income region in the New Member States would be higher than the low-income region in the old Member States. It is evident that the relatively low-income regions are driving the convergence process in Europe and some of the relatively high-income regions are overtaking and diverging away from the rest. The findings on divergence experiences by the high-income regions support the outcome of Petrakos et al. (2011) which concludes that divergence factors are getting stronger and dominant at the advanced levels of development. The evidence suggests that there is a coexistence of convergence and divergence in the EU which makes the assessment of the convergence process very complex and contributes to the "convergence puzzle" (Califano et al., 2019).

Combining the findings from the three selected locations, it is evident that the relatively richer regions are diverging away from the rest by growing faster as suggested by Petrakos et al. (2011) on faster growth of rich regions. The divergence process is supported by the principles of new growth theories and new economic geography. The rich regions have advanced technologies and capabilities that help them gain increasing returns on factors. Industrial production, skilled workforce, and higher wages come together in areas that have proximity advantages for interactions in terms of transportation, communication, free flow of ideas, knowledge development, technology diffusion, etc. The determinants of growth are important from the Marshallian perspective of agglomeration economies for knowledge diffusion (Capello and Nijkamp, 2010).

On the other hand, the relatively low-income regions demonstrate convergence with the rest, as predicted by the neoclassical convergence hypothesis. The low-income regions have the potential to augment labour productivity through capital investment. Shenggen and Zhang (2004) show that the difference in productivity in China could be improved by the level and efficiency of public investment in rural infrastructure, education, and science and technology. The increased infrastructure investment helps low-income regions to grow at a high speed. Such investments help easy access to raw materials as well as finished products, time-saving technology and equipment, human capital, etc. These investments could stimulate output production in less time, improving the productivity and efficiency of labour. Thus, the low-income regions grow fast and catch-up with the relatively high-income regions.

A distinct feature is revealed for the relatively rich States in the US and countries in Europe at the aggregate level. There is a high incidence of diverging pairs within the high-income group of regions for the US and the EU. This suggests that the performance of all regions lying in the same group is not the same as highlighted by the evolutionary approach of new economic geography. The reasons behind divergence within the same group of regions could explain the way clusters or groups of regions is formed.

The economic evolution of clusters of regions depends on many factors, such as the availability of infrastructure, industry life-cycle, local institutions, and local labour pool (Menzel et al., 2010). The evolutionary paradigm of economic geography focuses on the understanding of the evolution and transformation of various economic activities including clusters constituting the economic landscape (Martin and Sunley, 2006). In this regard, it becomes important to understand how clusters establish the regional path dependency, lock-ins, and related concepts of resilience (Hassink, 2010).

In addition to the formation of clusters, declining clusters are also gaining attention. The economic advantages that helped cluster formation once may not be relevant in changing circumstances in the long-run. For instance, Martin and Sunley (2011) underline situations where the economic landscape that flourishes in the industry cluster at one time may lack similar dynamism in the long-run. Similarly, there are possibilities that encourage the clusters of regions to shrink in size and undergo rejuvenation/transformation or gradually die down. The experience of decline may occur owing to the decline of agriculture, shortage of skilled workforce or necessary infrastructure, among others. The concepts of declining regions are an important part of the regional resilience literature. The resilience literature in the context of crisis is discussed in section 8.6.

8.5 Regional income mobility

The movement of regions within a distribution is an important implication of studying dynamic change in the convergence behaviour of economies. It emphasises the need to quantify the change in rank order positions of regions within the income distribution over time. Wu et al. (2019) highlight the significance of measuring the changing dynamics of the income distribution. This helps to identify regions that are overtaking, stagnating, or lagging behind. The pairwise comparison of regions' changing dynamics gives a better opportunity for the assessment of the relative mobility of regions.

The mobility dynamics literature presents evidence of a varied range of mobility behaviours, such as household income mobility, intergenerational income mobility, and socio-spatial mobility, etc. Household income mobility measures the movement of individuals to higher/lower income strata of the society (Chen and Cowell, 2017; Flachaire, 2018; Khor and Pencavel, 2011). Intergenerational income mobility explains the change in income from one generation to another (Jin et al., 2019; Chan et al., 2019; Corak, 2013). Upward socio-spatial mobility is about moving to neighbourhoods with greater levels of advantages to earn neighbourhood gains (Clark et al., 2014; Gough and Franch, 2005). These studies are associated with the roles played by individual's income, education, and wealth, among others (Clark et al., 2014; Chan et al., 2019).

Drawing the advantages from the abovementioned studies on mobility dynamics, the concordance and discordance estimates of the X-convergence technique provides an opportunity to work out the regional income mobility through the number of instances of convergence/divergence with switching (i.e., Type III and Type IV behaviours). Wu et al. (2019) highlight the benefits of dynamic regional income mobility analyses over a static analysis of income distribution by underscoring that it helps assess the dynamic development of regions from poverty to prosperity. The regional mobility dynamics are important indicators of income equalisation (Chan et al., 2019) and concepts of regional income inequality and mobility are interrelated. To address the problem of income inequality, the change in mobility dynamics need to be considered that could give direction to government policies through well-balanced initiatives (Wu et al., 2019).

Rey (2018) examined the mobility pattern of US States during 1929-2012 using interpersonal income distributions (social) and interregional income distributions (economic). The study found that the social inequality exhibited higher mobility than interregional inequality. Many challenges in measuring intergenerational mobility have been overcome by the availability of a wide range of representative data on incomes, education, health, family structures, etc. across multiple generations (Mazumder, 2018). This thesis argues that the way social mobility is important for understanding the evolution of individuals' social status, regional income mobility is important for understanding the evolution of regions' economic growth status.

The extent of the mobility of regions within the income distribution over time is considered important (Rey, 2018). However, very limited studies discuss the mobility of regions within the income per capita distribution like Rey (2018). There are studies that have used density functions (transition matrices) to visually inspect the income distribution to find the percentage of regions demonstrating polarisation or persistence behaviour (Maza and Villaverde, 2004; Ezcurra et al., 2005; Benedek and Moldovan, 2015). Highlighting some of the gaps using these methods, Castro (2003) argued that transition matrices fail to provide details on how mobility evolves over time. The study also underlined that the findings from transition matrices give an approximation to the actual mobility. Therefore, the actual mobility of regions as defined by Quah (1996a) such as "churning-like behaviour", is not captured by standard methods.

Fortunately, the X-convergence technique gives the exact number and name of pairwise regions that switch places with each other. It is easy to identify regions that are stagnating or lagging behind others. The findings from the empirical chapters suggest that there is persistence between high-income and low-income groups of regions with minimal switching behaviour between these groups. In other words, there seems to be a persistence between the high- and low-income groups, with the rich remaining rich and poor remaining poor. The evidence of instances of switching within groups is higher than between groups. The instances of switching are higher within the low-income group of regions. Therefore, this section addresses the second research question (RQ2) and the second objective (RO2) of the thesis on the assessment of within- and between-groups dynamics.

World economies have exhibited the highest number of instances of switching during the period of 1990s. This was the period when many countries were growing rapidly and exchanging places. The analysis of China, the US and the EU suggest that switching is more prominent within the low-income group of regions than within the high-income group. The findings also suggest that there are many stagnating high-income regions that need attention within the US and within the advanced countries of the EU, particularly after the 2008 global financial crisis. Stagnation or lagged behind economies whether within high-income or low-income groups would pose a threat to their future growth and development. Therefore, it is important to identify and help stagnating regions through appropriate policy initiatives. The third objective (RO3) on the identification of stagnating regions is addressed within each empirical chapter.

8.6 Recessionary effects

The thesis discusses the impact of the 2008 global crisis on income per capita convergence for countries across the world, provinces in China, States and MSAs in the US, and national and subnational regions in the EU. Hence this section addresses the fourth objective (RO4) of the thesis. The impact of the crisis has been varied across regions at aggregate and disaggregate levels across the world. This could be the aftermath of heterogeneous impacts of the crisis on economic activities across the world that led to varied rates of growth of regions. Consequently, the impacts of the crisis on the convergence process are also heterogeneous.

The sample countries across the world, as shown in chapter 4, started to demonstrate higher instances of convergence post-recession, implying fast growth of low-income countries and slow growth of high-income countries. The income disparity seems to reduce between countries after the 2008 global crisis. However, for Chinese provinces, the convergence started from 2005 and lasted till 2014 between the high- and low-income groups. For within low-income group of provinces, the converging pairs started to increase from 2008. The government focused on a “go west policy” in the 2000s to help the low-income provinces perform better, which helped them catch-up with the rest. Considering the effect of the 2008 global recession, many coastal and rich provinces experienced a decline in their growth which appear to contribute to the rising converging pairs. Emphasising the effects of the recession on exports of the emerging markets, Palley, T. (2012) argued that the effect of recession is implicit in the decline in export markets of emerging market economies. Coastal provinces are export-oriented regions of China. As a result, the impacts of the recession seem to partially affect the convergence from the top (lagging behind of high-income provinces) and government policy initiatives seem to promote convergence from the bottom (catching-up of low-income provinces).

Interestingly, the findings on the US States and MSAs largely suggest that the high-income group of regions exhibit higher instances of converging pairs (convergence from top) with the rest of the group members, suggesting a decline in income disparity within the group. For the low-income states, the poorest of the poor regions are diverging away from the rest of the group members, suggesting low growth experiences for them. The between-group analysis findings suggest that instances of converging pairs are largely higher for the States but instances of diverging pairs are higher for the MSAs. Therefore, the crisis seems to affect the MSAs severely, especially in the poor regions.

For the European regions, the impact of the two crises seem to be severe for the low growth subnational regions of Southern Europe which constitute the middle-income group of Europe. In addition, the crisis impacted some of the high-income regions that slowed down/stagnated and lagged behind (diverged) from the rest of the group members after the crises. Thus, the two 2008/2009 crises impacted some of the high-income and middle-income regions more than the low-income regions of CEE.

The economic crisis has drawn the attention of researchers towards regional resilience literature. Extending the understanding of regional resilience, Boschma (2015) explains resilience is not only the ability of a region to accommodate shocks but also its ability to develop new growth paths in the long run. There are many factors studied by researchers that have been considered to have an impact on the resilience of a region after the 2008 crisis. For instance, it is shown that most adaptive regions are better equipped to bear the shocks and bounce back quickly (Pike et al., 2010; Hassink, 2010). Regions dependent on the public sector were doing well in the EU until 2011 but after the austerity policies implementation, they had to go through significant public sector retrenchment (ESPON, 2014). Lagravinese (2015) emphasised that in Italy, regions with high manufacturing jobs or temporary workers suffered more than others. Similarly, Ray et al. (2017) showed that the manufacturing sector experienced high job losses and weaker recovery than business services in Canada. In Greece, Giannakis and Bruggeman (2017) found that rural regions were more resilient than the urban regions and the agricultural sector was more resilient than others.

8.7 Research contributions

Studies in the domain of regional convergence have widely discussed the regional dynamics of countries worldwide. Studies describing the regional convergence patterns in China, the US, and the EU are also very common in the literature. There has been a lot of research comparing the convergence trend of China with the US, China with the

EU, and US with the EU (Cheng et al., 2015; Mahoney and Baumgartner, 2008). All these consist of diverse regions with large economic and social disparities and thereby share similar challenges and goals of achieving balanced and sustainable growth. However, the heterogeneous mix of regions within these geographies calls for a comprehensive study to have a holistic picture on regional dynamics which is missing in the literature. However, we also need to simultaneously explain the convergence trends within regions of these three locations. This study, therefore, addresses these gaps by performing an in-depth analysis of regional dynamics and identifies conclusive trends.

The three locations (US, EU and China) provide a lot of opportunities to demonstrate changing regional dynamics. On the one hand, the role of China is consistently growing in the world economy and on the other hand, Grinin et al. (2015) conclude that it would be better for China to moderate growth to buy some time to avoid serious difficulties related to demographic problems. There is also a debate on China challenging the US hegemony in the near future (Layne, 2008; Urdinez et al., 2016). This originates from studies that conclude that there is a weakening of the US hegemony (Layne, 2009; Grinin et al., 2016). Therefore, the subject of growing China and weakening US makes it interesting to explore the similarity of regional dynamics within these countries. It is evident that in both the countries the rich and affluent places are located at the coast or near mineral-rich locations. In terms of regional disparity, findings suggest that the two countries were experiencing high inequalities between rich and poor regions until the late-2000s. Since the late 2000s, the poorest of the poor regions in the low-income group showed convergence towards the relatively high-income regions in China, however, the poorest of the poor regions show stagnation and lagging behind in the US.

Studies on regional dynamics in the EU explain the dimensions of European integration that emphasise the need for regional equalities (Bradley et al., 2005; Petrakos et al., 2005; Giannetti, 2002). For the success of regional integration, the process of convergence becomes important. The findings of the thesis suggest the co-existence of convergence and divergence between European regions which is supported by the literature (Giannetti, 2002; Longhi and Musolesi, 2007). The low-income regions of CEE are demonstrating convergence with the richer core Europe and at the same time, there are relatively high-income (or low-growth) regions of Southern Europe and some Core regions that are lagging behind and diverging away from the rest. Therefore, there is a simultaneous presence of convergence and divergence. This trend is different from what is found for Chinese and US regions where divergence has been a dominant trend until the late-2000s. Therefore, the evidence indicates that the inequality gaps between rich and poor regions are high in China and the US.

In terms of location of rich/affluent regions, in the EU the peripheral coastal areas of south and east are less affluent than the core regions. This is contrary to the locations of rich regions near the coast in China and the US. Comparing the evidence of post-recession convergence trend, some high-income regions in the US and the EU are not able to bounce back to the pre-crisis level even after a decade. This reflects the similarity between the US and the EU with respect to post-recessionary regional dynamics. Therefore, the contribution of this thesis in cross-comparison of regional dynamics is immense by revealing a comprehensive picture of regional behaviour within the three selected locations.

Poor regions demonstrating convergence attained through faster growth satisfies the hypothesis of the neoclassical theories. On the other hand, the new growth theory of convergence and new economic geography propositions explain the behaviour of rich regions demonstrating diverging growth paths away from the low-income regions. The neoclassical predictions of convergence fit very well with the CEE regions of the EU. For the US and China, the overall higher instances of divergence among regions support the new growth theory and new economic geography propositions. Geography plays an important role in the case of diverging growth paths (advancing ahead) of relatively rich regions. The rich regions grow faster in absolute terms and diverge away owing to the benefits of agglomeration economies, increasing returns, spillover effects, among others. The two strands of the theory of convergence and divergence do not take into account the dynamic nature of interactions of regions that could quickly change the behaviour of one region with others. The ignorance of churning/mobility of economies with the income distribution is emphasised by Quah (1993a, 1996a, 1996b, 1997). Studies in the domain have used measures such as Theil index and the transition matrix to quantify mobility but the interpretation/comparison was not simple (Novotný, 2011). Realising the importance of assessing mobility behaviour of economies and a lack of knowledge/assessment in the literature, motivated this study's objective to conduct a thorough assessment of their mobility behaviour. Therefore, another contribution of this thesis is to the knowledge and assessment of mobility within and persistence between the groups of regions.

The X-convergence technique allows the switching/mobility behaviour of pairs of regions to be assessed through the proportion of Type III and Type IV behaviours. The frequency of Type III and Type IV behaviours of pairs of regions within a group of similar regions provides insights into their mobility behaviour. The mobility of economies is important to understand which region is overtaking and which one is falling behind. A comprehensive analysis of two regions at a time gives exact identification of the regions that are overtaking or falling behind. The detailed mobility dynamics is not demonstrated explicitly in earlier studies. In earlier studies, mobility dynamics of regions have been widely understood with the help of a transition matrix, however, the constantly changing income distribution and increasing inequality between and within groups of regions require a comprehensive and detailed understanding of regional income mobility dynamics, which has been presented in this study.

Many new insights have been obtained while analysing the regional group behaviours in this thesis. For instance, for the Chinese provinces, the overall trend and between high- and low-income groups' convergence trends show that convergence started to dominate from 2005 and lasted until 2014. However, the convergence trend within the low-income provinces shows that convergence started to take place only after 2008, suggesting that the poorest of the poor regions actually started showing signs of convergence or faster growth in the group from 2008. The within-group analysis helps to unfold such nuances related to regional dynamics. Similarly, the within-group convergence analysis for the US and the EU for the high-income group throws light on the stagnation and lagging behind of some group members, particularly after the 2008 global crisis.

The between-group convergence trend provides immense knowledge on the dynamics of the persistence of regional income groups. If there is a low number of pairs of regions exhibiting Type III and Type IV behaviour, then that could be considered as persistence. For instance, in China the high-income group of coastal provinces demonstrate no switching with any low-income group of inland members. The persistence in regional income groups infer that the relatively rich regions are still rich and relatively poor regions are still poor. Therefore, the simultaneous assessment of regional dynamics of convergence, divergence, mobility, and persistence in income groups is a contribution of this thesis. The assessment is performed for pairwise regions on a year-over-year basis that makes the inferences more in-depth, reliable, and valid. The comprehensive examination of regional dynamics of pairs of regions reveals many important insights into patterns of regional disparity.

In summary, this thesis addressed the problem of finding a conclusive convergence pattern by performing a comprehensive pairwise study of regional dynamics. The thesis uncover many significant intricacies on regional convergence and disparity from the perspective of changing regional behaviour. The perspective of changing behaviour of regions with respect to each other provides a holistic view on the regional dynamics. There is a lack of studies investigating the changing behaviour, also known as “churning” or mobility dynamics, between two regions within and between similar income groups to demonstrate their dynamic regional behaviour. An assessment of regional mobility dynamics by identifying the behaviour of overtaking, lagging behind, and stagnating regions has not been fully explored in the literature. This thesis aims to address the research gap on regional convergence and disparity by providing empirical evidence on regional dynamics within and between similar income groups in the three selected geographical locations.

8.8 Policy implications

The literature in the domain of convergence, divergence, and mobility highlights their significance for appropriate policymaking and implementation. In chapter 2, section 2.2 describes the macroeconomic perspective of regional growth and a microeconomic perspective of regional development. Policy discussions on equity versus efficiency for regional growth and place-based versus people-based initiatives for regional development are common in this domain. Regional growth and development are necessary to reduce the gap between rich and poor regions. It is highlighted that regional inequality is common within both advanced and less advanced nations but the geographical concentration of inequality could differ. For instance, Piacentini (2014) underlines that in advanced countries, the disparities within large cities are high and in developing regions the urban advantage remains prominent and urban-rural differences are high. The analysis on the convergence of per capita incomes across selected geographies throw light on the extent that regional disparities need attention from a policy perspective.

The traditional measures give an indication of the behaviour of one average or representative economy within a group of economies being assessed. On the other hand, the X-convergence technique provides the assessment of the behaviour of the whole group as well as one individual economy with the rest in the group. This is an important difference between the X-convergence and the traditional measures of convergence. It could be considered in such a way that traditional measures of convergence provide a macro-level picture and the X-convergence measure provides both macro-and micro-level pictures of economies' regional dynamics. Hence which measure to use depends on the purpose of the study. If one wants to compare the behaviour of a group of economies as a whole, the traditional measures would be more appropriate, otherwise, to compare one economy with respect to another, the X-convergence technique would provide a holistic picture. It would provide an assessment considering the regional dynamics of convergence, divergence, mobility, and persistence, simultaneously. One of the advantages of this measure over the traditional measures is that it provides a one-to-one relationship with other economies which makes findings easy to interpret. This makes the assessment of regional behaviour within and between groups easy to interpret. However, the X-convergence measure provides an overwhelmingly comprehensive assessment that is computationally heavy.

The policymakers are concerned about the behaviour of groups of economies as well as an individual economy. The promotion of growth-enhancing conditions in low-performing regions is one of the objectives of convergence policies. The X-convergence technique can help in two ways—first, in identifications of lagging regions and second in understanding the after-effects of any policy implementation. For instance, if one wants to identify the low-income regions that are not converging with others and are lagging behind, the X-convergence technique can be used for this. Secondly, this method can be used to identify the high-income regions that are not converging within the group of similar regions. The policy requirements could be different for the two cases as low-income regions would need more resources to unfold the growth opportunities while high-income regions may have the resources but they need appropriate ways to channel the resources for better growth. The empirical chapters provide evidence of many high-and low-income regions stagnating after the global recession. The initially lagging/stagnating economy after getting a boost from policy implementation can be studied in detail over a period if they start to converge with peers.

The rising convergence among the countries across the world in recent years (details in chapter 4) gives an impression that disparities between countries are declining. At the same time, the prevalence of divergence within China and the US indicates the presence of rising inequality within countries. That suggests that regional inequality is not only restricted to the developing countries but also concerns the developed countries. Similarly, in Europe, the prevalence of divergence at the disaggregated level demonstrates the problem of increasing inequality between subnational regions. The evidence, thus, highlights the significance of fulfilling the objectives of equity policies across the world. With regards to policy, the findings of the thesis provide support for the evidence-based and place-based policies for optimal allocation of resources. The findings will assist authorities in making informed decisions on policies and programmes based on evidence.

Equity and territorial cohesion policies are related in terms of sharing the objectives of reducing geography-related disparities and hence promoting economic equity. The cohesion policies, apart from promoting regional development, also focus on accessibility and networking with the objective of maintaining equal access to services and facilities for every citizen (Mirwaldt et al., 2009). Meanwhile, the disagreement between equity-based and growth-based territorial cohesion has also been highlighted in the convergence policy literature (Kenworthy, 2003) which is further extended to include sustainability. For instance, Eriksson (2010) introduced sustainability in the tension between income equality and growth. The study argued that it is difficult to reconcile equality, growth, and sustainability all together at the same time for a particular region.

China's approach to regional development could be different from the US and some of the rich countries of the EU owing to the fact that China is a developing country and others are developed. Things like infrastructure, appropriate social security networks, legislations, taxation, good governance, etc. are already in place in many developed nations. However, developing countries are still making efforts to build on these initiatives and generate growth opportunities. Goodspeed et al. (2011) show that FDI is sensitive to a host country's level of development, governance measures, and corruption. Similarly, Hossain and Rahman (2017) found that governance in developing countries affects FDI inflows. Hence, the policy approach should be different for China than the US and Europe. However, the question arises whether the convergence that China has attained during the last decade is sustainable in light of the uncontrolled borrowing debt.

The European cohesion policy seems to reject the notion of a trade-off between efficiency and equity, indicating the possibility to attain growth and simultaneously achieving convergence in income and productivity across regions (Farole et al., 2011). In terms of the effectiveness of EU funds, they have different effects on different regions based on their abilities and capacities to adapt to changes (Cappelen, et al., 2003). For instance, it has been highlighted that regions with a certain level of unemployment experience positive impacts from EU support, whereas regions with high unemployment make policies and funds ineffective. Furthermore, EU regional support seems to favour regions with more developed backgrounds suggesting the importance of accompanying factors such as a high-skilled workforce that improves the capability and productivity of developed regions (Cappelen, et al., 2003: Mohl and Hagen, 2011; Crescenzi and Giua, 2016). This suggests that the findings of stagnation/slowing down of some of the high-income countries in the EU could have different policy implications than the regions experiencing low-growth or low-incomes.

In this line of research, it is also evident that there has been a debate on the effectiveness of place-based and people-based policies. These two types of policies have differential impacts on growth behaviours and hence regional dynamic behaviours of places. For instance, Doussard and Schrock (2015), inspired by the new economic geography principles, show that place and market-based policies are important to develop a high growth trajectory for the US. Similarly, McCann and Rodríguez-Pose (2011) emphasise that place-based policy approaches provide a wider range of possibilities to exploit untapped regional capabilities in a coordinated manner. Furthermore, Rodríguez-Pose (2018) stresses the importance of place-sensitive (focussing on regions that don't matter) policy initiatives rather than simply place-based. On the other hand, Doran and Fingleton (2015) argue that both people-based and place-based policy interventions are required for the US to be resilient from the recession.

The analysis of recessionary effects on different geographical regions and hierarchical levels support the studies indicating heterogeneous impacts of the recession. The impacts of a global recession vary across high-income and low-income groups of regions and across different hierarchical levels. To overcome the negative consequences of the crisis and build more opportunities for growth, it is important to implement appropriate policy initiatives (Martin et al., 2015). The different multi-level governance and heterogeneous impacts of recession call for differentiated and targeted development policies (Giannakis and Bruggeman, 2017). For instance, Doran and Fingleton (2018) stated the resilience of MSAs to the global crisis in the US was determined by the industrial structure of MSAs. This implies that, in general, policies related to the industrial structure would be more appropriate to help subnational regions overcome the negative consequence of any crisis (Holm and Østergaard, 2015). Similarly, the differential impact of the crisis at different hierarchical levels prompted Mirwaldt et al. (2009) to advocate the formulation of Cohesion policies across a multi-level governance system by giving levy to establish priorities by the local authorities with general rules laid down at the national/European level.

Effective government policies are needed for the optimal allocation of resources to those regions that need them the most. Efficient allocation of resources becomes all the more important in the current situation of COVID-19 crisis. The crisis accentuated the problem of regional inequality and unequal opportunities in many places. The situation to tackle the health and economic-social wellbeing crises during the current period call for some acute policy changes/initiatives. This could not only apply to the poor regions but also the stagnating rich regions. The findings of the thesis reveal important insights for evidence-based and place-based policy implementation. Therefore, heterogeneities across the regions necessitate multi-pronged policy initiatives based on regional/local government's priorities and capabilities.

8.9 Limitations and future research

This section will discuss some of the limitations of the study which could give directions for future work.

8.91 Data/variable

Convergence and inequality patterns have been studied in this thesis across the world for 108 countries. The countries demonstrate a wide range of GDP per capita, especially African countries. The high inequality in Africa and within other countries could have provided more insights into the overtaking and lagging regions. However, countries’ sizes differ a lot in Africa and the availability of data is a challenge for small countries. Therefore, the study used the Gini coefficient to shortlist countries for within-country analysis. Looking at the Gini coefficient for the worldwide countries, South Africa, Brazil and China were shortlisted for within-country analysis at one geographical level (provincial/state level) and the next step was to see which had wider disparities. South Africa consists of only 9 provinces, Brazil consists of 26 states, and China consists of 31 provinces. China is selected because of the highest number of provinces and wide disparity between the richest and poorest provinces. Regardless of the number of states and the size of the country, future research could continue to explore the gap within countries with high disparities in income per capita.

The empirical chapters strived to analyse the latest available data but due to the limitations of secondary data availability, the thesis employed different time scales for empirical chapters. The study acknowledges the fact that secondary data has its limitations on data collection and interpretation. It has been reported that some of the regional data have been inflated earlier and then rectified later. For instance, Liaoning province in China inflated its gross regional product from 2011-2014 (Asian Review, 2017). Similarly, CNBC (2015) reported that in the US, the first quarter of 2015 GDP data had been weaker than the other three quarters in the past five years and the BEA acknowledged the problem and assured the development process for addressing the issue. Therefore, the findings should be treated with caution.

Moreover, the inflated figures of GDP/GVA have the potential of being misleadingly over-estimating the actual regional economic disparities between regions. In such a case, the problem of comparing regional disparities using income per capita has been addressed by using indicators that measure productivity given by GDP per worker or GDP per hour. The advantage of using productivity indicators is that both numerators as well as denominators tend to be workplace-based.

According to an OECD report (2008), for measuring labour productivity with GVA per hour, first, there is a preference for value-added figures because taxes are excluded from and subsidies granted to different sectors are added to the GDP figure. Secondly, the number of hours worked is preferred over the number of employees because headcount of employed workers does not reflect changes in average hours worked by part-time workers, multiple jobs holders and self-employed workers. Therefore, GVA per hour is recommended over GVA per worker for comparing regional performance. This thesis used regional income per capita to understand the disparity between regions and the future study could consider the use of labour productivity data to assess regional disparities. A future study could compare the findings across different indicators such as income and productivity. Labour productivity is an important indicator that helps to understand the efficiency of regional government in allocating resources. Many regions in the EU are lagging behind in terms of productivity which would motivate future research to conduct a detailed productivity differential study.

8.92 Definition of region

Another limitation of the study is the definition of a region. Region is used as a unit of analysis in the thesis. The study assumes the pre-existing geographical boundary of economic units as regions. The problem is that in this case, the definition of regions may not represent the spatial dependencies between let's say a place where a worker lives and his workplace/employment centre. Recent geographical studies define regions in terms of spatially interdependent nodes (Dawkins, 2003). Exploratory spatial data analysis has been used in studies to take account of spatial autocorrelation and heterogeneity problems (Chen and Zhu, 2012; Fei and Chenghu, 2009; Dall'Erba and Le Gallo, 2008; Silveira-Neto and Azzoni, 2006; Egger and Pfaffermayr, 2006; Tian et al., 2010).

One of the objectives of the thesis was to provide insights on the understanding of convergence trend evolving in line with the literature and controversies surrounding the matter of convergence. Hence the thesis did not analyse the spatial dependencies of regions, however, future research could extend the study by employing the methods of exploratory spatial data analysis to complement the thesis findings.

Furthermore, for international comparison, an appropriate comparison of different types and sizes of areas play a key role in the analysis. This is particularly important for countries in the EU where countries/regions are highly heterogeneous. For instance, the sizes of NUTS2 regions of Paris are bigger than the NUTS2 regions constituting London as they are divided into smaller units. Even though the UK withdrew from the European Union on 31st January 2020, the thesis considers UK regions as part of the EU. The research had already been conducted before Brexit actually happened.

Although NUTS levels provide regions of comparable size, they are not the same across countries. For instance, given its relatively small population, Luxembourg, for instance, simultaneously represents the NUTS-0, NUTS-1, NUTS-2 and NUTS-3 levels. In Germany, the Federal States of Berlin, Hamburg, Mecklenburg-Vorpommern and Saarland function as both NUTS-1 and NUTS-2 regions (Eurostat Web site). In addition, despite the fact that this classification attempts to create comparable regions at all hierarchical levels, the regions at a given level can differ quite significantly with respect to land area, population, economic strength, and administrative importance. Therefore, if one wants to compare the income and productivity of regions across NUTS levels for different countries, adjustments need to be made for comparing regions with similar sizes, perhaps in terms of population or any other factor. Future research could do a sensitivity test to validate the findings by adjusting the regions based on their sizes.

Another issue that has been highlighted by researchers that advocates regions to be defined by their functional markets. Few researchers discuss that functional markets provide a better parameter to define a region rather than the administrative boundaries (Functional Economic Market Areas - An economic note, 2010; Oberst, 2012), and a classification known as Functional Economic Market Areas (FEMA) has been developed. FEMAs provide a spatial scale in which the limits cut across traditional local authority boundaries. According to FEMA, regions are divided based on the main drivers of economic activity in an area, using evidence gathered by the Local Economic Assessments. There is no standard approach to defining FEMA, as the trends of economic flow seem to differ depending on the market areas assessed. Some of these markets are labour market areas, housing market areas, consumer market areas, areas with easy transport and connectivity. It has been outlined that commuting flow data representing a labour market may best demonstrate FEMA (Berkshire Functional Economic Market Area Study, 2016). Apart from recognising the difficulty in data availability from other market areas like housing and consumer markets, it has been accepted that no single source of data is comprehensive enough in assessing FEMAs (Oberst, 2012). Most approaches in this domain have relied upon the analyses of one single market area. Considering just one type of market, however, overlooks the links between the decisions people make about where they live, work, shop and pursue leisure activities. Therefore, it is recommended that Local Planning Authorities develop a logical 'best fit' to encompass those FEMAs that exhibit strong inter-relationships to understand policy needs.

It has been recently established that FEMA holds an important place in local authority policy development and implementation plans. Nevertheless, the significance of administrative boundaries cannot be ignored. To resolve the issue of the importance of boundaries, the 'best-fitting' FEMA boundaries to local authority administrative boundaries is recommended by some reports (Berkshire Functional

Economic Market Area Study, 2016). However, considering the nebulous nature of defining FEMA and the infancy of methodological approaches adopted in classifying FEMA, this study used NUTS administrative boundary data for European regional data analysis. Consequently, European regional data based on NUTS classification is the best form of data that could achieve the goals of the PhD study. Since the data is structured in a hierarchy, it becomes relevant for detailed trend or pattern analysis within- and between-groups.

In addition, future studies could aim to replicate the results in a larger sample of within European countries. European data is rich and provides a good opportunity to work out the trends within countries and then compare with others. For instance, trends within the UK, France, Germany, Spain, etc. could be compared with each other at national and subnational levels. Similarly, the US states could be used to understand what is happening within states at metro and county levels.

8.93 Technique employed

The X-convergence technique is a distribution free or magnitude free test used to focus solely on the properties of convergence/divergence without getting affected by the rate of convergence or any magnitude of data involved (Webber and White, 2003, 2009; Novotný, 2011). The advantage of distribution free statistics is that it is not sensitive to extreme values and also able to detect small but important changes between two time periods. Differences in the ratios of income per capita between two regions in two periods (relative) are used in this thesis. This makes the X-convergence statistic dependent on the direction of change. In addition, the interpretation is based on the frequency of concordant and discordant pairs, hence they are dependent on the direction of change instead of the magnitude of change. Owing to the limitation of magnitude free statistics, the thesis does not comment on the magnitude of regional disparities. Future research might apply a magnitude dependent test in addition to the X-convergence statistic to add to existing findings.

Another important thing that needs attention while using the X-convergence technique is that the process of analysis is computationally heavy. The method is computationally intensive in terms of the number of pairs being analysed. If the sample size is large, it involves a large number of pairs to be analysed and big spreadsheets. It also requires great attention to detail while analysing pairs of regions. Another limitation is that it could provide a biased inference if, let’s say, the number of less developed countries is higher than the developed countries in a sample, then the behaviour of the whole sample will demonstrate the dominant behaviour of the developing countries. To address this issue, the thesis has grouped regions with similar characteristics using a grouping algorithm (GBTM).

Future studies could also compare the findings from techniques such as the Theil index that is used widely in the literature to understand regional disparities. Even though the Theil index measures the spread of the distribution and ignores the possibility of polarisation (Castro, 2003), it has been used widely in the inequality literature. It is used to decompose inequality into within and between inequalities (Milanovic, 2012) but the findings do not allow for detailed comparisons between regions (Novotný, 2011). It would be interesting to compare the findings obtained from the Theil index and those obtained from the X-convergence measure.

Furthermore, a few studies in the domain use the *log-t* test proposed by Phillips and Sul (2007) to identify convergence clubs and examine the different growth determinants for the clubs (Tian et al., 2016; Mazzola and Pizzuto, 2020). However, the thesis has used the group-based trajectory modelling to identify groups because the focus of the study is to identify groups based on the evolution of growth trajectories of regions. The *log-t* test is based on non-linear time-varying factor model that accommodates heterogeneous behaviour and the evolution of that behaviour (Du, 2017). It would be interesting to check the differences in the group assessment using GBTM and the *log-t* test in future work

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APPENDIX

Sensitivity Analysis

The X-convergence estimate gives a leeway to conduct a sensitivity analysis by removing regions with extreme values. In order to test the reliability of the data, sensitivity tests have been conducted across the empirical chapters by randomly removing the data points in some cases or removing the extreme data points in others. The frequency of pairs of regions demonstrated by each type of behaviour is compared before and after the removal of regions for a particular period. For instance, the table below shows the pairs of regions exhibiting each type of behaviour (Type I, Type II, Type III, Type IV) for the four geographical areas from 2000. Details below:

1. For the World economies, 19 countries in North America have been removed out of total 109 countries and the number of pairs has been compared before and after removing the countries (Total and Without). The removed countries are—United States, Trinidad and Tobago, St. Vincent and the Grenadines, Puerto Rico, Panama, Nicaragua, Mexico, Jamaica, Honduras, Greenland, Guatemala, El Salvador, Dominican Republic, Cuba, Canada, Costa Rica, Bermuda, Belize, The Bahamas.
2. For the Chinese provinces, three high-income provinces were removed—Beijing, Shanghai, and Tianjin.
3. For the US States, 2017 bottom 10 States have been removed—Alabama, Arizona, Arkansas, Idaho, Kentucky, Maine, Mississippi, Montana, South Carolina, West Virginia.
4. For the European countries, two extreme countries have been removed—Luxembourg and Norway.

While comparing the types of behaviours before and after removing the data points, the conclusion drawn on the convergence and divergence trend does not change. Removing regions with extreme values would provide the same proportion of pairs of regions in a particular Type (either Type I, II, III, or IV) of convergence behaviour. In other words, if Type I behaviour has the highest pairs of regions before removing the regions, then Type I behaviour will have the highest number out of the other three types of behaviour even after removing the regions. That is, the same conclusion is drawn that Type I behaviour predominates before and after removing the regions. Therefore, the conclusion drawn does not change by removing extreme data points from the sample while employing the X-convergence technique. That shows that data is considered to be reliable and it does not have any implications on the conclusion drawn on the convergence/divergence trend.

		World				China				US				Europe			
		Type I	Type II	Type III	Type IV	Type I	Type II	Type III	Type IV	Type I	Type II	Type III	Type IV	Type I	Type II	Type III	Type IV
2000-01	Total pairs	5502	6224	24	22	448	462	10	10	1274	1096	40	40	168	584	2	2
	Without	4533	5152	20	15	392	428	10	10	993	895	33	39	154	492	2	2
2001-02	Total pairs	5982	5708	54	28	542	382	2	4	842	1540	38	30	188	560	4	4
	Without	4947	4706	43	24	481	353	2	4	636	1265	33	26	142	500	4	4
2002-03	Total pairs	5118	6546	46	62	544	372	12	2	958	1426	34	32	216	536	2	2
	Without	4229	5398	41	52	504	322	12	2	731	1164	34	31	188	458	2	2
2003-04	Total pairs	6168	5484	58	62	394	522	12	2	1218	1118	60	54	220	532	0	4
	Without	5091	4525	54	50	356	470	12	2	945	915	50	50	182	464	0	4
2004-05	Total pairs	5650	6040	60	22	522	390	12	6	1272	1092	52	34	246	506	4	0
	Without	4721	4933	47	19	499	323	12	6	1043	847	42	28	214	432	4	0
2005-06	Total pairs	5970	5738	34	30	396	526	2	6	1286	1062	46	56	242	506	8	0
	Without	4964	4699	31	26	382	450	2	6	1033	831	41	55	212	430	8	0
2006-07	Total pairs	5608	6106	36	22	336	564	16	14	1340	1022	52	36	214	542	0	0
	Without	4715	4959	30	16	313	497	16	14	1080	803	45	32	166	484	0	0
2007-08	Total pairs	4410	7284	34	44	374	534	8	14	1106	1218	54	72	202	546	4	4
	Without	3608	6044	32	36	350	468	8	14	891	948	51	70	188	454	4	4
2008-09	Total pairs	3250	8458	38	26	386	514	18	12	1426	930	44	50	384	362	0	10
	Without	2594	7069	34	23	374	436	18	12	1150	726	41	43	328	312	0	10
2009-10	Total pairs	5200	6494	38	40	268	646	6	10	1124	1248	46	32	384	368	4	0
	Without	4327	5327	33	33	263	561	6	10	896	997	39	28	330	316	4	0
2010-11	Total pairs	5316	6394	24	38	244	668	14	4	1176	1192	38	44	270	480	2	4
	Without	4412	5252	22	34	241	585	12	2	901	989	33	37	248	396	2	4
2011-12	Total pairs	4014	7704	20	34	266	650	6	8	1340	1038	36	36	300	454	2	0
	Without	3319	6354	18	29	255	573	6	6	1041	848	35	36	254	394	2	0
2012-13	Total pairs	4506	7200	32	34	262	654	2	12	952	1442	34	22	302	450	2	2
	Without	3768	5894	29	29	246	580	2	12	761	1148	30	21	244	402	2	2
2013-14	Total pairs	5018	6702	30	22	356	552	14	8	1312	1068	40	30	284	468	2	2
	Without	4181	5497	23	19	338	480	14	8	994	901	37	28	244	402	2	2
2014-15	Total pairs	5338	6356	38	40	492	410	10	18	1388	1030	16	16	216	518	6	16
	Without	4437	5209	36	38	439	373	10	18	1032	899	14	15	150	478	6	16
2015-16	Total pairs					500	402	14	14	1086	1306	28	30				
	Without					438	378	12	12	868	1040	24	28				
2016-17	Total pairs									1348	1060	16	26				
	Without									1059	866	13	22				