Managerial Optimism and Investment Decision in the UK

Eman El-Gebeily, Cherif Guermat* and Vasco Vendrame

Bristol Business School, University of the West of England, UK

Abstract

We investigate the impact of managerial optimism on investment decision sensitivity to cash flow. Optimists tend to overestimate returns and make overly optimistic cash flow forecasts, which leads to increased investment levels, as well as increased sensitivity of investment decision to cash flow. We use several measures of optimism and a panel of UK listed firms to confirm two hypotheses, namely that optimism increases the sensitivity of investment to cash flow, and that this sensitivity is only found in cash constrained firms. Our results are generally consistent with previous studies conducted on US data.

Keywords:

Optimism, overconfidence, investment decision, cash flow, agency theory

* Corresponding author: Department of Accounting, Economics & Finance, Faculty of Business and Law, University of the West of England, Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY, United Kingdom. Tel.: +44 1173281706; fax: +44 1173282289. Email: eman_gebeily@yahoo.com (Eman El-Gebeily), Cherif.Guermat@uwe.ac.uk (C. Guermat), Vasco.Vendrame@uwe.ac.uk (V. Vendrame)

Managerial Optimism and Investment Decision in the UK

1. Introduction

Optimism is a revered human quality. For many, it is "an essential ingredient" for leadership (Gallo, 2019), innovation (Noyce, n.d.) and, of course, success (Campolargo, 2020). In the first two months of the recent pandemic, stock markets lost a third of their value and the world economy almost stood still (The Economist, Leaders, March 2020). Yet, despite the bleak outlook, many investors believed that some stocks had become under-valued (Morning Star, 2020).

People tend to make quick decisions under pressure, often based on a restricted set of information (Simon, 1995). Decision makers, therefore, do not always act rationally, and are often subject to psychological biases that nudge them towards sub-optimal solutions. Examples include relying on a subset, rather than the full set, of alternatives in decision making; over-estimating future payoffs; and under-estimating risks. Such departures from rationality in investor behaviour are well documented, especially at times of market exuberance or instability (Shiller, 2000; Lakonishok *et al.*, 1994; De Long *et al*., 1990; Rabin, 2002).

Corporate financial decisions are important determinants of firm success (Singh and Luthra, 2013). Chief among these are capital expenditure decisions (Durnev *et al*., 2005), which focus on identifying shareholder-value maximising projects. Given that corporate managers are not immune from psychological biases, it is interesting to see whether and how optimism affects managers' financial decisions.

Optimism is one of the most prominent biases affecting managerial decisions (Malmendier and Tate, 2005). Optimists tend to overestimate returns while simultaneously underestimate risk (Heaton, 2002). While they are likely to invest in more innovative projects, they may also disregard negative signals about these projects, ending up overinvesting and potentially investing in negative NPV projects whenever there is excess

of internal cash (Malmendier and Tate, 2005). Indeed, as Jacobs and Shivdasani (2012) emphasise, for many corporations, the availability of trillions of dollars in internal cash waiting to be invested exacerbates optimism and other managerial behavioural biases.

Optimistic managers reveal a distorted investment behaviour that is often confused with those arising from agency and information asymmetry problems (Jensen and Meckling, 1976; Jensen, 1986; Myers and Majluf, 1984). Previous explanations of investment distortion include the pecking order theory, which asserts that managers prefer internal cash, to debt, and then to equity (Myers and Majluf, 1984). Managerial optimism induces managers to follow a similar pattern to that predicted by the pecking order theory. Optimistic managers overinvest when there is internal cash flow, followed by debt, and will only use equity as a last resort, perceiving their equity as undervalued by the market.

Alternative explanations of investment distortions include agency theory and asymmetric information. The agency explanation focuses on the misalignment of managerial and shareholders interest (Myers and Majluf, 1984; Jensen and Meckling, 1976). Managers, for instance, may tend to overinvest to gain privileges associated with large empires. Greater cash flow amplifies such a behaviour while the market discipline associated with less cash flow dampens it. Under asymmetric information, managers act in the interest of shareholders, but their investment is also positively correlated with cash flow.

This paper contributes to the current debate in three ways. First, we pursue one prominent behavioural explanation of investment distortion by considering managerial optimism and therefore reducing the paucity of research on the topic. Heaton (2002) maintains that research in behavioural finance remains relatively lacking, whilst research in behavioural corporate finance is still in its early stages of development (Baker and Wurgler, 2011).

Based on Baker and Wurgler (2011) simple model, we show the interaction between the degree of optimism, the perceived cost of issuing equity, and the proportion of equity issued to finance projects. The model makes three major predictions: (i) optimistic managers over-invest; (ii) investment is sensitive to cash flow for cash constrained firms, and (iii) investment is insensitive to cash flow for cash unconstrained firms. We propose and test two hypotheses based on the second and third predictions. Our model shows that the first

prediction cannot be tested empirically because over-investment can also be caused by agency behaviour.

Second, in this paper we use data from the UK market to provide empirical evidence on predictions (ii) and (iii). Existing studies are mostly focused on the US market. Our study therefore complements the existing studies by providing further evidence from one of the leading markets in the world. Although the two markets are similar in many respects, they are also different in others. In particular, while the US market is dominated by large firms featuring slow but steady growth, the UK market has smaller companies with relatively more volatile growth. Moreover, while the UK and the US often share common economic shocks, such as the credit crunch and the COVID pandemic, the UK does have its own shocks such as the 1992 ERM crisis (Goodhart, 2014) and Brexit.

Third, we use a comprehensive set of optimism measures. While prior studies have relied on one or two measures of optimism, we use five proxies. This approach removes possibilities that prior results were driven by a poor choice of restricted optimism measure.

The remainder of the paper is organised as follows. In Section 2 we review the existing literature on optimism and corporate investment decisions. Section 3 presents the theoretical framework of the investment decision problem for the manager. We demonstrate the existence of a positive relationship between investment and cash flow for optimistic managers. In Section 4 we present the data, describe the construction of the optimism measures and introduce the empirical model. Section 5 contains the empirical results for several measures of optimism and exhibits evidence that optimism increases the sensitivity of investment to cash flow and that this sensitivity is particularly important in equity-dependent firms. Section 6 concludes.

2. Literature Review

Traditional corporate finance theory assumes that both managers and investors act rationally, thus leading to efficient financial markets. Yet, scientists have recorded many biases that affect human decision (Kahneman and Tversky, 1979; Weinstein, 1980; Odean, 1998; Thaler and Sunstein, 2008; Moosa and Ramiah, 2017). These psychological biases

often result in managerial decisions that are inconsistent with the traditional paradigm of rationality.

The most popular bias tested in a corporate setting is the optimism/overconfidence bias (Malmendier and Taylor, 2015). In psychology, overconfidence and optimism have several manifestations, including miscalibration, the above-average effect, and the illusion of control. Miscalibration is defined as excessive confidence about having precise information (Gervais and Odean, 2001, Shefrin, 2005). Miscalibrated decisions means that people tend to overestimate the precision of their own forecasts or underestimate the variance of risky processes. The above-average effect is defined as the tendency of individuals to believe that they are better than their peers within a particular group (Weinstein, 1980). Finally, the illusion of control is defined as the tendency of individuals to overestimate their ability to control events over which they have limited influence (Langer, 1975).

In this paper optimism is defined as the tendency by managers to over-estimate asset value, whereas overconfidence is defined as the tendency to excessively believe in the precision of one's estimates. In a statistical sense, optimism over-estimates the expectation (mean) while overconfidence under-estimates the uncertainty (variance).

Barros and Silveira (2007) state that while optimism and overconfidence may be treated separately for analytical purposes, psychological and behavioural research reveals that these biases are closely related and this seems to have led many studies to use the two concepts to denote the same bias of overestimation of value. For example, Heaton (2002) and Campbell *et al.* (2011) use the term optimism, while Malmendier and Tate (2003, 2008) use the term overconfidence for the same meaning. With this legacy at hand, we will use the two terms interchangeably, but only where the cited studies use the 'over-estimation of value' meaning.

Chen and Lin (2013) find that firms with highly optimistic CEOs invest more than firms with less optimistic CEOs, and that optimistic CEOs improve firm investment efficiency by reducing the amount of underinvestment. However, for over-invested firms, less optimistic CEOs do not appear to effectively improve firm investment efficiency by reducing the value of overinvestment. Overall, they conclude that overconfident CEOs are likely to increase their capital expenditure even in financially constrained firms.

Ben-David *et al.* (2010) use a survey-based approach and find that CFOs are on average extremely optimistic in their forecasts of stock returns and tend to invest more and engage in acquisitions more frequently. Hackbarth (2008) shows that overconfident managers overestimate the profitability of investments and prefer debt to equity, as they perceive their firm equity as severely undervalued.

Gervais *et al.* (2011) show that overconfident managers follow optimal risky investment opportunities with a flatter compensation schedule. Furthermore, overconfidence commits a manager to exert more effort to gather information that improves the success rate and value of the firm's investments.

Cooper *et al.* (1988) find evidence that investment decisions are affected by optimism as investment decisions of startup enterpreneurs are generally made under a halo of exaggerated optimism, whereas the actual performance of start-ups is a lot worse. Campbell *et al.* (2011) show that a moderate level of optimism causes a CEO to invest at the first best level (investment level that maximizes firm value – where marginal value of investment equals cost of capital). Too little (too much) optimism leads the CEO to underinvest (overinvest), implying that firm value is concave in CEO optimism. However, their model does not consider external financing or the cost to issuing equity.

Optimistic managers believe that the market undervalues their firms' securities, implicitly creating a perceived cost to issuing equity and leading them to prefer financing projects with internal funds (Heaton, 2002). Stein (1996) and Baker *et al.* (2003) argue that investments are sensitive to the mispricing of shares in equity-dependent firms, since managers of undervalued firms would rather underinvest than issue new undervalued shares.

Hence, free cash flow can be valuable as it can prevent social losses resulting from under-investment due to managers perceiving the cost of external financing as being too high and hence declining positive net present value projects. Conversely, managerial optimism causes overly optimistic cash flow forecasts and causes managers to overvalue a firm's investment opportunity. In this case, free cash flow may be harmful as it allows the avoidance of market discipline and scrutiny involved in obtaining external financing and makes it easier to take negative net present value projects mistakenly perceived to be

positive. Managerial optimism theory thus links the benefits and costs of free cash flow to two variables, the level of managerial optimism and the investment opportunities available to the firm (Heaton, 2002).

Malmendier and Tate (2005) show that optimistic CEOs are likely to increase their investment levels given the availability of internal cash flow (retained earnings). Optimistic managers believe (incorrectly) that the public underestimate the present value of their investment returns and the value of the firm and therefore view external financing as unjustifiably costly and prefer to use cash or "riskless" debt. Their results show that overconfident CEOs have a greater sensitivity of corporate investment to cash flow, and especially amongst equity dependent firms. Since over-investment is not unique to optimism, sensitivity to cash flow is key in testing optimism. We turn to this point next.

3. Theoretical framework

The impact of optimism on investment and capital structure can be shown theoretically using a simple model proposed by Baker and Wurgler (2013). We assume that the true value of a firm's assets and investment opportunities are given by $f(K,\cdot)$, where f is increasing and concave in new investments K. The fundamental value of the firm is

$$f(K,\cdot) - K \tag{1}$$

where the cost of capital is normalised to unity for convenience. The firm value is maximised when the marginal value of new investment equals the cost of capital. As the assets are fairly priced, selling a fraction of the firm's equity does not entail shareholder loss.

An optimistic manager would perceive an asset value greater than $f(K,\cdot)$, say $(1+\gamma)f(K,\cdot)$, with optimism parameter $\gamma > 0$. The fundamental value of the firm, with non-equity financing, is therefore

$$(1+\gamma)f(K,\cdot) - K \tag{2}$$

The manager believes the assets are under-priced by $\gamma f(K,\cdot)$, and thus selling a fraction e of the firm would entail a shareholder loss of $e\gamma f(K,e)$. The function f is now sensitive to capital structure.

Thus, the perceived fundamental value of the firm is

$$(1+\gamma)f(K,e,\cdot) - K - e\gamma f(K,e,\cdot) \tag{3}$$

Issuing equity results in the asset function f becoming dependent also on the equity issued as $e\gamma f$ is fed back into the cost of investment through the optimism parameter γ. This effect vanishes with rational managers ($\gamma = 0$). The aim of the optimistic manager is to find an investment level K and an equity percentage e that will solve the problem

$$\max_{K,e}(1+\gamma)f(K,e,\cdot) - K - e\gamma f(K,e,\cdot) \tag{4}$$

Differentiating with respect to K and e gives the following optimal conditions for investment and financing

$$f_K = \frac{1}{1+(1-e)\gamma} \tag{5}$$

$$f_e = \frac{\gamma}{1+(1-e)\gamma} f \tag{6}$$

where f_K and f_e are the marginal value of investment and the marginal loss of shifting away from equity, respectively.

Several implications for financing policy, investment policy and firm value can be drawn. First, Equation (5) shows that an optimistic manager over-invests, since the manager continues to invest beyond the cost of capital, and to a point where the marginal value of investment is less than the cost of capital ($f_K \leq 1$). If the firm raises less than 100% of the capital via equity ($e < 1$) the manager will always over-invest and the extent of over-investment is increasing in γ. The higher the γ the lower the marginal value of investment required to achieve the maximisation problem in (4). Thus, more optimistic managers tend to invest more in negative NPV projects, which depresses the true value of the firm.

Second, the manager perceives selling equity to the market as loss-making. From (6) the cost of moving away from equity is always positive for optimistic managers. It is also increasing in γ, so the greater the optimism the more the perceived loss of issuing equity.

This cost is also increasing in e - the greater the share of equity issued the greater the perceived cost. Thus, the optimistic manager is averse to issuing equity, and issues as little equity as possible. One implication is that the manager issues $min(e)$. However, this minimum equity depends on the cash and debt capacity of the firm. In other words

$$min(e) = 1 - min(C + D, 1)$$

where C and D are the cash and debt capacity of the firm respectively. Although debt is technically external financing, we include it here with internal capacity because D is the proportion of capital from which a firm can draw without recourse to equity issuance. We may think of it as a line of credit. When the firm has ample capacity to invest internally ($C + D \geq 1$) the manager chooses $e = 0$. From (5) this would produce the maximum over-investment.

As the firm becomes limited in its internal capacity, $C + D < 1$, the manager is forced to issue equity $e > 0$ despite the perceived loss. From (5) the manager's overinvestment would diminish, as the denominator would diminish and the threshold gets closer to the true cost of capital.

When the firm has no capacity at all ($C + D = 0$) the manager is forced to issue 100% equity despite the maximum cost ($min(e) = 1$). Counter-intuitively, it is at this point that the marginal value of investment equates the cost of capital ($f_K = 1$), and thus the manager maximises the true value of the firm (against his will) as can be seen from (5).

A clear empirical implication of Equation (5) is therefore the sensitivity of new investments to both optimism and cash flow. While optimism increases investment, this increase is also sensitive to the availability of non-equity financing.

One objection might be that agency theory also implies over-investment. One may therefore be unable to distinguish the consequences of optimism from those of empire-building. An empire-building manager will solve the following problem

$$\max_{K,e}(1 + \delta)f(K, e, \cdot) - K - c(e)$$

where δ measures the manager's preference for empire building and $c(e)$ is the cost of raising equity imposed by the market (rational investors are assumed to recognise the agency problem). This does indeed look very similar to Equation (4).

However, there are two major differences. First, the cost of issuing equity is perceived by the optimistic manager, rather than imposed by the market as with the agency effect. This is why the cost of issuing equity might not be the same. In particular, the optimistic manager is averse to issuing equity because of the interest of shareholders. The empire builder, on the other hand, is only averse to the extent of securing his own interests. Second, the additional cost, $c(e)$, is actually paid by the firm, so it is a real rather than perceived cost. Because of that, one can include $c(e)$ in the cost of capital.

In order to disentangle the effects of optimism and agency theory, we assume a manager who can be potentially optimistic and empire builder at the same time. His objective function becomes

$$\max_{K,e}(1+\gamma+\delta)f(K,e,\cdot)-(1+\alpha\delta)K-e\gamma f(K,e,\cdot) \qquad (4^*)$$

The difference from (4) is that the manager over-estimates future investment cash flows (γ) and aims to make these investments as large as possible (δ). The cost of capital is higher for empire builders (the market reacts negatively to moral hazard). This additional cost, $\alpha\delta$, is an increasing function of the agency problem δ and market sensitivity, α.

Differentiating with respect to K and e gives the following optimal conditions for investment and financing

$$f_K = \frac{1+\alpha\delta}{1+\delta+(1-e)\gamma} \qquad (5^*)$$

$$f_e = \frac{\gamma f+\alpha\delta K}{1+\delta+(1-e)\gamma} \qquad (6^*)$$

The first implication comes from (6*). For the pure agency problem ($\gamma = 0$), the marginal cost of moving away from equity does not depend on the proportion of equity issued, e. The empire builder does not directly perceive a cost of moving away from equity, and

would naturally maximise e. However, market discipline is imposed by (5*) and depends on market penalty α.

Figure 1 shows the case of pure optimism ($\delta = 0$), with the efficient cost of capital set at unity. Figure 1(a) shows a plot of the optimal cost of capital of an optimistic manager for several values of equity proportion and degrees of optimism (e, γ). The optimal cost of capital is clearly lower than unity (100% of the true cost of capital) except when $e = 1$. More importantly, as the manager gets more optimistic, i.e. as γ increases, the relationship between equity issued (e) and the optimal cost of capital (i.e. overinvestment) becomes steeper. The more the cash and debt capacity, the more the overinvestment.

For cash rich firms, $C + D \geq 1$, the manager will always set $e = 0$ regardless of C or D. Thus, as in Malmendier and Tate (2005) we expect the relationship of all-cash investments to be unrelated to cash flows. This is shown in Figure 1(b).

In Figure 2 we show the case of pure agency problem ($\gamma = 0$). For a given equity, the effect of empire building depends on the degree of moral hazard as well as the sensitivity of the market to moral hazard, α, and hence cost imposed by the market. All market penalties that are lower than the true cost of capital lead to over-investment (Figure 2(a)). This over-investment is sensitive to the degree of moral hazard. Empire builders with greater benefit preferences over-invest more. When the market imposes a penalty that is equal to the true cost of capital, managers invest at first best levels, regardless of moral hazard. From (5*) when $\alpha = 1$, $f_K = 1$. However, the market can over-react and impose too high a penalty, at which point, managers under-invest (Figure 2(b)).

One important implication is that the relationship between investment and equity issued is flat in the agency case. This is not surprising since, from (6*), the manager does not perceive a cost to issuing equity. This is in contrast to optimism where the level of overinvestment for a given optimism level is always decreasing in equity issue, and hence, increasing in cash flows.

A clear empirical implication here is that while empire building managers may or may not overinvest, optimistic managers always overinvest, and cash flow (and availability of debt) play a significant role in increasing their overinvestment.

One important implication from the above discussion is the impossibility to test a hypothesis that optimism increases investments. As we can see from Figure 1 and Figure 2, both optimism and agency lead to an over-investment (assuming market under-reaction). Fortunately, only under optimism is investment decision sensitive to cash flow. We therefore propose the following hypotheses:

H_1: Managerial optimism increases investment decision sensitivity to cash flow.

H_2: Given optimism, investment decision sensitivity to cash flow only exists within equity dependent firms.

The first hypothesis states that investment sensitivity to cash flow is more pronounced for optimistic managers compared with rational managers. This can be seen in Figure 1(a). For rational managers ($\gamma = 0$) the optimal cost of capital equals 1 and does not depend on equity issue. For optimistic managers, not only is there overinvestment (optimal cost of capital below 1) but the slope between the optimal cost of capital and equity issue is positive, indicating sensitivity of investment to cash flow.

The second hypothesis states that, within optimistic firms, cash rich firms' investment decisions are not sensitive to cash flow. This is shown in Figure 1(b).

[Insert Figure 1 about here]

[Insert Figure 2 about here]

4. Data

The sampling frame consists of listed firms in the UK from 2005 to 2018. The starting date was chosen in order to control for any effects that may have been caused by the global financial crisis of 2008. Complete data for the UK were available for 776 firms from the total population. Data were collected from financial statements of the constituent firms from *Bloomberg*. To ensure that outliers do not contaminate our results we trim our data at the 1% level.

4.1 Optimism Proxies

Our measures of optimism are based on the exaggerated *activities of the manager* as proposed by Schrand and Zechman (2012) and Campbell *et al*. (2011). Our first proxy for optimism ($\mathrm{SZOP1}_{it}$) is obtained from the work of Schrand and Zechman (2012). This proxy is measured as a firm-specific score calculated from the investing and financing activities of the firm that have been consistently found to be related to managerial optimism. An optimistic manager in firm *i* and year *t* is given the score $\mathrm{SZOP1}_{it} = 1$ if that manager scores highly in at least two out of four components. The first component is based on investment level, calculated as total asset growth to sales growth. In a given year, the firm will be given a score of 1 if its investment level is in excess of the industry median level for the same year. Optimistic managers are more likely to overestimate the returns from investment, causing them to overinvest, particularly when there is an abundance of internal cash flow i.e. retained earnings (Malmendier and Tate, 2005). The second component is the net dollar acquisitions made by the firm. The firm will be given a score of 1 in a given year if its net dollar acquisitions are greater than the industry median level for the same year. Acquisitions are taken as the net value of acquisitions obtained from the statement of cash flows. Malmendier and Tate (2008) and Ben-David *et al.* (2013) among others, find that optimistic managers engage more in mergers and acquisitions, and may even overpay for their acquisitions to the point where it may be damaging to the firm. The third component is the firm debt to equity ratio. The firm will be given a score of 1 if its debt to equity ratio is greater than the industry median level for a given year. An optimistic manager views firm equity as undervalued by the public, when there is a financing deficit, an optimistic manager will be more likely to take on more debt rather than issue undervalued stocks (Heaton, 2002). The fourth component is based on whether a firm uses convertible debt or preferred stock. The firm will be given a score of 1 if it uses either convertible debt or preferred stock. Schrand and Zechman (2012) explain that optimistic managers will choose risky debt, where risky debt is measured as a debt with longer duration. If a firm totals a score of 2 or higher in a given year, its manager will be considered optimistic ($\mathrm{SZOP1}_{it} = 1$).

Schrand and Zechman (2012) then expand their measure by including a fifth component, namely dividend yield. They give the firm a score of 1 if its dividend yield is equal to zero. This assumes optimistic managers unwillingness to pay-out dividends and their tendency to preserve cash for future investment opportunities. Combined with the above four components, if a firm totals a score of 3 or more, its manager is considered optimistic ($\mathrm{SZOP2}_{it} = 1$).

The underlying reason for including dividend as a separate measure is that dividend policy could proxy for firm characteristics rather than managerial optimism. For example, a new firm with more investment opportunities, may be unlikely to pay out dividends in order to preserve cash for investments compared to a well-established firm having less investment needs. Schrand and Zechman (2012) combine several binary measures of investing and financing activities because any individual activity may not necessarily be evidence of managerial optimism. For instance, a given activity may be related to firm policy or firm characteristics. On the other hand, a composite of several activities taking place simultaneously is more likely to be due to the consistent impact of an optimistic manager.

One criticism of Schrand and Zechman (2012) proxies is that they can reflect decisions taken by previous CEOs. For example, capital structure and dividend policies are usually sticky, and thus the observed level in the current period may be related to the decisions made by a previous CEO. We therefore use an alternative measure of optimism introduced by Campbell *et al.* (2011), which focuses solely on the investment levels observed in relation to the industry mean. Investment policies are arguably less sticky than capital structure and dividend policies (Kim *et al*., 2016).

Campbell *et al.* (2011) propose a measure of CEO optimism that is related to the firm investment level, and argue that the CEO investment choice decreases with risk aversion and increases with optimism. A risk averse CEO with low optimism chooses investment below firm value maximising levels, whereas, an over-optimistic manager would overinvest and harm firm value by investing beyond the firm value maximising levels. Although our model takes risk aversion as given, we can nevertheless capture a large proportion of optimism. While we predict over-investment for any level of optimism,

Campbell *et al.* (2011) predict the same effect for above moderate levels of optimism. We can therefore use their measure of optimism to test our hypotheses.

This measure of CEO optimism is based on the ratio of capital expenditure, CE_{it}, to beginning of year net property, plant and equipment, $PPE_{i,t-1}$.

$$OPT_{it} = \frac{CE_{it}}{PPE_{i,t-1}} \tag{7}$$

Campbell *et al.* (2011) specifically classify a CEO as highly optimistic if the firm industry-adjusted investment OPT_{it} in Equation (7) is above the 80th percentile of all firms within a given industry for two consecutive years. The reason for specifying two consecutive years is that investment can be "lumpy" in time, and a CEO should not be classified as highly optimistic simply for choosing to bunch investment in a particular year. Conversely, they classify CEOs as having low optimism if the firm industry-adjusted investment is below the 20th percentile of all firms for two consecutive years. Their measure of optimism is denoted as $OPT80_{it}$ and $OPT20_{it}$ respectively.[1] The CEOs that do not fall into these two categories, are classified as moderately optimistic.

Our third measure of CEO optimism is the net stock purchase measure, denoted $PURCHASE_{it}$. This measure was introduced by Malmendier and Tate (2005) and adopted by Campbell *et al.* (2011). The logic behind this measure is that optimistic CEOs may think that a firm's value perceived by the market is much lower than the value perceived by themselves, so they have greater propensity to purchase stocks as net buyers. By increasing the net purchases of their firm's shares, they are putting themselves at a greater risk as they fail to diversify their idiosyncratic risk. This measure is also in line with the investor bias discussed by Odean (1998) where optimism in investors can lead to higher trading volume in financial markets. Odean (1998) argues that optimistic investors trade more aggressively and hold less diversified portfolios leading to a lower expected utility than rational traders. The same logic can be applied to optimistic CEOs.

The stock purchase measure may be especially appropriate for the UK market because regulations of insider trading are much stricter in the UK than they are in the US. This

[1] Note that OPT20 is not a measure of overconfidence, rather a measure of the "lack of confidence" or pessimism of the manager.

makes it very difficult for managers to benefit from purchasing stocks on the basis of insider information.

Following the work of Malmendier and Tate (2005), Campbell *et al.* (2011) and Ahmed and Duellman (2012) we will define net purchases as stock purchases minus stock sales, both defined in units of stocks. The stock purchase measure of optimism is classified as a dichotomous variable where $PURCHASE$ is set equal to one if the CEO's net purchases are in the top 80th percentile of net purchases by all CEOs in that year and, at the same time, increase the CEOs ownership of the firm by 10% during the fiscal year, and zero otherwise. This measure labels a manager as optimistic if the amount of net purchases is both large in absolute terms and substantially increases the CEOs ownership in the firm.

The conditions for the $PURCHASE$ measure may be restrictive. Therefore, an alternative measure to stock purchases will also be used, which is the net purchase ratio NPR (Doukas and Petmezas, 2007; Billet and Qian, 2005; Ataullah *et al.*, 2017). This is a relative measure and is calculated as:

$$\text{NPR} = \frac{\text{insider purchase - insider selling}}{\text{insider purchase + insider selling}} \qquad (8)$$

The NPR ranges from -1 to 1, where a higher value of NPR implies that managers are buying more shares and thus have more optimism. Similar to $PURCHASE$, NPR purchases and sales are both defined in units of stock.

4.2 Empirical Model

Following Malmendier and Tate (2005) the following regression model will be tested:

$$INV_{it} = \alpha_i + \beta_1 CF_{it} + \beta_2 OP_{it-1} + \beta_3 CF_{it} OP_{it-1} + X'_{it} B_1 + CF_{it} X'_{it} B_2 \qquad (9)$$

where INV is investment; measured as capital expenditures normalized by the beginning of the year property plant and equipment (PP&E). The right-hand side variables are as follows. CF is cash flow before extraordinary items plus depreciation; normalized by the beginning of the year PP&E. X_{it} is a vector of control factors which include: Q, firm size,

return on assets, and leverage. B_1 and B_2 are vectors of coefficients, and the remaining coefficients are scalars.

Q_{it} is Tobin's q, measured as market value of assets over book value of assets. Market value of assets is defined as total assets plus market value of equity minus book value of equity. Book value of assets is the total assets obtained from the balance sheet. Firm size, denoted SIZE_{it}, is calculated as log of market capitalization. Return on assets, denoted ROA_{it}, is calculated as net income divided by total assets. Finally, leverage, denoted LEV_{it}, is calculated as total debt divided by total assets. Because cash flow is expected to have a moderating effect on these variables, the model also includes interaction terms between cash flow and control variables.

OP_{it} is optimism, proxied by SZOP1, SZOP2, OPT80, PURCHASE and NPR. OPT20 is a measure of non-optimism or pessimism. The model hypotheses imply that managers investment decision is a function of optimism and the amount of internal cash flow. Therefore, an interaction term of cash flow by optimism ($CF{\times}OP$) is included in the model. We expect a positive relationship between the interaction term, $CF{\times}OP$, and investment.

We expect a positive relationship between cash flow and investment, since internal cash flow increases the firm's ability to invest. Tobin's Q is an approximate measure of firm performance. Good performance is expected to lead to increased levels of investment. Larger firms are expected to have better investment capabilities as well as opportunities. We thus expect a positive relationship between firm size and investment. A positive relationship between ROA and investment is also anticipated. Firms with high ROA tend to have high performance and are thus more likely to be able to invest. On the other hand, we expect a negative relationship between leverage and investment. Firms with high levels of debt may be financially constrained and thus unable to increase investment.

The panel model includes firm fixed effects, year fixed effects and the interaction of cash flow with industry. We use a fixed-effects panel regression, with serial correlation and heteroskedasticity controlled by clustering observations by firm in order to produce robust standard errors. We also include an interaction term between the industry dummy and cash flow, to capture any change in effects after considering the effects of the industry group.

The optimism measures are lagged by one year to allow for sufficient time for the effect of optimism bias to take place. Another important consideration is reverse causality. It may be argued that firms with higher risk or lower firm value tend to employ optimistic CEOs. Thus, an increase in investment may be the result of firms trying to improve firm value. That is, firms with low firm value and several investment opportunities available to them, may hire an optimistic manager to mitigate this problem. Curiously, Malmendier and Tate (2005) lag Tobin's Q but not the other measures of optimism.

5. Results

5.1 Descriptive statistics and correlation matrix

Table 1 provides summary statistics for the main variables. The mean value of investment is £245.05 million. The mean values of the various optimism proxies are generally high, reflecting the dominance of stable and growth periods within the sample. Specifically, the means of SZOP1 and SZOP2 are 47.4% and 34.8% respectively. The mean value of the proxy of high optimism OPT80 is 19.5%. Finally, the mean value of low optimism OPT20 is 18.2%. These figures point to high levels of optimism within the UK market.

It is also interesting to note that the minimum ROA shows the existence of firms with substantial losses. Finally, (log) Size is negative for equity sizes under one million pounds.

Table 2 shows a more detailed summary of investment and cash flow, tabulated by the different optimism measures. Investment and cash flow are normalized by capital. As we can see, the mean value of normalized investment is always much higher for the group of firms with optimistic managers than that of non-optimistic ones. For example, under the SZOP1 measure of optimism the mean level of investment for the optimistic manager is 0.371, while the mean value for the non-optimistic group is 0.069. While this is not enough to conclude a true causal relationship between optimism and increased investment, it provides initial hints in support of previous literature (Hirshleifer and Luo, 2001; Baker *et al*., 2004; Malmendier and Tate, 2005). The mean value of normalized earnings is not necessarily higher for optimistic firms. These results make sense since investment decisions are made by the manager and are thus subject to the optimism bias. Earnings, on

the other hand, depend on numerous factors, some of which cannot be influenced by managers.

Correlations are shown in Table 3. As expected, the correlation between investment and cash flow, Q, and the optimism measures are positive, though not very high. Investment and cash flow are highly correlated at 0.799. Meanwhile Tobin's Q is weakly correlated with Investment at 0.139. We can see that the optimism variables are all positively correlated with each other, and negatively correlated with OPT20 (the measure of pessimism). The highest correlations of optimism are between SZOP1 and SZOP2, at a value greater than 0.7. This is reasonable as they are both derived from a similar composite score. We intend to remedy this potential collinearity by including only SZOP1 or SZOP2 in our model. We can see that none of the other variables are highly correlated, so there is no concern about multicollinearity.

[Insert Table 1 about here]

[Insert Table 2 about here]

[Insert Table 3 about here]

5.2 Cash Flow and Optimism Regression

Table 4 provides the main results for all five optimism proxies. The first column presents the regression using control variables only. We use fixed firm and year effects for all our models. We follow standard practice and include cash flow, Tobin's Q, ROA, size and leverage as potential control variables for investment.

As can be seen, the relationship between investment and cash flow is positive and significant at the 1% level. As expected, firms with higher cash have a better ability to invest. The relationship between investment and Tobin's Q is marginally significant and has the expected positive sign. Again, more successful firms tend to invest more. Apart

from ROA, all other variables and interactions are significant at the 5% level. The R-squared suggests that nearly 78% of the variation in investments is jointly explained by these control variables. However, in the remaining five columns we note that most of these controls become insignificant and at the same time the R-squared increases substantially (except in the case of PURCHASE). This is a strong indication of the importance of optimism in explaining investment.

As in Malmendier and Tate (2005) we can see from Table 4 that the interaction between Cash flow (CF) and Tobin's Q is significant and positive (with a coefficient = 0.0001 and p-value = 0.015), indicating that the effect of Q on investment increases with increasing cash flow. However, this impact disappears when we introduce optimism.

Furthermore, the effect of leverage on investment is highly significant and negative, as firms with higher levels of debt will tend to invest less. However, leverage is only significant in two of the five models with optimism.

Although size is significant and positive in the baseline model, it is not significant in any of the five optimism models. However, the size and cash flow interaction term (coefficient = -0.202, p-value = <0.001), while significant, has a negative coefficient, indicating that larger firms invest less as their cash flow increases. While this result is somewhat puzzling, it may be reasoned that large firms are better able to raise debt at lower rates, having already set up their credit worthiness in the market, and thus do not necessarily depend on internal cash flow when making investment decision. Furthermore, as indicated earlier, large firms are running close to steady state dynamics which means that they have little need for investment; a situation which exacerbates a negative correlation. Although this result is also in line with Malmendier and Tate (2005), it remains puzzling because if the above explanation was true, the interaction should be insignificant at most but not negative. The same pattern is also seen in three of the five optimism models.

The SZOP proxies.

The SZOP1 and SZOP2 proxies of optimism proposed by Schrand and Zechman (2012) are interesting because they represent different levels of optimism. Because SZOP2 is more stringent, it could be seen as measuring higher levels of optimisms relative to SZOP1.

The results shown are based on a fixed effect model including interactions of cash flow and industry. The results based on a fixed effect model using errors clustered by firm are similar and therefore unreported.

The two proxies produce results that are qualitatively similar. The only major difference is the cash flow interaction with size, which is negative for SZOP1 but positive for SZOP2. However, in terms of the impact of cash flow and its sensitivity to optimism, both proxies suggest the same effect direction but different scale of impact. For moderate optimism (SZOP1) model, the impact of non-optimists on investment is 0.175 (pval=0.008), while the impact of optimism is -0.041 (pval=0.059), reflecting the optimist's aversion to issuing equity. However, for non-zero cash flow, the additional impact of cash flow induced by optimism is 0.099, giving a total impact of 0.274 (0.175+0.099), an increase of more than 56% in the impact. For high optimism (SZOP2), the impact of non-optimists is 0.645 (p-value<0.001), but this increases by 1.526 (p-value=0.004) for highly optimistic managers. In other words, the cash flow impact with optimism is 2.180, or an increase of more than 230% in the cash flow impact.

The above results show that optimism increases the sensitivity of investment to cash flow (H1). Moreover, the results also demonstrate that this sensitivity increases with heightened levels of optimism. This effect can be seen in Figure 1(a) where increasing levels of optimism (γ) yields steeper trends between the optimal cost of capital and equity issue.

The results lend support to previous theoretical findings in the literature such as Malmendier and Tate (2005), Campbell *et al.* (2011) and Oran (2013) who suggest that optimistic managers do not take advantage of investment opportunities unless there is an abundance of internal cash flow (retained earnings). If optimistic managers have to tap into the external market to finance their investments, they will view any debt as risky, and their company stock as undervalued, and are thus likely to omit some of the available investment opportunities even if they provide positive NPV.

Note that the negative coefficient (-0.041) of the SZOP1 term needs to be combined with the positive coefficient of the interaction term to get the total effect of SZOP1. To see the effect of optimism without interaction, we re-estimated the same model without the interaction term between SZOP1 and cash flow. SZOP1 showed a significant positive coefficient of 0.024 and a p-value of 0.043. Thus, optimism does yield higher levels of investments. Similar results were obtained for SZOP2.

The OPT proxy.

The OPT proxy is based on Campbell *et al.* (2011) who define OPT80=1 for optimistic managers, and OPT20=1 for pessimistic managers. The regression model testing the effect of the interactions of cash flow and OPT on investment is presented in the fourth column of Table 4. The results show that OPT80 is statistically significant. The impact of cash flows increases by 0.353 (p-value<0.001) for highly optimistic managers, suggesting that the sensitivity of investment to cash flows increases from 0.129 (p-value=0.149) for moderate or non-optimists to 0.483 (0.354+0.129) for highly optimistic managers. The pessimist proxy OPT20 and its interaction with cash flows are insignificant, suggesting similar behaviour of pessimists and moderately optimistic managers (using the parlance of Campbell *et al.* (2011)).

Thus, the OPT80 results almost perfectly align with those found in the SZOP1 and SZOP2 models, and provide further evidence that the impact of cash flows on investment is greater for optimistic managers. Again, these results are in line with the results reported by Malmendier and Tate (2005).

The PURCHASE and NPR proxies.

The PURCHASE and NPR proxies define optimism by the stock purchasing decisions of managers. The results of the regression on investment are presented in the last two columns of Table 4. The PURCHASE proxy and its interaction with cash flows are insignificant. While both PURCHASE and NPR measures of optimism are based on stock purchases, the

PURCHASE measure is relatively restrictive and thus may not be very efficient in capturing managerial optimism.

On the other hand, while NPR has an insignificant coefficient (p-value=0.308), its interaction with cash flows is highly significant (p-value=0.028), suggesting that optimistic managers' impact of cash flows increases by 0.120 compared to non-optimistic managers.

[Insert Table 4 about here]

5.3 Optimism and Equity Dependence

The results presented in the previous section show that optimistic managers are more sensitive to cash flow in their investment decision than rational managers. However, there remains the question of whether optimistic managers with more than enough internal financial means exhibit a different behaviour. Our model predicts that investment should not be sensitive to cash flow in that case, since (over-)investment would reach a ceiling coinciding with the lowest optimal (irrational) marginal cost of capital for a given level of optimism. Setting $e = 0$ in Equation (5) yields $f_K = 1/(1+\gamma)$ which only depends on the optimism parameter γ. Additional internal funds will not change e and hence will not lead the manager to increase or decrease investment. This is shown in Figure 1(b), where the optimal cost of capital flattens out for firms that do not require issuing equity. Once a firm becomes equity-dependent, the manager's optimisation yields optimal costs of capital that are increasing in equity issue, thus reducing over-investment. The more the equity required, the less the over-investment.

Thus, cash flow impacts investment mostly within firms that are equity dependent (either because they have low cash reserves and/or reduced debt capacity to finance investments).

To assess whether this effect is present within our sample of UK firms, we use the KZ-index (Kaplan and Zingales, 1997), which is a relative measure of firm reliance on external financing. The KZ-index classifies firms as constrained or unconstrained based on five accounting ratios: cash flow to total capital, Q, debt to total capital, dividends to total

capital, and cash holdings to capital. This estimate is presented as follows (rounded to three decimal places):

$$KZ_{it} = -1.002 \times \frac{CF_{it}}{K_{it-1}} + 0.283 \times Q_{it} + 3.139 \times Lev_{it} - 39.368 \times \frac{Div_{it}}{K_{it-1}} - 1.315 \times \frac{C_{it}}{K_{it-1}} \quad (10)$$

K_{it-1} is the lagged value of PP&E. The lagged value of the KZ index is then divided into 5 quantiles with higher quantiles indicating a higher degree of financial constraints. We performed five separate regressions, one for each quintile. We will use SZOP2, OPT80 and NPR[2] as measures of optimism, as these are the main measures that showed significant results in Section 5.2. The results are presented in Table 5.

Consistent with Malmandier and Tate (2005), the effect of SZOP and OPT measures of optimism on the sensitivity of investment to cash flow was significant for the top and middle quintiles of the KZ index. Roughly, these represent firms that are most severely and moderately constrained respectively. In terms of Figure 1(b) these represent the right-hand side cases where the curves are steep. The bottom two quintiles are the least constrained. These are represented by the left hand side case where curves flatten out. Note that we have adopted a conservative approach by using standard errors that are clustered by firm. Despite this, the effect in these two quintiles remains strong with p-values close to zero.

The first two optimism measures SZOP and OPT80 are significant for the top and middle quintiles. For example, for the most constrained firms, SZOP has a coefficient of 0.049 with a p-value of 0.014. The coefficient of the middle quantile for OPT80 is -0.130 with a p-value less than 0.001.

More importantly, the coefficients of the two interaction terms $\mathrm{CF} \times \mathrm{OPT80}$ and $\mathrm{CF} \times \mathrm{SZOP}$ for the top and middle quintiles are positive and highly significant. For example, the interaction term CF×SZOP has a coefficient of 0.322 with a p-value of less than 0.001 in the top quintile. The interaction term CF×OPT80 has a coefficient of 0.464 and a p-value of 0.001 for the middle quintile. The NPR measure is mostly insignificant for all quintiles. However, the interaction term CF×NPR is positive and significant (coefficient = 0.230, p-

[2] We chose to exclude SZOP1 to avoid multicollinearity, as SZOP1 and SZOP2 are highly correlated, and SZOP2 is the more comprehensive composite of overconfidence. We also exclude PURCHASE as it was consistently insignificant in the previous models.

value = 0.022) for the middle quintile. Overall, the positive interaction coefficients provide strong evidence for the sensitivity of investment to cash flows for constrained firms.

For quintiles four and five (least constrained firms), none of the optimism variables or their interaction with cash flows are significant. This suggests a flat relationship between cash flows and investment regardless of optimism level. This supports the left hand side pattern in Figure 1(a) and confirms our second hypothesis.

However, the lack of significance of the three optimism variables in unconstrained firms is not consistent with the over-investment prediction. If optimism within cash-rich firms led to over-investment we should have at least one of the optimism variable coefficients positive and significant. We cannot bring a satisfactory explanation to this result. We can only speculate that perhaps when firms are least constrained, the managers have free hand to pursue investment strategies that are independent of optimism because the perception of under-pricing becomes less important to these managers. We leave this important question for future research.

[Insert Table 5 about here]

6. Conclusion

This paper investigates the relationship between managerial optimism and corporate investment decisions contingent on the availability of cash flow. We test two main hypotheses on the sensitivity of investment decision to cash flow on a panel of listed UK companies. These hypotheses are grounded on theory as well as prior empirical findings. We employ several measures of optimism, and find that four of the five measures confirm our first hypothesis. Specifically, there is a strong positive relationship between the sensitivity of investment to cash flow and managerial optimism in the UK market. In other words, optimistic managers are more investment sensitive to cash flow than rational managers. Moreover, the higher the level of optimism the higher the sensitivity of investment to cash flow.

In relation to the second hypothesis we further supplement the tests on the UK market by using the Kaplan and Zingales (1997) index of financial constraint to sort firms from most to least financially constrained. The results support the findings that more optimistic

managers over-invest, but the sensitivity to cash flow disappears if abundant cash is available. In other words, sensitivity only exists for equity dependent firms. Financial constraints are therefore a disciplining mechanism that reduces the level of overinvestment induced by optimism.

The overall results for the UK are similar to the findings of Malmendier and Tate (2005) on the US market. Investment is generally sensitive to cash flow and increasingly so for optimistic managers. However, Malmendier and Tate (2005) results imply that sensitivity is present at all levels of internal finance, and that it is greater for cash constrained firm. Our argument is different in that investment decisions are not sensitive to cash flow when there is abundance of internal finance. We find strong support for this argument. In other words, we find no, rather than low, sensitivity for cash rich firms.

Our work has a number of limitations that could be considered for future research. First, the implications drawn in this paper are dependent on the modelling specification (Baker and Wurgler, 2013). Our approach is to keep the theoretical model simple in order to identify the essence of behavioural implications. For example, separating cash from debt in our model would produce a more complete theory. Another limitation is that we only consider pure optimism. However, there may well be managers that exhibit both optimism and empire building tendencies. While considering both dimensions would be theoretically and empirically complex, it could lead to more interesting findings.

Future studies could also consider pessimism. The combination of Brexit and the Covid-19 pandemic may well have created a mood of pessimism among firm managers. Rather than under-priced, pessimistic managers could see their firms as over-valued. It would, therefore, be interesting to see if pessimism induces under-investment and sensitivity of investment to cash flow. This, however, would require not only a new set of theoretical results, but also a new set of proxies similar to the ones used in this study.

References.

Ahmed, A. and Duellman, S. (2013). Managerial overconfidence and accounting conservatism. *Journal of Accounting Research, ,* 51(1), pp. 1-30.

Ataullah, A., Vivian, A. and Xu, B. (2017). Time-varying Managerial Overconfidence and Corporate Debt Maturity Structure. *The European Journal of Finance*, 24(2), pp. 157-181.

Baker, M., Ruback, R. and Wurgler, J. (2004). *Behavioural Corporate Finance: A Survey*. NBER Working Papers 10863, National Bureau of Economic Research.

Bartlett, R. and Partnoy, F. (2018). *The Misuse of Tobin's Q.* Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3118020 [Accessed 27 2 2020].

Baker, M. and Wurgler, J. (2011) Behavioural corporate finance: an updated survey. In: Baker, M. and Wurgler, J., ed., (2011) *Handbook of the Economics of Finance.* National Bureau of Economic Research, pp. 357-424.

Ben-David, I., Graham, J. and Harvey, C. (2013). Managerial miscalibration. *The Quarterly Journal of Economics,* 128(4), p. 1547–1584.

Billett, M. and Qian, Y. (2005). Are Overconfident Managers Born or Made? Evidence of Self-Attribution Bias from Frequent Acquirers. *Management Science*, 54(6), pp. iv-1211.

Campbell, C., Gallmeyer, M., Johnson, SH., Brooke, J. and Stanley, W. (2011). CEO optimism and forced turnover. *Journal of Financial Economics,* Volume 101(3), pp. 695–712.

Campolargo, J. D. (2020). Why Optimism Is Such a Key Ingredient of Success. Thrive Global. February 11. Available from https://thriveglobal.com/stories/optimism-success-mindset-feedback-loops-tackle-problems/

Chen, J. and Lin, S. (2013). Managerial optimism, investment efficiency, and firm valuation. *Multinational Finance Journal, ,* 17(3/4), pp. 295-340.

Chowdhury, A. and Chowdhury, S. (2010). Impact of capital structure on firm's value: Evidence from Bangladesh. *Business and Economic Horizons,* 3(3), pp. 111-122.

De Long, J. B., Schleifer, A., Summers, L. and Waldmann, R. (1990). Noise Trader Risk in Financial Markets. *Journal of Political Economy*, 98(4) pp. 703-38.

Doukas, J. and Petmezas, D. (2007). Acquisitions, overconfident managers and self-attribution bias. *European Financial Management,* , 13(3), pp. 531-577.

Durnev, A., Morck, R. and Yeung, B. (2005). Value-enhancing capital budgeting and firm-specific stock return variation. *Journal of Finance,* 59(1), pp. 65-105.

Dziubinsky, S. (2020). 7 Undervalued Stocks with Healthy Yields, Morning Start, July 14. Available from https://www.morningstar.com/articles/991525/7-undervalued-stocks-with-healthy-yields

Gallo, G. (2019). The Optimist's Bookshelf, Forbes, 12 November.

Gervais, S. and Odean, T. (2001). Learning to be overconfident. *Review of Financial Studies,* 14(1), pp. 1-27.

Goodhart, C. A. E. (2014). The parlous state of macroeconomics and the optimal financial structure. *International Review of Financial Analysis*, 36, 78-83.

Hackbarth, D. (2008). Managerial traits and capital structure decisions. *Journal of Financial and Quantitative Analysis,* 43(4), pp. 843-881.

Heaton, J. (2002). Managerial optimism and corporate finance. *Financial Management,* , 31(2), pp. 33.

Hirshleifer, D., Low, A. and Teoh, S. (2012). Are overconfident CEOs better innovators. *Journal of Finance,* , 67(4), pp. 1457-1498.

Jacobs M.T. and Shivdasani, A. (2012). Do you know your cost of capital? *Harvard Business Review*, (7-8), 119-124.

Jensen, M. and Meckling, W. (1976). Theory of the firm: Managerial behaviour, agency costs and ownership structure. *Journal of Financial Economics,* 3(4), pp. 305-360.

Kaplan, S. N. and Zingales, L. (1997). Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints?. *Quarterly Journal of Economics*, 112(1), pp. 169-215.

Langer, E. (1975). The illusion of control. *Journal of Personality and Social Psychology,* 32(2), pp. 311-328.

Lakonishok, J., Schleifer, A. and Vishny, R. W. (1994). Contrarian Investment, Extrapolation, and Risk. *Journal of Finance*, 49(5), pp. 1541-1578.

Malmendier, U. and Tate, G. (2005). CEO overconfidence and corporate investment. *Journal of Finance*. 60 (6), pp. 2661-2700.

Malmendier, U. and Tate, G. (2008). CEO overconfidence and the market's reaction. *Journal of Financial Economics*. 89 (1), pp. 20-43.

Myers, S. (2001). Capital Structure. *The Journal of Economic Perspectives*, 15(2), pp. 81-102.

Myers, S. and Majluf, N. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics,* 13(2), pp. 187-22.

Noyce, Robert (no date). Available from https://www.azquotes.com/quote/752395

Odean, T. (1998). Volume, volatility, price, and profit when all traders are above average. *The Journal of Finance*, 53(6), pp. 1887-1934.

Oran, J. and Perek, S. (2013). An empirical test of optimism bias in capital budgeting decisions. *Journal of Modern Accounting and Auditing,* 9(2), pp. 287-296.

Rabin, M. (2002). A perspective on psychology and economics. *European Economic Review*, 46(4-5), pp. 657-685.

Schrand, C. and Zechman, S. (2012). Executive overconfidence and the slippery slope to Financial misreporting. *Journal of Accounting and Economics*, 53(1-2), pp. 311-329.

Shefrin, H. (2005). *Behavioural corporate finance.* Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=288257 [Accessed 16 1 2020].

Shiller, R. J. (2000). Irrational Exuberance. Princeton University Press.

Weinstein, N. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology,* 39(5), pp. 806-820.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Assets	3540.048	26384.130	0.573	748808
PP&E	1424.752	12382.37	0.500	695081
Investment	245.052	2250.417	0	78355
Investment normalized by PP&E	0.267	1.244	0	63.376
Investment normalized by assets	0.045	0.075	0	1.904
Cash flow	338.151	2747.406	-19270.640	45046.950
Cash flow normalized by PP&E	-7.850	347.134	-7875.556	16303
Cash flow normalized by assets	0.002	0.372	-17.193	2.597
Q	3.338	46.663	0	1469.958
SZOP1	0.474	0.499	0	1
SZOP2	0.348	0.476	0	1
OPT80	0.195	0.396	0	1
OPT20	0.182	0.386	0	1
PURCHASE	0.166	0.372	0	1
NPR	0.061	0.923	-1	1
ROA	-2.914	30.936	-45.393	12.782
Size	4.462	2.451	-4.645	13.547
Lev	0.118	0.333	0.001	20.485

Statistics are based on 8586 firm year observations. All currencies in GBP(Million). Assets are book value of total assets. Investment is defined as capital expenditure. Cash flow calculated as earnings before extraordinary items plus depreciation normalized by beginning of year PP&E. Q is the market value of assets divided by the book value of assets. SZOP1, SZOP2, OPT80, PURHCASE and NPR are measures of optimism. OPT20 is a measure of pessimism. Lev is leverage or total amount of debt divided by total assets. ROA is return on assets calculated as net income divided by total assets. Size is calculated as the log of market value of equity.

Table 2. Investment and cash flow tabulated by optimism measures

		Summary of INV			Summary of CF		
	Group	Mean	Std. Dev.	Freq.	Mean	Std. Dev.	Freq.
SZOP1	Non-Optimist	0.069	2.173	5,607	-0.190	26.371	5,507
	Optimist	0.371	12.458	4,442	-0.081	29.975	4,418
SZOP2	Non-Optimist	0.198	10.050	6,906	-0.441	33.536	6,794
	Optimist	0.213	2.432	3,143	0.508	7.066	3,131
OPT80	Non-Optimist	0.099	2.173	9,234	0.088	18.959	9,111
	Optimist	1.363	28.715	815	-2.703	74.543	814
OPT20	Non-Pessimist	0.224	9.016	8,804	-0.132	29.604	8,734
	Pessimist	0.051	0.486	1,245	-0.206	11.020	1,191
PURCHASE	Non-Optimist	0.248	5.973	8,526	-0.160	30.380	8,415
	Optimist	0.444	10.558	1,523	-0.030	4.633	1,510
NPR	Non-Optimist	0.073	0.870	682	0.037	5.588	891
	Optimist	0.142	1.284	2,019	0.285	9.731	1,796

INV is investment, defined as capital expenditure normalized by beginning of year PP&E. CF is cash flow calculated as earnings before extraordinary items plus depreciation normalized by beginning of year PP&E. SZOP1, SZOP2, OPT80, PURCHASE and NPR are measures of optimism. OPT20 is a measure of pessimism. NPR ranges from -1 to +1. Negative values reflect non-optimism, positive values reflect optimism, and values of 0 are excluded.

Table 3. Correlation Table

Variables	Inv	CF	Q	SZOP1	SZOP2	OPT80	OPT20	PURCHASE	NPR	ROA	SIZE
CF	0.799	1									
Q	0.039	-0.002	1								
SZOP1	0.054	-0.002	0.028	1							
SZOP2	0.040	0.021	0.030	0.826	1						
OPT80	0.019	-0.009	0.073	0.134	0.075	1					
OPT20	-0.017	-0.017	0.003	-0.215	-0.192	-0.087	1				
PURCHASE	0.017	-0.014	-0.025	0.049	0.045	0.008	-0.041	1			
NPR	0.010	-0.011	-0.097	0.094	0.161	0.025	-0.014	0.02	1		
ROA	-0.079	0.016	-0.028	0.084	0.178	-0.035	-0.107	-0.019	0.027	1	
SIZE	0.076	0.012	-0.113	0.223	0.357	-0.141	-0.177	-0.003	0.127	0.264	1
LEV	-0.022	0.003	-0.032	0.069	0.094	-0.007	-0.034	-0.011	0.029	0.025	0.472

Table 4. The interaction of cash flow and optimism

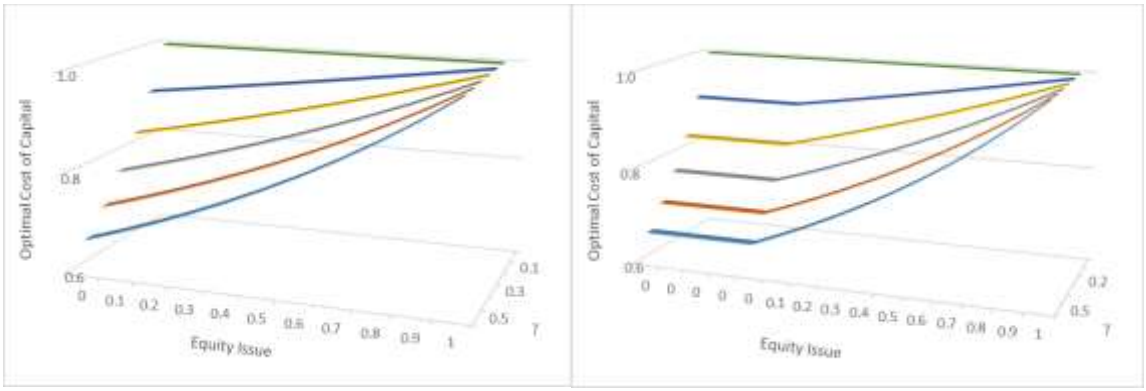
Variables	(1) Control Only	(2) OP=SZOP1	(3) OP=SZOP2	(4) OP=OPT80	(5) OP=PURCHASE	(6) OP=NPR
CF_t	0.488 (<0.001)	0.175 (0.008)	0.645 (<0.001)	0.129 (0.149)	0.487 (0.001)	0.119 (0.074)
Q_{t-1}	0.001 (0.055)	-0.002 (0.797)	-0.011 (0.548)	-0.001 (0.990)	-0.001 (0.545)	0.001 (0.994)
ROA_t	0.0003 (0.751)	-0.0004 (0.910)	0.003 (0.631)	-0.001 (0.947)	0.0004 (0.856)	0.003 (0.023)
$SIZE_t$	0.552 (0.014)	0.159 (0.338)	0.074 (0.543)	0.168 (0.372)	0.067 (0.570)	0.001 (0.955)
LEV_t	-0.004 (<0.001)	-0.006 (0.922)	-0.0003 (0.012)	-0.0001 (0.620)	-0.0001 (0.007)	0.0001 (0.332)
$CF_t \times Q_{t-1}$	0.0001 (0.015)	-0.0004 (0.370)	0.001 (0.214)	0.0041 (0.438)	0.0001 (0.218)	0.0001 (0.934)
$CF_t \times ROA_t$	0.0002 (<0.001)	0.0001 (0.498)	0.0001 (0.748)	0.0041 (0.650)	0.0002 (0.281)	-0.003 (0.005)
$CF_t \times SIZE_t$	-0.202 (<0.001)	-0.106 (0.002)	0.410 (0.001)	-0.076 (0.036)	-0.198 (0.024)	0.033 (0.458)
$CF_t \times LEV_t$	0.0002 (0.006)	-3.130 (0.902)	0.0001 (0.120)	0.0004 (0.652)	0.0003 (0.008)	-0.0001 (0.868)
OP_{t-1}		-0.041 (0.059)	-0.252 (0.024)	-0.205 (0.014)	0.028 (0.761)	0.038 (0.308)
$CF_t \times OP_{t-1}$		0.099 (<0.001)	1.526 (0.004)	0.353 (<0.001)	-0.203 (0.564)	0.120 (0.028)
$OPT20_{t-1}$				-0.028 (0.495)		
$CF_t \times OPT20_{t-1}$				-0.097 (0.401)		
Intercept	0.212 (0.066)	-0.029 (0.303)	-0.253 (0.608)	-0.726 (0.293)	-0.248 (0.646)	-0.142 (0.264)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-CF FE	No	Yes	Yes	Yes	Yes	Yes
R-Sq	0.778	0.915	0.890	0.927	0.781	0.915
Rho	0.153	0.157	0.117	0.186	0.147	0.613

The table presents the regression of investment on cash flow, optimism and other control variables. The dependent variable is investment, defined as capital expenditure normalized by beginning of year PP&E. CF is cash flow calculated as earnings before extraordinary items plus depreciation normalized by beginning of year PP&E. Q is the market value of assets divided by the book value of assets. LEV is leverage or total amount of debt divided by total assets. ROA is return on assets calculated as net income divided by total assets. SIZE is calculated as the log of market value of equity. The number of firms is 761, the time period is from the year 2005 to 2018. The total number of observations is 8586. Results are based on Fixed effect with Industry-CF Interaction. We control for serial autocorrelation by clustering observations by firm. Results based on Std. Errors Cluster by Firm are not reported and are available from the authors upon request. All currencies are in GBP. Rho is the proportion of variation in the dependent variable explained by independent variables in the cross section dimension.

Table 5. Regression results with KZ index

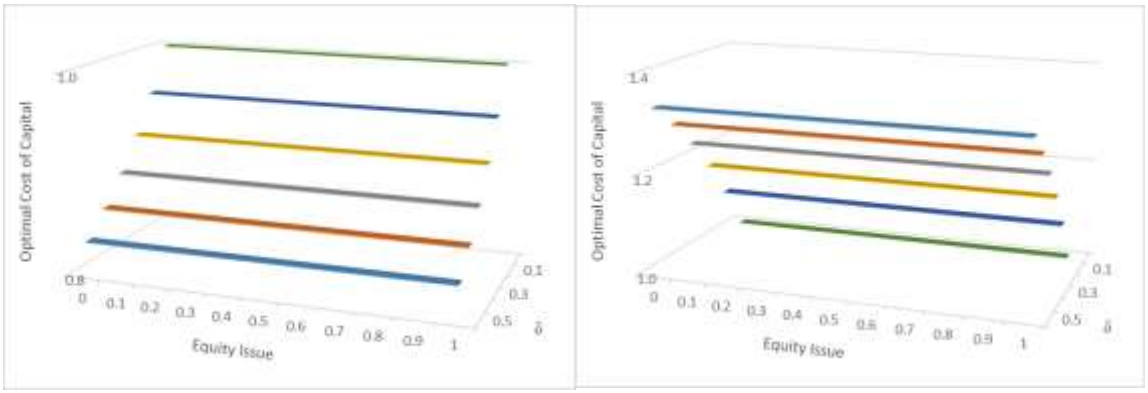
	Most Constrained				Least Constrained
	1	2	3	4	5
CF_t	0.393 (0.008)	0.018 (0.830)	1.976 (<0.001)	0.007 (0.960)	-0.689 (0.055)
Q_{t-1}	0.013 (0.001)	-0.010 (0.047)	-0.062 (0.032)	0.002 (0.817)	-0.019 (0.558)
ROA_t	-0.005 (<0.001)	-0.002 (0.225)	0.027 (<0.001)	0.001 (0.559)	0.019 (0.06)
$SIZE_t$	-0.018 (0.194)	-0.019 (0.686)	-0.025 (0.310)	-0.008 (0.519)	0.044 (0.721)
LEV_t	0.0001 (0.951)	-0.002 (0.285)	0.0001 (0.413)	-0.0001 (0.249)	0.0001 (0.325)
$CF_t \times Q_{t-1}$	-0.009 (0.004)	-0.003 (0.102)	0.107 (0.007)	0.014 (0.058)	0.051 (0.006)
$CF_t \times ROA_t$	-0.011 (<0.001)	-0.001 (0.069)	0.001 (0.868)	0.001 (0.282)	0.011 (0.247)
$CF_t \times SIZE_t$	0.036 (0.266)	0.039 (0.352)	0.043 (0.691)	-0.021 (0.097)	0.032 (0.524)
$CF_t \times LEV_t$	-0.001 (0.556)	0.008 (0.296)	0.0002 (0.112)	0.0001 (0.07)	-0.0001 (0.419)
$SZOP2_t$	0.049 (0.014)	-0.028 (0.415)	-0.066 (0.002)	-0.016 (0.237)	0.058 (0.546)
$CF_t \times SZOP2_{t-1}$	0.322 (<0.001)	-0.137 (0.193)	0.472 (0.001)	-0.013 (0.750)	-0.123 (0.247)
$OPT80_{t-1}$	0.072 (0.006)	0.087 (0.500)	-0.130 (<0.001)	-0.0001 (0.999)	-0.088 (0.236)
$CF_t \times OPT80_{t-1}$	0.113 (0.024)	-0.115 (0.066)	0.464 (0.001)	0.088 (0.375)	-0.013 (0.939)
NPR_{t-1}	0.013 (0.241)	-0.012 (0.292)	0.029 (0.103)	0.014 (0.065)	0.017 (0.619)
$CF_t \times NPR_{t-1}$	-0.057 (0.121)	0.071 (0.242)	0.230 (0.022)	-0.045 (0.082)	-0.001 (0.991)
Intercept	-2.135 (<0.001)	0.027 (0.889)	0.242 (0.026)	-0.023 (0.756)	-0.537 (0.539)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Rho	0.919	0.589	0.983	0.785	0.717

This table presents regression models to study the effect of optimism, cash flow, control variables and their interaction on investment. The regression equation is $INV_{it} = \alpha_i + \beta_1 CF_{it} + OP'_{it-1}B_1 + CF_{it}OP'_{it-1}B_2 + X'_{it}B_3 + CF_{it}X'_{it}B_4$. The dependent variable here is investment, defined as capital expenditure normalized by beginning of year PP&E. CF is cash flow calculated as earnings before extraordinary items plus depreciation normalized by beginning of year PP&E. OP_{it} is a vector of the optimism measures which include SZOP2, OPT80, and NPR. X_{it} is a vector of control variables, Q, LEV, ROA, and SIZE. These are defined in Table 4. The number of firms is 761, the time period is 2005 to 2018, the number of observations is 8586. The currency is GBP. The p-values are shown in parentheses. Rho is the proportion of variation in the dependent variable explained by independent variables in the cross section dimension.



(a) Constrained (b) Constrained and Unconstrained

Figure 1. Optimal Investment under Optimism



(a) Market Under-reaction ($\alpha = 0.5$) (b) Market Over-reaction ($\alpha = 2$)

Figure 2. Optimal Investment under Agency Problem