HIGHER EDUCATION TEACHING AND TRAINING SYSTEM AND ECONOMIC PERFORMANCE: AN EMPIRICAL INVESTIGATION

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ABSTRACT

This paper investigates the importance of higher education characteristics for economic performance in both developing and developed economies. Despite a relatively plethoric literature, there is still a clear lack of understanding of (i) how the higher education teaching and training interact with knowledge, innovation and economic performance; (ii) the heterogeneity across levels of economic development; and (iii) the mediating role of innovation and knowledge. In this paper we aim to fill this gap. The existing literature on higher education policy, economics, and innovation helps us identify four key higher education characteristics relating to the size, funding, subsidies and mismatching (to economic needs). Cross-country education data as well as data on patents and publication production is used to estimate the direct and indirect effects of several higher education characteristics on economic performance. Several interesting conclusions are drawn, including the desirability of subsidies and greater access to higher education, and the non-desirability of the 'ivory tower' system. We also find a significant difference in the interaction of higher education characteristics with economic performance across levels of economic development.

Keywords: Higher Education and Training System, Economic Performance, Patent, Publication,

Cross-Country; Developing and Developed Countries

1. Introduction

The Higher Education (HE) system has three known missions. The "first mission", the provision of human capital, has been recognized as an important element of any HE institution (Sam and Van Der Sijde, 2014).; Fagerberg and Shrolec, 2008). The literature has also recognised the importance of another couple of missions, namely research activities (the "second mission") and the economic application of HE institutions' teaching and research activities (the "third mission") (Etzkowitz et al., 2000; Martin, 2003; Gulbrandsen and Slipersaeter, 2007; Laredo, 2007).

Although there is a consensus as to the effect of higher education institutions (HEIs) on economic growth, scholars largely disagree on what makes these institutions efficient. In other words, the question of what are the "key institutional features" that can provide effective support to the development of innovation, productivity and economic growth remains largely unanswered. In particular, the HE policy issues related to the development of human capital through education, training and teaching which can support economic development are largely unexplored. Moreover, there is little empirical data supporting current education policy debates (Bonaccorsi et al., 2010).

A variety of HE systems have been adopted by different governments around the world (Teichler, 2007; Ansell, 2008). Some governments tend to favour controlling the running of their HEIs while others prefer to keep some distance (Etzkowitz, 1998). Some governments place a greater emphasis on maintaining an elitist model of higher education system (HES), while others move towards an open and accessible system (Ansell, 2008). Some governments provide direct subsidies and public funding to their HEIs, while others provide no such privilege. Given such heterogeneous institutional characteristics of HES around the world, it seems natural to ask whether correlations exist between certain "institutional characteristics" of HES and the country's economic performance.

The aim of this paper is to attempt to answer the above question. It aims to provide empirical evidence to support and contribute to the emerging policy debate regarding the appropriate model of National HES and its relationship with economic performance. It investigates whether certain "institutional characteristics" of HES can be associated with greater economic performance.

Our main arguments are that each of these missions may be hindered or supported by HE policy choices. For example, the 'third mission' can be more effective with an entrepreneurial university and greater emphasis on research with a commercial potential (Martin and Etzkowitz, 2000). Therefore, a strict focus on the more traditional 'teaching and research' university may hinder this third mission (González-Pernía et al., 2012).

We empirically examine five hypotheses and provide evidence that three of these are fully or partially supported. Our results suggest that, for developing economies, the size of the HES has both a direct and indirect (positive) effect on economic performance. In contrast, Size shows only an indirect effect on economic performance within the OECD. Subsidies are irrelevant for the developing economies, but have both direct and indirect (positive) effect within the OECD.

We reject our prediction that it matters little whether the HES looks more like an 'Ivory Tower' or more like an 'Application Driven' system. Although there is no direct link between Mismatching (Ivory tower) and economic performance, Mismatching is negatively connected with Publications. Thus, Publications fully mediate Mismatching, and this latter therefore is negatively related with economic performance.

There appears to be significant differences within the OECD between subsidised and non-subsidised systems of HE. However, we find no evidence in support of a positive impact of investment in higher education on innovation, knowledge or economic performance. That is, higher levels of investments do not seem to improve any of these three pillars.

The rest of the paper is organised as follows. Section two reviews the literature on the multiple roles of HEIs in national economic, knowledge and innovation development. The section highlights the need for further research into the characteristics of the Higher Education System

in supporting national economic performance. Section three reviews the literature on four HE characteristics and proposes five hypotheses related to how these characteristics may be associated with the country's economic performance. Both the moderation of the level of economic development and the mediation of innovation and knowledge are considered. In section four, the methodology, data, and model are described. Section five presents the main empirical results. Section six discusses the results and outlines their implications for policy making. The final section concludes.

2. Higher Education Institutions and Economic Development

The Higher Education sector is often described as contributing to the development of the national economy by creating productive labour and skilled human resources, usually called "Human Capital" and producing new and useful knowledge that can support the development of economic growth.

Human capital is the stock of competency, knowledge and personality attributes embodied in the ability to perform labour so as to produce economic value. It is somewhat similar to the "physical means of production" such as machines or factories (Mincer, 1964; Becker, 1964). Economists like Becker (1994) argue that Human Capital increases through education and experience. Barro (1991) found that GDP growth rate was positively correlated with school enrolment number. Romer (1994) suggested that economic growth is a function of the availability of human capital.

On the other hand, the availability of human capital depends on, amongst other things, the availability of Higher Education infrastructure (Furman et al., 2002). Nelson and Phelps (1966) confirm that the ability of a country to be competitive and to catch up with more advanced nations can be related to the growth of the stock of human capital through education.

Diversity is viewed, by the education policy literature, as a positive and necessary feature of HES (Trow 1997), and can help significantly improve its performance (Eastman and Santoro, 2003; Conceição and Heitor 2005; Horta et al., 2008). The importance of diversity as an engine for

economic growth was also highlighted by Audretsch et al. (2004). However, most of the economics and innovation system literature has neglected the existing variety of HES around the world, and has considered HES as a black box. It is thus assumed to be institutionally similar across the world. In fact, as will be shown in the next section, HESs around the world are rather diverse. The effects of this variation on the development on knowledge, innovation and economic growth of a nation are still not well researched.

3. The Characteristics of Higher Education Teaching

The higher education policy literature has observed that there are varieties of HES around the world (e.g. Teichler, 1988; Bauer and Kogan, 2006; Teichler, 2007; Conner and Rabovski, 2011). For example, some wrote about the various governance patterns of HEIs (Amaral et al., 2002); the various types of public accountability (autonomy) in HEIs (Huisman and Currie, 2004); the different boundaries (local, national and global) of HEIs (Jones et al., 1998); the different types of financing HEIs (Herbst, 2007; Titus, 2009); and the different roles of government/state intervention in HE sector (Neave and Van Vught, 1994). Heller (2001), Mok and Lo (2002) and Texeira et al. (2004) contrasted HESs which emphasize greater access against the system based on market intervention. These works have shown that HESs around the world are institutionally diverse and that the effect of such diversity on national knowledge and innovation production and economic performance is not yet well understood.

The empirical studies on the relationships between the production of human capital through education and the national economic performance have been conducted by various scholars (e.g. Barro, 1991, 2001; Benhabib and Spiegel, 1994; Barro and Sala-i-Martin, 1995; Gemmell, 1996; Bils and Klenow, 2000; Seetanah, 2009). Using the endogenous growth theory as a starting point, they mostly found – although not robustly - that the initial stock of human capital can be associated with economic performance at country level. Some of them (Barro, 1991, 2001) also found that the quality of education (schooling) is significantly more important than

the amount of education offered to produce human capital in their relation to economic performance.

Badinger and Tondl (2005) and Chi and Qian (2010) found that the high level of higher education attainment (i.e. number of persons with higher education degree) facilitated the level of innovation activity in a region. Simonen and McCann (2008) found that the high mobility of human capital between regions can enhance the innovation performance of the firms in the region. Finally, using panel data from a sample of 29 countries, Varsakelis (2006) found that the investment on quality education (as measured by the score in mathematics at the Third International Mathematics and Science Study) can be associated with higher output of innovation activity. Within these works, the "institutional diversity" of HES are not specifically studied or discussed.

In this paper, the analysis of "institutional diversity" of HESs will be focused on previous works carried out by Trow (2005), Ansell (2008) and Schneider (2008). Based on their studies, we identify four main HES characteristics: (i) the capacity of the HES and number of students enrolled; (ii) the level of funding/investment allocated to the HES; (iii) the amount of total public investment (or subsidies) to the HES; and (iv) the matching between HES activity and societal needs. These characteristics are discussed in the following subsections. However, Ansell (2008) argues that HE policy, in the context of developing countries and resources constraints, will always be faced with the difficult challenge to manage and mediate a three-way trade-off between focusing on the extent of coverage of HES (E.g. Mass Vs Elitist HE system); the degree of subsidization to HEIs; and the overall cost of HE.

3.1. Mass versus Elitist HE System

One of the main characteristics of a HES is its ability to absorb demand for HE places (Trow, 2005). Certain systems are designed to cope with high numbers of students. Such systems are usually called 'Mass' HESs. Other systems are more focused on a restricted number of qualifying students. Such systems are often described as 'Elitist' models of HES (Ansell, 2008). Although

somewhat arbitrary, Trow (2005) defines an elitist system as that which takes less than 15% of students. This leads us to the question of whether and how a greater HES capacity is associated with economic performance.

Some scholars have argued that size is not necessarily good for economic performance. For example, the expansion of HE may lead to poorer quality of education (Dore, 1976; Wolf, 1997; Barro, 2001), and, hence, to a significant degradation in the quality of produced skill. HE expansion has been argued to harm prosperity and to become a form of consumption (Murphy, 1993). There is also an argument in favour of small HESs because smaller systems are more able to adapt, by re-arranging and re-mobilizing their resources, to a changing globalised trade (Robinson, 1960; Van de Ven et al., 1999).

The empirical evidence on the effect of HES scale is also divided. Barro (1991) studied developed countries and found a positive effect of the enrolment ratio on per capita GDP growth. However, he used the enrolment ratio to primary and secondary, rather than higher, education. Seetanah (2009) replicated Barro (1991) for a sample of developing countries. Benhabib and Spiegel (1994) found a positive association between education attainment (as a proxy for the level of human capital) and per capita GDP growth. However, human capital growth was found to be negatively associated with GDP growth. Moreover, education attainment data might not be a good proxy to estimate the diverse capacity of HESs around the world. Finally, Varsakelis (2006) found insignificant correlation between "the total number of students enrolled in higher education with scientific orientation" and the national innovation outputs of a sample of mainly OECD countries.

The above theoretical arguments and empirical results are not conducive to a clear conclusion. One potential explanation as to why the literature is so divisive is the distinct economic and social conditions of developed and developing countries. Unlike developed economies, developing countries lag behind in terms of human capital and suffer from severe shortages in qualified and educated manpower. In contrast, developed economies have reached a steady state situation, with low population growth and no shortage in skilled labour. This explains why

most developing countries allocate, when they can, a significant part of their resources to education in order to increase the level of their human capital who could play a key role in the development of their economy and society (Romer, 1994; Nelson and Phelps, 1966; Furman et al., 2002)

It therefore seems likely that the relationship between HE size and economic performance may not be strong in the developed world, but significant in the developing economies. This is supported by prior empirical evidence that suggests the likelyhood of a significant and positive association between enrolment and innovation performance in developing countries. From the above discussion we propose the following hypothesis:

H1: The relationship between HE size and national economic performance is moderated by the country's economic conditions. Specifically, the relationship is significant and positive for developing economies, but insignificant for developed economies.

The size of HES is proxied by the gross enrolment ratio of students. This is defined as the ratio the number of the students enrolled in higher education to the size of the population within the higher education age group.

$$Size = \frac{Number\ of\ Students}{Population\ with\ HE\ age} \times 100$$

Our basic assumption is that the shortage in skilled labour within developing economies makes every additional student a positive net present value because his marginal contribution will be greater than the investment in his/her human capital. Thus, greater numbers of students enrolled in HES will provide a higher potential to improve economic output. In contrast, developed economies do not suffer from a shortage of skilled labour. Given that their economic output is likely to be at optimal levels, additional (excessive) skilled graduates may not lead to an increase in economic output.

3.2. The impact of funding

Many countries are experiencing pressure to fund and support their growing HESs (Scott, 1998; Kane et al., 2005, Doyle et al., 2009). Good quality teaching and research activities require an

adequate level of funding. However, funding is a necessary but not sufficient condition. In the context of developing countries, Barro (1991, 2001) claims that the quality of education (schooling) is significantly more important than the amount of education offered to produce human capital in their relation to economic performance.

The impact of education funding on economic performance is widely researched in economics (Barro and Sala-i-Martin, 1995; Barro, 1998; Bassanini and Scarpenta, 2002; Greenaway and Haynes, 2003; Abbott and Doucouliagos, 2003; Barr 2004; Barr and Crawford, 2005). This body of research suggests that the quality of knowledge and research delivered by HEIs is fundamentally related to their resource levels and funding. Specifically, in developed economies, a significant and positive relationship between funding in education and economic growth has been empirically demonstrated (Jorgenson and Fraumeni, 1992). This relationship is more pronounced in more advanced economies (Petrakis and Stamakis, 2002) or in technologically advanced regions (Vandenbussche et al. 2006).

For the developing world the results are mixed. Some studies found no significant relationship between education expenditure and national economic growth (e.g. Landau, 1986; Devarajan et al., 1996; Miller and Russek, 1997; Temple, 2001), but others found a strong relationship (e.g. Baldacci et al., 2004; Bose et al., 2007; Neycheva, 2010). There is also some evidence that HE is less important for growth than primary and secondary education (McMahon, 1998; Pereira and Aubyn, 2008). From this discussion we propose the second hypothesis:

H2: There is a positive association between investment in higher education and economic performance. This association is moderated by the level of the country's economic development. Specifically, we expect a weaker link between investment in HE and economic performance within developing economies compared with developed economies.

The second hypothesis explores the relationship between the level of the education support in terms of total funding invested in HES and economic performance. Investment in higher education is proxied by 'relative support', which is calculated as follows:

$$RelativeSupport = \frac{TotalExpHE/GDP}{TotalEnrol/Pop}$$

This is the ratio of relative expenditure (total HE expenditure (tertiary educational level) to GDP) to relative enrolment (total enrolment in HE to population). The relative support is a better measure than an absolute funding measure (such as total education expenditure for HE) because of country heterogeneity in terms of population size as well as levels of economic output. The second hypothesis implies a significant and positive relation between relative education support and economic growth.

3.3. Higher education subsidies

It has been noted earlier that the size of investment in HE is necessary but not sufficient for a strong contribution of the HES in the economy. This lack of sufficiency is due to two inter-related reasons, namely the source of funds (the where) and how the funds are spent (the how). Although these two reasons are highly qualitative, we can attempt to quantify them by using subsidies as proxy for the source of funds, and by 'alignment' as a proxy for how the funds are spent.

There is a general agreement that, HEIs need to be more accountable, efficient and productive in the use of their (state or market-based) resources (Martin, 2003; Clark, 1983; Layzell, 1999; Trow, 1997).

HES funding strategies have been discussed extensively (Geuna, 1999; Mumper, 2001; Harter, Wade and Watkins, 2005; Hearn, 2006; Archibald and Feldman, 2008). However, there are two main views regarding subsidies. The first view advocates greater levels of subsidies to support HE (Cheslock and Gianneschi, 2008). Subsidies are considered as critical for the intensification of access to higher education (Heller, 2001; Mumper, 2003; Ryan, 2004; Gladieux, 2004; Titus, 2006; Dowd and Coury, 2006). Jongbloed and Vossensteyn (2001) explain that the mechanisms for subsidies and public funding form the basis for enabling HEIs to achieve quality, efficiency and equity.

The HE system is considered by many as being central to the development and maintenance of human capital (Paulsen, 2001). According to Barr (2004), the number of HEIs has greatly

increased in both developed and developing countries. This growth has been evidently associated with a swelling of the cost of education, which, in turn, has caused increased pressure on governments in their attempts to provide funding for bigger and more complex HESs (Scott, 1998; Kane et al., 2005; Doyle et al., 2009; Barr, 2004). This has pushed many governments, particularly in the developed economies, to seek alternative sources of funding to counter at least partially the lack of public funding (Greenaway and Haynes, 2003; Liefner, 2003).

Liefner (2003) argues that the funding of subsidised HEIs are mostly non-performance-based. Since funding and salaries are guaranteed regardless of project results, there is an inherent incentive for these institutions to run unsuccessful projects. Thus, there is a clear need for alternative mechanisms of funding that would ensure a more effective role of HEIs in producing better quality human capital. This need gave rise to a second school of thought which emphasises market mechanisms (Ansell, 2008; Barr, 2004; Tilak, 1991; Dill and Soo, 2005; Levin, 2001). New sources, such as fees, tuitions, gifts, and grants have been suggested. These new forms of funding from the non-government sector are presumed to produce incentives for HEIs to improve their performance and be more responsive to market conditions (Clark, 1983; Greenaway and Haynes, 2003; Layzell, 1999).

This second view is driven by the belief that market orientation of HEIs would be linked to their performance (Tooley, 2000; Walford, 1994). This second school believes that market orientation is relevant to profit as well as not-for-profit organisations. Although intuitive, this view is not unanimous. Because of its complexity, the market orientation in HE is neither sufficiently investigated (Caruana, Ramaseshan and Ewing, 1998) nor well understood (Barr 2004). Jongbloed and Vossensteyn (2001) and Barr (2004) argue that the market in which HEIs operate is subject to market failure. The use of competition and performance measurement with HEIs can lead to risk-avoidance and game playing that can be counterproductive as HEIs would turn towards easier or less costly outputs and objectives (Jongbloed and Vossensteyn, 2001).

Despite the significant divergence of the two schools, both types of funding mechanisms have been used by HEIs worldwide (Liefner, 2003). The primary condition for the success of funding,

regardless of its type or source, is dependent on its effective and productive use. There are many examples of OECD countries whose economic performances improved thanks to increased and satisfactory levels of funding despite the fact that different countries adopted different policies and strategies for funding (Barr, 2004; Liefner, 2003; Jongbloed and Vossensteyn, 2001). Based on the above discussion, we propose the following hypothesis:

H3: There is no association between the level of HE subsidies and economic performance

The level of subsidies is measured by the ratio of public expenditure (in HE) to total expenditure (in HE), and is given as follows:

$$Subsidy = \frac{Public\ Expenditure\ on\ HE}{Total\ Expenditure\ on\ HE} \times 100$$

3.4. Alignment of HES with its social and economic environment.

An important determinant of the effectiveness of HEIs is the relationship between these HEIs and the society they are supposed to serve (Schneider, 2008). In some countries HESs are designed to serve the needs of their society directly. Other systems are instead focused on the advancement of scientific knowledge and critical thinking. Presumably, societal needs can be served indirectly through (unfocused) academic progress. The literature calls this latter system an 'Ivory Tower' system.

Humboldtian Universities are an example of this 'Ivory Tower' system (Krull, 2005). This system is based on the liberal idea of Wilhelm von Humboldt and Friedrich Schleiermacher. Humboldt and Schleiermacher argued that HEIs sole purpose should be the advancement of science solely through scientific freedom of thinking (Martin, 2003). Under this model, future human capital (the students) are given knowledge and taught critical and scientific thinking.

Countries such as France and the USA have adopted more economically focused HEIs. Most French HEIs were established during the Napoleonic era to serve the needs of the state. These universities would do research and supply the country with 'relevant' human capital in exchange for full state support. In the USA, the state's involvement was almost inexistent.

Instead, social and economic factors were the main reason for the development of HEIs. Some HEIs were established according to the needs of particular regions, individuals or groups. For example, the US "Land-Grant" (or The Morrill Act) Universities were established to teach students practical agriculture, science and engineering as a response to the industrial revolution and changing social class (Martin, 2003).

The difference between the 'Ivory Tower' (IT) HEIs and 'Application Driven' (AD) HEIs has implications on the nature of the knowledge to be produced. Gibbons et al. (1994) distinguish two models of knowledge production. The first model of production is the Ivory Tower system where knowledge is mainly initiated and produced by disciplinary academics, separated from society and usually based on the autonomy of scientific investigation. The German university is an example. The second model knowledge is described as specific, related to a context of application and initiated by practical needs (Gibbons, 2000; Nowotny et al., 2003). It involves a multidisciplinary and collaborative approach (Greve et al., 2009) which can help better understand and address the complexity and requirements of the context (Aribi and Dupouët, 2015). Mode 2 knowledge is more geared towards solving societal problems rather than being based on the curiosity of scientists.

The modern US 'entrepreneurial' universities are a good example of the second model (Etzkowitz and Leydesdorff, 2000). Supporters of the 'Ivory Tower' model argue that basic research and curiosity-driven academic activities produce better scientific knowledge, which is essential for future long term innovation performance (Polster, 2000; Nelson, 2004; Ziman, 2000). For Nelson (2004) critical thinkers and unconstrained scientists are useful for an effective innovation process.

Contrary to the Ivory Tower proponents, many scholars argue that having to serve society would be more appropriate for successful exploitation of knowledge and innovation production (Etzkowitz and Leydesdorff, 2000; Etzkowitz, 1998; Schulte, 2004; Kitagawa, 2005; Shattock, 2005). Market demand creates new opportunities for socially useful research and education. As

a consequence, HE policy should support close cooperation between HEIs and its clients (Etzkowitz and Leydersdorf, 2000).

Prior empirical results are inconclusive. Some studies have reported positive impact of HEI's engagement with industry (Gulbrandsen and Smeby, 2005). Van Looy et al. (2004) show that involving researchers in contract research stimulates scientific productivity. Jensen and Thursby (2004) found that commercialisation within HES could actually promote basic research and scholarly education. Stephan et al. (2007) found that patents (which are more commercially beneficial) were positively and significantly correlated with publishing. Thursby et al. (2007) showed that licensing positively impacted research. Finally, Thursby and Thursby (2004) also showed the likelihood of licensing increased the willingness by faculty members to engage in commercial activities.

In contrast, other studies have found more evidence favouring the importance of basic research, as opposed to applied research. Mansfield (1991) estimates that 11% of new products and 9% of new processes were only possible thanks to basic academic research. Other scholars found that firms' patenting activities were higher in regions with high numbers of academic publications by universities (Jaffe, 1989; Mansfield and Lee, 1996; Anselin et al., 1997). However, we know very little on the direct difference of these two models in terms of the production of human capital and innovation. To date, we know of no empirical evidence that shows whether a HES which focuses more on the production of 'curiosity scientists and critical thinkers (i.e. 'Ivory Tower' HES) is more or less superior in the production of human capital and innovation (and hence economic performance) than a more 'Application-Driven' HES. Taking into account the above debate, we thus propose our fourth hypothesis:

H4: there is no difference between the 'Ivory Tower' and the 'Application Driven' HES in supporting economic performance.

We analyse the impact of HES alignment upon economic performance by investigating the relationship between the number of unemployed HE graduates and the national economic performance. Thus, the independent variable related to this hypothesis is

$$Mismatch = \frac{Unemployed\ HE\ Graduates}{Total\ Population} \times 100$$

This ratio gives the rate of unemployed graduates relative to population. Ideally, the independent variable should be a dummy variable representing one system or the other. Unfortunately this is not possible. First, it is not possible to identify whether a given country adopts IT or AD models. Second, some countries could have a mixture of both systems. A continuous measure would therefore be preferable.

The choice of unemployed HE graduates is based on our assumption that this kind of unemployment rate is correlated with how deep a particular country is within the IT or AD systems. For example, with an extreme 'Ivory Tower' system we expect the variable 'Mismatch' to be at its highest value because it would lead to the highest unemployment rate of graduates. On the other hand, an extreme 'Application Driven' system will produce the lowest value for 'Mismatch'.

3.5. Innovation and Knowledge Production as Mediators.

The above discussion also suggests that HE effect on economic performance may be mediated by innovation and knowledge. While HE does provide the economy with human capital, it also produces and disseminates knowledge for innovation (Shane, 2004; Mowery and Sampat, 2005; Gulbrandsen et al., 2011) that can potentially benefit the economy (Guena and Muscio, 2009). Furthermore, within its third mission, HE is increasingly exploiting its own knowledge and producing innovation (Anatan, 2013; Etzkowitz 2003).

The role of HE in the production of knowledge as a basis for innovation and its impact on their economic and social environment is increasingly being debated by the literature (Gulbrandsen et al., 2011; Guena and Muscio, 2009; Etzkowitz, 2008).

In addition to the first mission aimed at producing human capital, the literature has also recognised the importance of the second mission which focuses on research activities and the third mission (also known as the entrepreneurial university) which is driven by the need to

commercialise knowledge and be more active in the production of innovation (Etzkowitz et al., 2000; Martin, 2003; Gulbrandsen and Slipersaeter, 2007; Laredo, 2007). This explains the emphasis placed by economic development policies on the production of knowledge and innovation as the basis for economic prosperity (Freeman and Soete, 1997; Honjo, 2017). According to the systemic approach of national innovation production (Edquist, 2005), innovation performance of a country depends on the existence of highly effective National Innovation System (NIS) (Lundval, 1992). The concept of NIS is based on the proposition that innovation is an important determinant of country economic growth and competitiveness (Freeman, 1987). An effective NIS consists of interconnected institutions, such as HEIs and production institutions, that are capable to effectively and efficiently produce, diffuse and exploit economically useful knowledge (Lundvall, 1992). Edquist and Hommen (2008) claim that HEIs are not only producing highly skilled and educated labour but also creative, innovative and entrepreneurial human resources to feed into the NIS.

It is widely accepted within the endogenous growth literature that the availability of human capital stock in a country can be very useful for innovation and knowledge production, which in turn supports economic growth (Romer, 1994). The innovation literature also supports this view. It suggests that skilled human resources are good for innovation performance. Moreover, having a greater mass of highly educated labour force can lead to a substantial amount of technological knowledge and data through mass experimentations (Thomke, von Hippel and Franke, 1998; Nightingale, 1998; Nightingale, 2000a). Thus according to these two lines of enquiry, the size of a HES has a positive effect on innovation and knowledge. In the same logic, the other HES characteristics should have a similar influence.

Given that innovation and knowledge have a direct effect on economic performance, it follows that innovation and knowledge play a mediating role between the higher education system and economic performance. Figure 1 summarises the direct and indirect effect of HE characteristics on economic performance.

It is, however, worth acknowledging that the NIS in developing countries are usually not well-developed (Lundvall et al., 2006). Many institutions that form the NIS might be missing (George and Prabhu 2003); whereas existing institutions may lack sufficient resources, capabilities or supports to operate effectively (Tseng, 2006). At the same time, those existing institutions often do not have yet effective links to collaborate to play a key role in producing innovations (Liu and White, 2001). On the basis of the above discussion, we propose the following:

H5: The relationship between HE characteristics and national economic performance is mediated by innovation and knowledge.

4. Data and Methodology.

We rely on several databases. Higher education and economic data was collected from the World Bank's World Development Indicator database, while population data was obtained from the US Bureau of Census (USBC). USBC provides yearly statistics of various countries' population using a standardised estimation technique. Innovation performance is proxied by the annual average of patent family between 2005 and 2008. Although patents may not necessarily be an accurate measure of innovation (Crosby, 2000), we expect them to be highly correlated with future innovations. This is because patents reflects the inventiveness of a society and it would be reasonable to assume that some of these patents will lead to the end product (innovation), though this usually takes long time (Freeman and Soete, 1997). Given that directly measured innovation data is not available, patents remain the best available indicator of the relative innovation performance of a nation (Pavitt, 1998).

Patent data was collected from the World International Patent Office (WIPO). Country publication data was taken from the SCImago Journal & Country Rank database, available from Scopus database. Recent studies have shown that the country level indicators provided by Scopus are similar to the ones provided by the ISI Web of Science (Archambault et al., 2009). However, we chose Scopus because it is less biased in favour of English speaking or US journals

(Fingerman, 2006). It also tends to cover more scientific and interdisciplinary publications than the ISI Web of Science.

Knowledge performance is measured as the average of academic publications per year between 2005 and 2008. This is a noisy measurement of knowledge performance as it reflects the quantity rather than the quality of publications. Unfortunately, quality measures such as the impact factor is not available across disciplines.

Our first hypothesis, Size, is measured as the annual average of the number of enrolled students in HE between 2005 and 2008 relative to total population. This is not a direct measure of the country's HE capacity. Nevertheless, it is argued that this measure should be close to the country's capacity as the world has seen a substantially increased demand in HE places in the last decade (Brandenburg et al., 2008).

The level of support (hypothesis 2) available to the HES in a particular country, is measured as the annual average of total HE expenditure per student (in current thousand US$ and PPP). This figure is combined with GDP, total enrolment and population size to produce our second independent variable, which we label relative support.

The third independent variable (hypothesis 3) measures subsidy. It is proxied by the ratio of public expenditure on HE to total HE expenditure per student.

Finally, we measure the ability of a country's HES to match its output with the needs of its economy by the variable 'Mismatch' (hypothesis 4). This uses the ratio of the number of unemployed higher education graduates to total population. We control for extraneous country effect via seven additional variables as described below.

The dependent variable, economic performance, is proxied by per capita GDP, measured as the yearly average between 2005 and 2008.

Although the data on education from most OECD countries is complete, data from the developing economies has many missing or incomplete information. As our objective is to study the international variation in the education system rather than the variation within the OECD countries, we are obliged to use this incomplete dataset.

Because the extent of data imperfection is correlated with the level of economic development[1] we cannot estimate the models and simply ignore the missing observations. Doing so would bias the estimated parameters and may produce spurious results. Drukker (2011) provides a brief review on how to deal with missing observations.

The most popular approach is to replace the missing values in a given variable with the mean of the non-missing observations of that same variable. Unfortunately, this produces biased (and unrepresentative) estimates (Honaker and King, 2010).

Another approach is to estimate the model with the missing information, and then 'predict' the missing observations using the estimated model. This method yields unbiased estimates but only in the case where the independent variables do not contain missing values.

In this paper we use instruments to estimate missing observations. Assuming that countries that share one or more observed characteristics (such as GDP, patens, population) are more likely to share another unobserved characteristic. We therefore estimate a given missing observation with the average non-missing observations of the most similar countries. For example, suppose we use two instruments, say, GDP and HE spending and we have a missing HE Size observation of country X. Then the estimated observation for country X is simply the average of GDP from countries Y and Z, where country Y has the closest GDP to country X, and country Z has the closest HE spending to country X. In other words,

$$\min(\mathrm{GDP_X} - \mathrm{GDP_Y}) \text{ AND } \min(\mathrm{Expend_X} - \mathrm{Expendl_Z}) \Rightarrow \mathrm{Size_X} = \frac{1}{2}(\mathrm{Size_Y} + \mathrm{Size_Z})$$

We use 5 instruments to estimate missing observations, namely (i) average GDP between 2005 and 2008; (ii) average per capita GDP (2005-2008); (iii) average GDP growth (2005-2008); (iv) average GDP growth (2001-2004); and (v) average gross expenditure on research and development to GDP (2001-2004). For each of these five instruments, the observation of the country with the closest value is used. The estimated missing value is then calculated as the average of the five observations. This method, however, does not fill all missing observations

[1] For example, the full data sample is dominated by OECD countries (21 out of 30 countries), while there are only five OECD countries in the missing data sample.

because neighbouring countries might themselves have missing observations. When this happens we keep the observation as missing. We believe this to be more accurate than relying on more distant neighbours which have increasingly dissimilar characteristics, which can result in the inserted data becoming a less accurate representation of the missing observations.

The estimation uses simple OLS. The two mediating variables (innovation and knowledge) are proxied by the average number of patents and publications between 2005 and 2008 per capita. We use per capita measures in order to mitigate the size effect since larger countries tend to produce more patents and publications.

Testing for mediation involves estimating three models simultaneously. In the first two models the mediators (Patents and Publications) are predicted by the four HE characteristics. The third model involves HE characteristics, mediators and control variables as predictors of economic performance. Specifically,

$$(1)\ Patent_i = \alpha_0 + K_{1i}Size_i + K_{2i}Sup_i + K_{3i}Sub_i + K_{4i}Mism_i + Control_i$$

$$(2)\ Public_i = \alpha_0 + K_{1i}Size_i + K_{2i}Sup_i + K_{3i}Sub_i + K_{4i}Mism_i + Control_i$$

$$(3)\ PCGDP_i = \alpha_0 + K_{1i}Size_i + K_{2i}Sup_i + K_{3i}Sub_i + K_{4i}Mism_i + Control_i + K_{5i}Patent_i + K_{6i}Pub_i$$

where

$$K_{si} = \alpha_s + \beta_s D_i$$

$$Control_i = \gamma_1 GERD_i + \gamma_2 MATH_i + \gamma_3 GDPgrowth_i$$

$Size_i = \frac{Number\ of\ Students}{Population\ with\ HE\ age} \times 100$ is the gross enrolment ratio for country i;

$Sup_i = \frac{TotalExpHE/GDP}{TotalEnrol/Pop}$ is the relative support for country i;

$Sub_i = \frac{PubExpHE}{TotalExpHE} \times 100$ is the subsidy for country i;

and

$Mism_i = \frac{Unemployed\ HE\ graduates}{Total\ Population} \times 100$ is the mismatching of country i;

D_i is a dummy equalling one if country i is an OECD member. $GERD_i$ is the ratio of Gross Expenditure on Research and Development to GDP; and $MATH_i$ is a perception variable on the quality of math and science education in country i. GDP growth is between 2001 and 2004.

If one or more of the first two regressions are non-significant then mediation is unlikely. Full or partial mediation is inferred from model (3). If none of the HE characteristics is significant in model (3), we conclude full mediation. Otherwise, the findings would support partial mediation. Moderation would be assessed via the β coefficients. An insignificant β parameter would imply no moderation for that particular characteristic or mediator.

Summary of Data.

The World Bank's World Development Indicator database contains 208 countries. Eleven of these have no usable data and were removed.[2] The remaining 197 countries have mostly data with missing values. Only 30 countries, of which 21 are OECD countries, have complete data sets. A selection of OECD and developing countries is shown in Table 1. The countries are ordered by number of patents. We note the lack of data for support and subsidies (H2 and H3). However, as Table 2 shows, we still have 35 and 41 observations for these two hypotheses respectively.

The summary statistics for the dependent, independent and control variables are shown in Table 2. As the table shows, there are few missing observations for the dependent and mediating variables (per capita GDP, Patents and Publications). The large standard errors for the two mediating variables indicate the presence of outliers on both variables. We have fairly good information on size (H1) with 142 observations, and mismatching (H4) with 76 observations. However, the remaining characteristics (H2 and H3) show many missing observations. Finally, the control variables have fewer missing observations.

[2] These are: Curacao, Gibraltar, Kosovo, Puerto Rico, San Marino, Somalia, South Sudan, Taiwan, Turks and Caicos Islands, Tuvalu, and The Vatican.

Table 1. Dependent and Independent Variables for a Selection of Full and Missing Data Countries.

Country	Per Capita GDP	PATENTS	PUBLICATIONS	Size	Sup	Sub	Mism
	Selected OECD Countries						
Japan	31052.53	65298.33	106821.75	51.77	37.99	41.37	1.43
USA	43175.17	61538.33	373854.50	77.29	52.12	39.32	2.54
South Korea	24301.46	19335.33	40958.00	87.35	33.45	17.58	1.05
France	30125.29	8915.67	76834.75	54.56	35.57	83.65	1.66
UK	33538.37	5539.00	117650.00	61.14	29.75	70.70	0.67
	Selected Developing Countries						
China	4919.20	4923.00	193774.25	13.94			
India	2561.10	710.33	10105.75				1.66
Singapore	47762.55	201.00	4522.00	28.86			0.64
Malaysia	12259.03	1444.67	44529.00	10.58	89.49	79.15	
Panama	10366.15	201.00	4522.00	28.86			0.64

Notes: Per Capita GDP is in Constant 2005 PPP $. PATENT is the average number of patents between 2005 and 2008. PUBLICATION is the annual average of academic publications between 2005 and 2008. Size, Sup, Sub, and Mism are the gross enrolment ratio, the relative support, subsidy, and mismatching, respectively.

Table 2. Summary Statistics.

	Observation	Mean	Std Error	Minimum	Maximum
Log Per Capita GDP 12-15	187	8.687	1.469	5.671	12.029
Log Per Capita GDP 5-8	183	8.713	1.307	5.652	11.187
PATENTS (per thousand)	181	0.066	0.436	0	5.701
PUBLICATIONS (per thousand)	192	0.343	0.622	0	3.304
Gross Enrolment Ratio (Size) h1	142	28.332	23.409	0.922	87.353
Relative Support (Sup) h2	35	43.087	23.375	16.246	122.866
Subsidy (Sub) h3	41	71.454	22.609	17.478	100.000
Mismatching (Mism) h4	76	1.422	1.145	0.003	5.684
GERD to GDP 1-4	93	0.880	0.937	0.014	4.443
MATH 3-4	101	4.127	1.130	1.900	6.500
GDP growth 1-4	192	4.166	4.040	-7.789	33.329

Notes: PATENTS is the average number of patents between 2005 and 2008 per thousand population. PUBLICATIONS is the annual average of academic publications between 2005 and 2008 per thousand population. Gross enrolment ratio, relative support, subsidy, and mismatching are defined in Section 4. Per Capita GDP 5-8 (12-15) are average values across the years 2005 to 2008 (2012-2015) in 2005 PPP $. GERD to GDP 1-4 is the average value of the ratio of Gross Expenditure on Research and Development (GERD) to GDP between 2001 and 2004. 'GDP growth 1-4' is percent growth in GDP for the years 2001-2004. 'MATH 3-4' is the average perceived quality of math and science education between 2003 and 2004.

5. Results.

Table 3 presents the simultaneous estimation results for the three models needed to assess mediation of innovation and knowledge and moderation of OECD status. The table shows the results for the 2005-2008 average per capita GDP. The patent equation is insignificant as none of the HE characteristics seem to impact patents. A Chi-square test that the eight slope coefficients are insignificant confirms this ($\chi^2(8) = 4.67$, p-val=0.792). This clearly suggests that Patents do not mediate the relationship between HE characteristics and economic performance. However, Publications are significantly impacted by some of the characteristics. As the table shows, Size, Mismatching and Subsidy have significant coefficient, though the impact comes mostly from the OECD countries. A Chi-square test that the remaining coefficients (including those of the Patent equation) are insignificant could not reject the null hypothesis ($\chi^2(12) = 8.41$, p-val=0.753). Thus, Publications could potentially mediate the relationship between the four characteristics and economic performance. This is confirmed by the results of Table 4, which uses the more recent 2012-2015 average per capital GDP. The results for the Patent and Publication equations are almost identical. The results for the third equation are similar in terms of scale and significance of coefficients, but the point estimates are slightly different. We use the more recent dependent variables in Table 4 for the remaining analysis.

The third equation confirms the mediation of Publications. Indeed, the coefficient of Publication and its interaction with the OECD dummy are both significant. However, only two characteristics are significant, namely Size (coeff=0.021, p-val<0.001), and OECD-Subsidy (coeff=0.015, p-val=0.024). Thus, Publications is a partial rather than full mediator. All control variables are insignificant. A Chi-square test for all insignificant coefficients in the three equations fails to reject the null hypothesis that they are all zero ($\chi^2(21) = 13.82$, p-val=0.877). Thus, the mediating role of publications is confirmed, whereas there is no evidence in support for patents as mediator. Nevertheless, Patents are an important determinant of economic performance. The moderating role of the OECD dummy is very important throughout. The coefficient for Patents in the OECD countries is positive and economically important

(coeff.=2.951, p-val=0.025). This means that, an additional patent (per 10,000 population) increases per capita GDP by a factor of $exp(0.2951) = 1.34$. However, the Patent coefficient for developing countries is small and insignificant (coeff.=0.196, p-val=0.299), suggesting that patents do not explain economic performance within the developing countries. This might be explained by two reasons. First, patents emanating from developing countries may not have a significant economic value. Thus, higher patent count does not necessarily indicate higher economic performance. Second, economic growth in developing countries may not be driven by innovation.

Contrary to Patents, Publications are a more important explanatory variable for developing countries. The coefficient for Publications is 1.597, suggesting that an increase of one publication per 10,000 population increases economic performance by a factor of $exp(0.1597) = 1.17$. Publications for the OECD are significant but small. The coefficient for the OECD is 1.597-1.246=0.351 and a Chi-square test confirms that the difference is significantly distinct from zero. Thus, publications also seem to explain economic performance for the OECD countries, but to a lesser degree ($exp(0.0351) = 1.03$). In other words, economic performance appears to be driven mainly by knowledge (essentially produced through education and teaching) in the developing countries, and driven mainly by innovation within the OECD.

Figure 1 summarises the mediation of publication as well as the moderating role of OECD dummy. The HE Size of developing economies has both a direct (0.021) and indirect (0.008) effect. Thus, developing economies seem to benefit directly from the size of their HE, possibly through the provision of educated workforce. This is not the case for the OECD countries. OECD-Size has a positive (0.021), OECD-Mismatch has a negative (-0.322), and OECD-subsidy has a positive (0.010) impact on publications but OECD-publication has no effect on economic performance. Thus, OECD-publications play no mediating role between HE characteristics and OECD-economic performance. OECD-Subsidy, however, does have a direct and positive effect (0.015) on economic performance.

In summary, there is a significant mediating role for publication in both OECD and developing economies (DE). DE-Size has both a direct and indirect (via Publications) impact on economic performance. Thus, publications have only a mediating role for HE Size within the developing countries. On the other hand, the OECD countries have a richer mediation. OECD-Subsidy has both a direct and indirect (via Publications) impact on economic performance. OECD-Size and OECD-Mismatch, on the other hand, have an indirect effect only.

Patents are very important for the OECD and irrelevant for the developing countries. Importantly, HE characteristics do not seem to have any impact on patents in both groups of countries.

In terms of hypotheses, our first hypothesis that the relationship between HE size and national economic performance is significant and positive for developing economies, but insignificant for developed economies, is strongly supported. The Size coefficient (equation 3) for developing economies is both positive and highly significant (direct effect = 0.021), suggesting that developing countries with larger HE sectors tend to perform better economically.

Our fourth hypothesis is also strongly supported. The coefficients for mismatching (equation 3) are insignificant, implying that there is no association between mismatching and economic performance.

The results do not support hypotheses 2 and 3. Our second hypothesis of a positive association between investment in higher education and economic performance is rejected as we find no association between relative support and economic performance. We also find no moderating effect for the OECD countries (insignificant relationship for both developing and OECD countries). The third hypothesis is partially rejected. We find a positive association between subsidies and economic performance for the OECD countries but no association within the developing countries.

Our final hypothesis that the relationship between HE characteristics and national economic performance is mediated by innovation and knowledge is only partially supported. First, innovation has a strong impact on economic performance but has no mediating role as it is

found to be independent of HE characteristics. However, although variability in HE characteristics does not explain variability in patents, it does not necessarily mean that HE has no value. It simply means that the variability in HE characteristics across countries does not predict how Patents (innovation) are developed.

On the other hand, publications do have a mediating role that is limited to HE Size within the developing economies, and Size, Mismatch and Subsidies within the OECD. However, the mediation of publications is about three times as important for the developing economies.

Table 3. Regression results for the extended set. (Average PC-GDP 2005-2008).

Dependent	Patent (1)		Publication (2)		PCGDP (3)	
	Coef	p-val	Coef	p-val	Coef	p-val
Constant	0.202	0.455	-0.332	0.092	7.528	0.000
Patent					*-0.487*	*0.005*
Publication					*1.442*	*0.000*
Patent × OECD					*2.953*	*0.020*
Publication × OECD					*-1.456*	*0.001*
Size (H1)	-0.001	0.689	*0.008*	*0.001*	*0.019*	*0.002*
Relative Support (H2)	0.003	0.288	0.002	0.254	0.006	0.130
Subsidy (H3)	-0.004	0.178	0.001	0.548	0.000	0.991
Mismatching (H4)	0.048	0.435	0.078	0.082	-0.033	0.741
Size × OECD	0.003	0.670	*0.013*	*0.008*	-0.008	0.518
Relative Support × OECD	-0.004	0.550	0.000	0.989	0.003	0.793
Subsidy × OECD	0.003	0.443	*0.010*	*0.000*	*0.017*	*0.006*
Mismatching × OECD	-0.066	0.724	*-0.320*	*0.018*	0.226	0.454
GERD to GDP 1-4					-0.186	0.182
MATH 3-4					0.047	0.616
GDP Growth 2001-2004					-0.005	0.851
N=117						

Table 4. Regression results for the extended set. (Average PC-GDP 2012-2015).

Dependent	Patent (1)		Publication (2)		PCGDP (3)	
	Coef	p-val	Coef	p-val	Coef	p-val
Constant	0.234	0.363	-0.334	0.085	7.706	0.000
Patent					0.196	0.299
Publication					*1.597*	*0.000*
Patent × OECD					*2.951*	*0.025*
Publication × OECD					*-1.246*	*0.007*
Size (H1)	0.000	0.985	*0.008*	*0.001*	*0.021*	*0.000*
Relative Support (H2)	0.003	0.259	0.002	0.226	0.004	0.378
Subsidy (H3)	-0.005	0.074	0.001	0.528	0.000	0.957
Mismatching (H4)	0.037	0.520	0.080	0.066	-0.022	0.826
Size × OECD	0.001	0.840	*0.013*	*0.005*	-0.013	0.286
Relative Support × OECD	-0.004	0.509	0.000	0.976	0.006	0.551
Subsidy × OECD	0.004	0.303	*0.010*	*0.000*	*0.015*	*0.024*
Mismatching × OECD	-0.057	0.749	*-0.322*	*0.016*	0.284	0.362
GERD to GDP 1-4					-0.257	0.073
MATH 3-4					0.013	0.892
GDP Growth 2001-2004					-0.014	0.586
N=120						

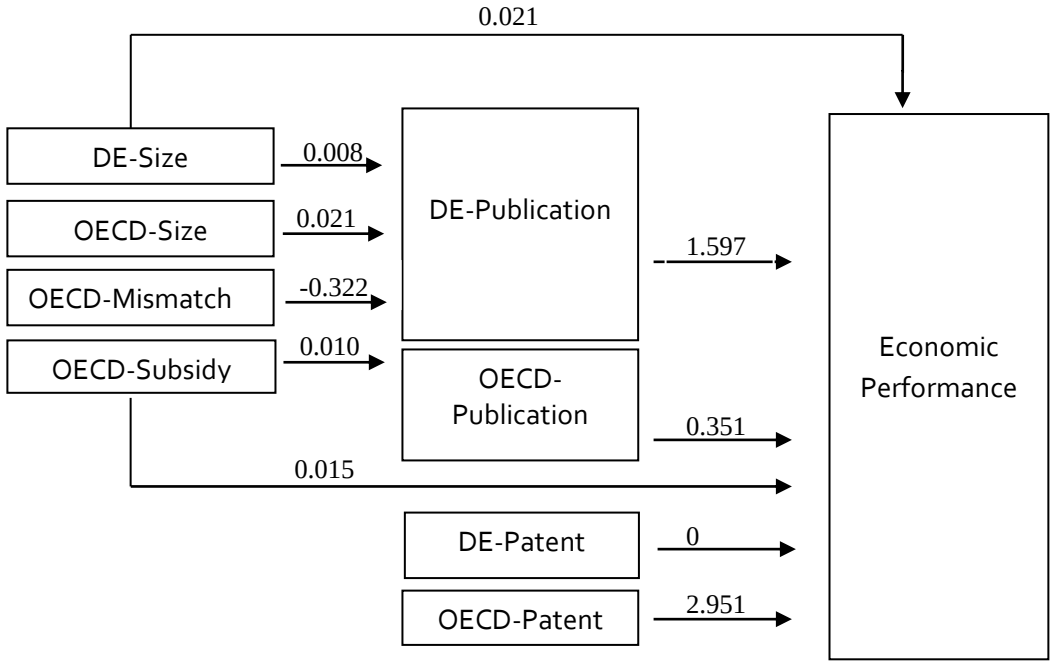

Figure 1. Direct and Indirect Effect of Higher Education Characteristics.

6. Discussion.

Our findings are mixed. Considering direct effect only, we find strong support for the first and fourth hypotheses, no support for the second and third hypotheses, and partial support for our last hypothesis. The capacity level of HE is positively associated with economic performance within the developing countries but not within the OECD (H1). This lends support to the notion that the country's economic conditions are a strong moderator for the impact of HE size on economic performance.

We also confirm H4 and find no significant difference between the ivory tower and application driven systems. This is true for both developed and developing countries.

The level of funding (i.e. the level of teaching and learning support to HE students) does not necessarily lead to better or worse economic performance (H2). This is also true for both developing and OECD countries.

Contrary to proposition of H3, we find that while subsidies have no impact within the developing world (perhaps due to the fact that there is little variation in terms of subsidies within the developing countries), there is a positive and significant impact within the OECD.

Overall, the moderating role of 'economic development' is confirmed for two characteristics only, namely Size (HE capacity) and Subsidies. Specifically, while Size is only effective for the developing countries, Subsidies are only effective for the OECD.

The importance of the capacity of the HE sector (H1) for economic performance is not surprising. Indeed, it seems sensible to assume that an increase in graduates makes more human capital available to the industry and, hence, opens up the possibility for a greater effectiveness of production capacity. However, it should be noted that the size of HE needs to be associated with the quality of education to be productive (Barro, 2001; Coleman et al., 2003; Hanushek and Woessmann, 2008; Yahya, 2007). This seems to explain why Size is significant for the developing but not OECD countries. Advanced economies are based on highly skilled human capital, and the quantity of graduates has therefore less importance. It is the quality that

matters. In contrast, developing countries have industries that require low to medium skills essentially aimed at production. The quantity of graduates is therefore more relevant. There could also be an alternative explanation. Unlike developing countries, the OECD countries have a well-developed and effective national system of innovation with a productive and diverse HE system (Eastman and Santoro, 2003; Conceição and Heitor, 2005; Horta et al., 2008) capable of acting as an engine for economic growth (Audretsch et al., 2004). Developing countries with NIS still in transition or in construction (Lundvall et. al., 2006) are more focused on the development of human capital and yet not sufficiently equipped in terms of resources and capabilities to play a more active role in the production of innovation (Liu and White, 2001).

Our results (H2) are not consistent with the view that quality teaching and learning require a higher level of investment per student (Barr, 2004). We find no significant difference between the various levels of financial support for HE in both developing and developed economies. This suggests that the level of available funds may be less important than how these funds are invested. That is, the efficiency of the HE system might counter the relative lack of funding. Thus, although it is evident that an adequate level of funding and resources are important for the delivery of a high quality standard in teaching and training (Barro, 1998, Greenaway and Haynes, 2003, Barr, 2004, Bassanini and Scarpenta, 2002), we do not find any significant difference within our sample, possibly because lower funding states compensate with higher efficiency and vice versa. Thus, expecting to secure immediate results by simply increasing HE funding can be misleading (Geuna and Muscio, 2009, OECD, 2010a).

Our fourth hypothesis (H4) reflects the mixed evidence of the current literature as to whether there is any difference between the 'Ivory Tower' and 'Application Driven' approaches, in supporting economic performance (Mansfield, 1991; Gulbrandsen and Smeby, 2005; Nelson, 2004).[3]

[3] Although we do not have direct literature on economic performance, we use research carried out on the impact on knowledge and innovation. Since these two are positively correlated with economic performance, we use them as proxies.

Our results unambiguously show a lack of direct relationship between the extent of matching graduates to labour demand economic performance. However, Mismatching has a negative and significant impact on Publications. Thus, our results clearly suggest that an HE system (Ivory Tower) focused more on curiosity scientist and critical thinkers is less effective than the more application oriented HE system in supporting the economic performance. This reflects the increasing call for HESs to develop greater links and engagement with their external economic and social environment (Geuna and Muscio, 2009).

The purpose of our last hypothesis (H5) was to investigate whether publications and patents played a mediating role between HE characteristics and economic performance. We are only able to partially find support for the view that the ability of a country to build up a knowledge society and to innovate is related to the development of its human capital through education and training (Martin and Etzkowitz, 2000; Barro, 2001; Thomke, von Hippel and Franke, 1998; Nightingale, 1998; Barr, 2004; Romer, 1986; Nightingale, 2000b; Badinger and Tondil 2005; Grasjo 2008; Chi and Qian 2010). Indeed, our fifth hypothesis is only partially confirmed. Specifically, the characteristics of HE do not have a significant impact on Patents (innovation), clearly indicating that the innovation system is not related to HE characteristics (even though it is very important for economic performance). On the other hand, HE characteristics are crucial for the development of a knowledge society (Publications), which in turn is positively associated with economic performance. Although this latter result is expected, the lack of association between HE and innovation is not. One possible explanation is that we use Patents as a proxy for innovation, and patents are mostly produced within the industrial sector. It is also possible that the required human capital necessary for innovation is produced via in-house training rather than directly by the university.

The mediation of knowledge is based on the idea that this latter is dependent on the level of total funding invested in HE (Arcalean and Schiopu, 2010; Muscio, Quaglione and Vallanti, 2013). We find no evidence that the level of investment improves knowledge (Publications).

Conversely, Mismatch (negative impact) and Subsidies (positive impact) have a significant impact on knowledge (Publications) but only for the OECD countries. Again, this could be due to the homogeneity in terms of mismatch and subsidies within the developing countries (i.e. they are all Ivory Tower and heavily subsidised systems). Size, however, has a significant impact on publications in both developing and developed countries.

Our mediation results contribute to the on-going debate on HEI funding systems and the lack of clear consensus with regards to their effectiveness and impact on national innovation performance (Arcalean and Schiopu, 2010; Muscio, Quaglione and Vallanti, 2013; David and Hall, 2000; Geuna and Martin, 2003). The existing literature recognises that an appropriate implementation of HE policy can lead to improved levels of innovation and knowledge performance (Liefner, 2003; Muscio, Quaglione and Vallanti, 2013; OECD, 2010b). Our study confirms that Size, Mismatching and Subsidies are appropriate policy tools only for knowledge and only for OECD (except for Size). It seems that innovation is driven by factors outside the realm of higher education systems. It is also apparent, that apart from the Size of the HES, developing countries have no other policy tools that they can use to improve knowledge and innovation.

7. Conclusions.

The importance of knowledge, innovation and human capital and their impact on economic performance are widely recognised. The production, maintenance and quality of these three pillars are naturally attributed to the HES. The first of the three missions of HESs (education, teaching and training) produces highly educated labour, which is considered to be crucial for the production of goods and services. New knowledge from essentially research and commercialisation of knowledge, are attributed to the second and third missions of HESs. The interaction between these pillars and the way HES influences them has received little attention in this literature.

Our paper sought to fill a gap in the higher education literature concerning the appropriate HE policy to support economic performance. Specifically, we assessed whether various HE characteristics influenced economic performance directly (via the development of human capital) and indirectly (via the production of knowledge and innovation). This paper helps gain a better understanding of the direct and indirect impacts of higher education on knowledge, innovation, and economic performance.

The area of HE policy in relation to building a national stock of educated labour is relatively well developed. However, this research has mainly focused on issues such as accessibility, governance and accountability of HES. Less is known on the effect of particular HE policies on the production of knowledge and innovation and how these two pillars influence economic performance. Thus, it is important to provide empirical evidence that could help policy makers adopt HE Policies that are more suited for the development of the national economy.

Following an extensive review of the literature, four HES characteristics were identified; (i) the relative size of the HES; (ii) the level investment in HE; (iii) the government subsidy to the HES; and (iv) the matching of HES activity to societal needs.

We use cross-country education surveys, as well as patent and publication data, to show that economic performance is strongly and positively associated with the capacity of the HE sector. This relationship is also mediated by knowledge production but the mediation is more pronounced for the developing economies. On the other hand, the level of investment in HE sector has no impact on knowledge, innovation or economic performance.

The level of subsidies in HE within OECD countries is found to have both direct and indirect effects (via publications) on economic performance. This is not the case for the developing economies. The lack of alignment between the HES and its external environment is only relevant for the OECD and has a negative impact on knowledge. Nevertheless, this mismatching only has an indirect effect on economic performance via knowledge. Thus, it seems that the 'Ivory Tower' systems produce lower economic performance than 'Application Driven' systems.

Our empirical evidence suggests that one key institutional characteristic should form the basis for HE policies aimed at supporting economic performance in both developing and developed economies. In particular, policy makers should focus on greater access to HE as it is key to promoting both knowledge production and economic performance.

Policy makers within the OECD should also focus on the level of subsidies which appear to promote both knowledge and economic performance. This is not true for developing countries where subsidies do not appear to have an impact on publications or economic performance. Finally, policy makers should focus on a greater alignment between HE institutions and their social and economic environment in order to promote both knowledge and economic performance. In addition, developing countries with resources constraints need to be prepared to manage and mediate a three-way trade-off between focusing on the extent of coverage of HES (E.g. Mass Vs Elitism HE system); the degree of subsidization to HEIs; and the overall cost of HE.

This paper has two main limitations. First, because we use cross-country level information, the relationship between HE characteristics and economic performance is seen as an aggregate phenomenon. The within country heterogeneity of HESs, such as countries with both subsidised and non-subsidised systems, is therefore ignored. Within country, information on HE institutions may well improve the empirical relevance of our results. Unfortunately, even if such data were available within the developed economies, it is highly unlikely that they are available within most developing countries. Another limitation is due to our choice to use a sample that includes developing countries. Data for these latter countries are mostly incomplete, and our sample therefore suffers from a large number of missing observations even though we partially mitigate this problem. Thus, although our study is more interesting because our conclusions are not specific to the OECD, our conclusions should be treated with caution.

Our research could be extended in at least two directions. First, future work could use more flexible metrics to innovation and knowledge. For example, rather than proxying knowledge by the number of publications alone, one could use exploratory factor analysis that combines publications with other variables that could potentially measure knowledge. Examples include

adoption of new information and communication technologies (e.g. number of internet users), production of books, and intellectual property. Similarly, innovation could be measured via a metric that combines patents with variables such as R&D expenditure, or other statistics on product and process innovations. However, it should be stressed that measuring knowledge or innovation is not straightforward (Nelson et al., 2014). Second, future research could focus on the efficiency of the higher education system. Thinking of investment in HE as input and economic performance as output, one could use stochastic frontier techniques to estimate the influence of HE characteristics on the technical efficiency (or the return to education) of HE investment.

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