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Real Economy Effects of Short-Term Equity Ownership

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Abstract

Investor time horizon varies by company, industry and economic system. In this paper we explore the importance of this variation by studying the impact of shareholder time horizon on the investment decisions of the firms they own, and externalities on the wider market. We demonstrate theoretically that short-term shareholders cause Boards to care about the path of the stock price, rationalising firms' pursuit of investments for signalling reasons at the expense of long-term value. We demonstrate that short-termism has spillover effects, leading to higher costs of equity capital; bubbles in the price of input assets; and predictable excess returns. We build testable cross-country hypotheses and evaluate these using existing evidence coupled with a new dataset on owner duration of U.S. and Germanic firms.

Keywords: investor time-horizons; short-term shareholders; bubbles; cost of capital; short-termism; signaling; shareholder register.

JEL Classification: G12, G34, L21, L25.

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"*As long as the music is playing, you've got to get up and dance. We're still dancing.*" Chuck Prince, former Chairman and CEO of Citigroup, July 2007.

1 Introduction

Investment time horizon can have a significant impact on the motivation of shareholders. Those planning on selling their ownership stake in the near-term will be most interested in the near-term value of the business. To the extent that managers are responsive to the interests of their shareholders, the presence of these short-term investors on the register may impact corporate decisions on investments. This paper formally studies this issue using theoretical finance and industrial organization methods. We explore the effect of corporate investors with short-term investment horizons on Board decision making and any spillover effects this might have through the industry. We find that when investors are uncertain about the ability of firms, some management will inefficiently invest in a risky technology to portray themselves as a high-ability firm, boosting the near-term share price. This "artificial" demand for the risky technology leads to a bubble in the price of the required input asset; raises the cost of equity capital for all firms; and generates predictable excess returns. We use data on matched U.S. and Germanic firms to demonstrate how short-termism varies across the two economic systems; we construct cross-country hypotheses from our theory; and we demonstrate empirical support for some of our results.

Summarizing the findings of a series of papers on the topic, Porter (1992) argues that through deregulation and a variety of socioeconomic factors, publicly owned U.S. firms face a higher percentage of short-term ownership than their German or Japanese counterparts. Porter (1992) contends that U.S. firms are more likely to underinvest or invest inefficiently as a consequence of this ownership pattern. Black and Fraser (2002) corroborates this view by offering evidence that U.S. and U.K. investors undervalue long-term cashflows relative to investors in Australia, Japan and Germany. La Porta et al. (1998) argue that the difference in ownership practice across countries is a consequence of the difference between the levels of shareholder protection in the U.S./U.K. versus Germany and other Civil Law based countries.[1] Scholars have sought to characterise stock holders as having long or short investment horizons to support further study. Family ownership, investment churn-rate and other empirical methods have been used as proxies for investor time horizon and its impact on investment decisions, entrepreneurship and stock market returns (see for example Anderson and Reeb (2003), Gaspar et al. (2005) and John et al. (2008)).

This long standing concern over short-term shareholders has led to persistent calls for regulatory intervention to try to encourage long-term share ownership. For example

[1] There are competing theories as to the reason behind the difference in the level of short-termism across countries, see for example Shao et al. (2013).

Porter (1992), writing in the Harvard Business Review, calls for major changes to the U.S. system of corporate ownership to address the alleged problem. More recently the Aspen Institue (2009) suggest short-termism in the U.S. is '*system-wide.*' They propose, inter alia, that shareholders should be able to vote only after a minimum holding period to try to ensure only long-term owners influence corporate decisions.[2]

We contribute to the above discussion by providing a formal theoretical foundation for the relationship between investor time horizon, management decision making and the cost of capital, complementing some of the prior informal reasoning on these issues. We explore how these forces contribute to spillovers and distortions in both the upstream and downstream markets for a particular technology. Existing empirical work has shown that the presence of longer-term investors, usually represented by family ownership or defined by investor "type", tend to be associated with better long-term firm performance. Our work supplements this literature by helping to understand the mechanisms through which this relationship exists.

We present a tractable model in which we simultaneously consider firm investment decisions, shareholder preferences and the market for inputs. There are two key assumptions that underpin the analysis. The first is that the Board of a firm has better information regarding the company's skills and so is better placed to judge business model risks.[3] The second assumption is that the Board of a firm seeks to maximise the aggregate expected value of the shareholders on their register at the time a business decision is taken.[4] In the model studied the firms in an industry must decide between two competing technologies. One is a business-as-usual technology and offers a known payoff that is identical for all firms. The second is a risky technology. The expected payoff of this technology depends upon the ability of the firm to profit from the opportunity. For some firms the expected payoff from the risky technology will be greater than from the business-as-usual technology. Investors are uncertain about the ability of firms and so do not know the long-term payoff to firms from investing in the risky technology. This framework has broad applicability. For example, prior to the financial crisis a bank could decide to pursue a business model of securitising mortgage-backed securities, or not. Not all banks would be equally adept at assessing the value of the underlying assets; or not all banks would be equally able to resell these assets and distribute them to the market.

If firms were owned solely by long-term investors, each firm's Board could maximise its

[2] In the U.K. the Kay review also concluded that '*short-termism is a problem*' (Kay (2012) Executive Summary, para ii). They proposed, inter alia, that CEO remuneration should be altered to forcibly reduce the weighting on current performance. In the EU the European Commission are looking into increasing the voting weight of shareholders who are long-term holders of the stock. (See *Brussels aims to reward investor loyalty*, Financial Times, Jan 23, 2013.)

[3] This asymmetric information assumption is not controversial. However this is not to say that management cannot learn anything from the market; Foucault and Laurent (2014).

[4] The alternative to this assumption is that firms maximise the net present value (NPV) of future cash flows. (DeAngelo (1981)) argues that when asymmetric information exists (as in the model presented), this alternative paradigm would not apply.

value by developing the technology with the greatest expected long-run payoff. However, suppose that the population of shareholders include a proportion who are subject to liquidity shocks, forcing them to sell their stake before payoffs are fully realised. Or equivalently suppose the shareholder population contains a proportion of owners who buy shares intending a short investment horizon. Such shareholders care about the price of the shares at the time of sale. The Board, representing the totality of the shareholder base, is therefore concerned with both the time-path of the share price as well as the final payoff. As management have better information than investors, the market uses the firm's choice of technology as a signal about firm type. High-ability firms that are most able to profit from the risky technology would select it. However, some lower-ability firms would see short-run value from pooling with such firms. By choosing the risky technology a firm is signaling that it is a high-ability firm. This leads to an increase in the short-run market value of the firm as investors infer that the firm type is drawn from a set that includes high-ability firms. In an economy containing short-term shareholders, firms might be willing to sacrifice some long-run value for the sake of a short-run price increase.

It follows that the presence of short-term shareholders increases the demand for the inputs required for the risky technology above the level justified by fundamentals. This causes an increase in the price of the input asset. A price distortion, or bubble, is created. This is a bubble in the technical sense used by Allen and Gale (2000), however it is not a bubble in the commonly used sense in which prices rise without limit. On average too many firms will choose to develop the risky technology and the inputs required to do so are more expensive. Hence the cost of equity capital must rise for all firms with the presence of short-term investors as equity is used ever less effectively and input assets are raised in price. If the input can be supplied elastically then the increased demand will lead to increased supply, and a more modest input price rise. In this case we show that the pooling value increases further, due to the reduction in the price of the input asset, hence the mis-allocation effect is exacerbated. One might describe this result in the words of the former CEO of Citigroup, that the short-run shareholders encourage the firms to *get up and dance*. This insight generates the empirical prediction that the cost of equity capital, at the point of making a business model choice, should be higher in economies where short-termism is prevalent.

In our empirical analysis we formulate a test of this theory. We argue that the purchase of a target company is a purchase of an asset or set of assets and is a business model choice. We then formally extend our analysis to an M&A setting and predict that abnormal returns across the bid announcement window should be smaller for an industry that has greater exposure to short-term shareholders. We then provide a meta-analysis comparing the U.S. to Switzerland/Germany, offering some evidence in favour of our theory.

In an extension of our theoretical model we allow for the possibility that the market underestimates the short-term pressure on firms. We find that this could exacerbate the level of distortion from the base model, and leads to abnormal positive returns in the short-run followed by negative abnormal returns in the long-run. We formulate a cross-country test of this implication of our theory by again extending the model to consider M&A decisions, making testable predictions on long-run abnormal returns.

Information asymmetry is key to the mechanism developed in this study. If there were perfect information as to firm type then the liquidity preferences of investors would be immaterial. Given this we explore the effect of an informative signal as to firm type on the firm's choice of technology. We find that a sufficiently positive signal can amplify the value of pooling described above, increasing the benefit of choosing the risky technology, leading to even greater market distortion. We use this result to generate a final testable empirical hypothesis from our theory.

The empirical analyses described above are developed in the final part of this paper. We draw on existing evidence and supplement this with a new dataset on ownership duration for U.S. and Germanic firms. We show that short-termism in share ownership differs significantly between large companies in Germany/Switzerland versus those in the United States. This study therefore contributes to a more nuanced analysis of the consequences of shareholder behaviour. Further our model builds testable predictions which, we hope, open new avenues for empirical studies to explore.

2 Review Of The Literature

Scholars and policy makers have argued that short-termism is more of a problem in some economies than in others. In Section 1 we noted evidence relating to the level of short-termism in the United States, the United Kingdom, Australia, Germany and Japan, as well as cross-country studies covering tens of countries. Our paper contributes to this finance and international business literature by characterising the effect of differing owner investment horizons on business decisions, industry wide spillovers, and excess returns. Here we present the academic literature concerning international variation in ownership norms and firm performance, contrasting our contribution relative to existing research.

In order to better understand international differences in firm performance researchers have studied how ownership structures and corporate governance differ across countries, hypothesizing that because of these differences the pressures Boards are under will vary geographically. Stemming from the seminal work of Berle and Means (1933) accepted wisdom used to be that for most large corporations, particularly those in the U.S., ownership was dispersed amongst many small shareholders. Subsequent research has rolled back this claim, determining that in general blockholders are more the norm. La Porta et al. (1998) establish this for 27 large corporations from the wealthiest countries in the world; Claessens et al. (2000) do the same for large companies in East Asia and Faccio and Lang (2002) for companies in Western Europe. More recent research emphasizes that though blockholders are more common than thought, the type of blockholder ownership differs by region. Holderness (2009) finds that corporate entities play a significant role in corporate governance in the U.S., whereas in East Asia and continental Europe, families are found to play a bigger role (Claessens et al. (2000), Faccio and Lang (2002)).

Complementary literature looks at the impact of variation in ownership norms and corporate governance on the incentives and performance of management. In particular researchers consider how cross-country variations effect firm investment and R&D decisions (Hillier et al. (2011), Anderson et al. (2012), and Shao et al. (2013)); firm performance (Anderson and Reeb (2003)); managerial entrepreneurship (Zahra (1996)); and risk taking (John et al. (2008)). Our approach is different in that we consider the direct and indirect effects of investor time horizon as opposed to corporate governance. We find that variations in the time horizon of shareholders can lead to differences in individual firm investment behaviour as well as to negative spillovers across firms and industries, bubbles in key input asset markets and excess returns. We also demonstrate the potentially distortionary effect of better information for investors. We offer a theoretical model to allow these links to be explained and understood; and we document and offer empirical evidence for the effects we identify.

The impact of owner investment-horizon on firm behaviour has rarely been analysed theoretically. Perhaps the most relevant recent contribution is that of Bolton et al. (2006) who also study owner characteristics. They consider a setting where some investors are rational while others are overly optimistic (boundedly rational), leading them to incorrectly value certain projects. Our study is complementary as there is no bounded rationality in our work, and we study industry-wide effects and not just individual firm effects. Our work also considers information aggregation effects amongst investors. Albagli et al. (2011) develop a rational expectations model of information aggregation in asset markets and demonstrate that this can lead to corporate distortions. Their model is fundamentally different in that the firm has no control over the information environment whereas in our study the Board can send a signal to investors through its business decisions.

Related literature has studied the effect of CEO myopia on firm performance, as opposed to our focus on investor short-termism. Stein (1989) shows that if the market cannot observe investment decisions then the short-run motivated manager will underinvest. This contrasts with our framework where the actions of firms are observable. Bebchuk and Stole (1993) study investment levels when earnings are observable. They document that the market draws inferences on the extent of investment based on public earnings announcements, finding that this can lead to distortions in investment policy. We use a similar signalling mechanism where the choice of business model can send a signal to the market as to the skill of the firm. However, we go further by studying the role of investors, industry equilibrium and industry wide spillovers.

In this paper we document a link between investor time-horizon and firm and industry performance. There has been a fruitful research agenda seeking to establish such a link empirically. We will assess the empirical evidence relating to our model's predictions in Section 6. More generally our work contributes to the on-going study of the manipulation of corporate outcomes for short-term gain. Graham et al. (2005) conduct a survey of CFOs of public companies. They find that top management, responding to perceived shareholder preference, would forego valuable investment opportunities in order to lower the volatility of announced results. Other studies have provided further evidence of the manipulation of earnings for short-term gain (Strobl (2013), Lambert et al. (2007, 2012), and Kumar and Langberg (2009)). In related work Antia et al. (2010) show that short-term incentivisation can be profit reducing. Given that CEO behaviour is incentivised by the remuneration contracts they are offered, the key question to be addressed is why such apparently profit-reducing short-termism arises. Our contribution here is to rationalise firm short-termism as a function of the investors' investment time horizon. Other explanations advanced are: that reduced managerial tenure leads to short-termism (Mannix and Loewenstein (1994), Laux (2012)); that competitive labour markets and the chance of rapid promotion lead to short-termism (Campbell and Marino (1994)); and that consolidation in an industry leads to increased wage and bonus levels, which in turn leads to reduced deferred pay and so shorter CEO time-horizons (Thanassoulis (2013)).

Finally, methodologically this work is also related to the rich literature on bubbles in asset markets. Allen and Gale (2000) offer a model of asset bubbles where investors borrow from a banking sector that cannot observe their investments. Due to assumed limited liability, investors seek to risk-shift and move funds into the risky asset, pushing the price of the asset above fundamentals. A related mechanism is at work in Allen et al. (1993). There is no risk-shifting rationale in the framework we present.

3 The Model

Consider a continuum of firm types indexed by variable $\tau \in [0, 1]$. The types of firms in the population are distributed according to the commonly known cumulative distribution function $G(\tau)$ with probability density $g(\tau)$. The Board of the firm privately knows its type. Thus management are more informed about their firm's capabilities than investors. The Board publicly selects and announces a business activity choice at time $t = 1$. There are two possible technologies to select from. The Board can choose to develop a business-as-usual technology. This technology requires an input priced at the numeraire of 1 and yields an expected payoff at $t = 2$ of $r > 1$. Alternatively the Board can choose to develop a risky technology. In this case the firm must buy a different input labelled the input asset. It has an endogenously determined price per unit of P. The $t = 2$ expected payoff (gross of investment costs) from investing in a unit of the risky technology is $\bar{R} \cdot \tau$.[5] This simple formulation captures that for some firms the risky technology generates a higher expected payoff. However for others the risky technology is dominated in that the firm's skills are better adapted to profit from the business-as-usual technology. One can interpret the risky technology as a true new business model, or as a fad or fashion. The input asset might be an intellectual or physical asset; or a target company to acquire. What is key in the model is that the new technology is not self-evidently a good idea for all firms in the industry. For example, firms might not be equally adept at managing overseas factories and long distance supply chains; or financial institutions might not be equally adept at trading and managing a portfolio of loans to a given sector.

Each firm is assumed to have a unit of capital, and the input asset is assumed to be in restricted supply of b. We assume that

$$\bar{R}b < r < \bar{R} \tag{1}$$

This guarantees that we remain within an interior solution so that an intermediate proportion of firms will develop the risky technology. The price, P, of the input asset will be determined in equilibrium by the balance of supply and demand. The input asset captures the specific input needed to access the risky business line. For example in finance, the input asset may be sub-prime mortgages that can be securitized and so used to create tranches of mortgage-backed securities. The type τ captures that firms differ in their ability to value and/or harness these assets.

The firms are assumed to be entirely equity owned. The shareholders however, differ in their investment horizon and will not all be long-term owners, that is not all investors will hold onto their shares until after all profits are realised. A proportion L are short-term investors and sell their shares at the end of $t = 1$. The proportion $1 - L$ are long-term investors and hold on to their shares until $t = 2$. We allow short-termism to have two possible interpretations. One interpretation is that short-term shareholders are impatient and intentionally have a short time horizon, selling before results are realised. The second is that shareholders are ex ante identical, but have a probability L of suffering a liquidity shock.[6] Our results hold for both of these possibilities, allowing us to keep the interpretation of short-termism relatively general. Short-term shareholders will sell their holding at the end of $t = 1$, after the Board makes its decision as to the type of technology, but before the true firm type is revealed. The sale price at the end of $t = 1$ will be the market's expected value of the firm, conditional on all public information. The remaining shareholders, proportion $1 - L$, hold their shares until the payoffs are realised

[5] We normalise the discount factor between the first and second periods to 1. This is without loss of generality for a risk-neutral Board. A time discount factor δ would alter anticipated $t = 2$ payoffs to $\delta\bar{R}\tau/P$. The analysis would be unchanged if one substituted $\delta\bar{R}$ for $\bar{R}$.

[6] This liquidity shock assumption is standard in the banking literature, see (Allen and Gale (2009)).

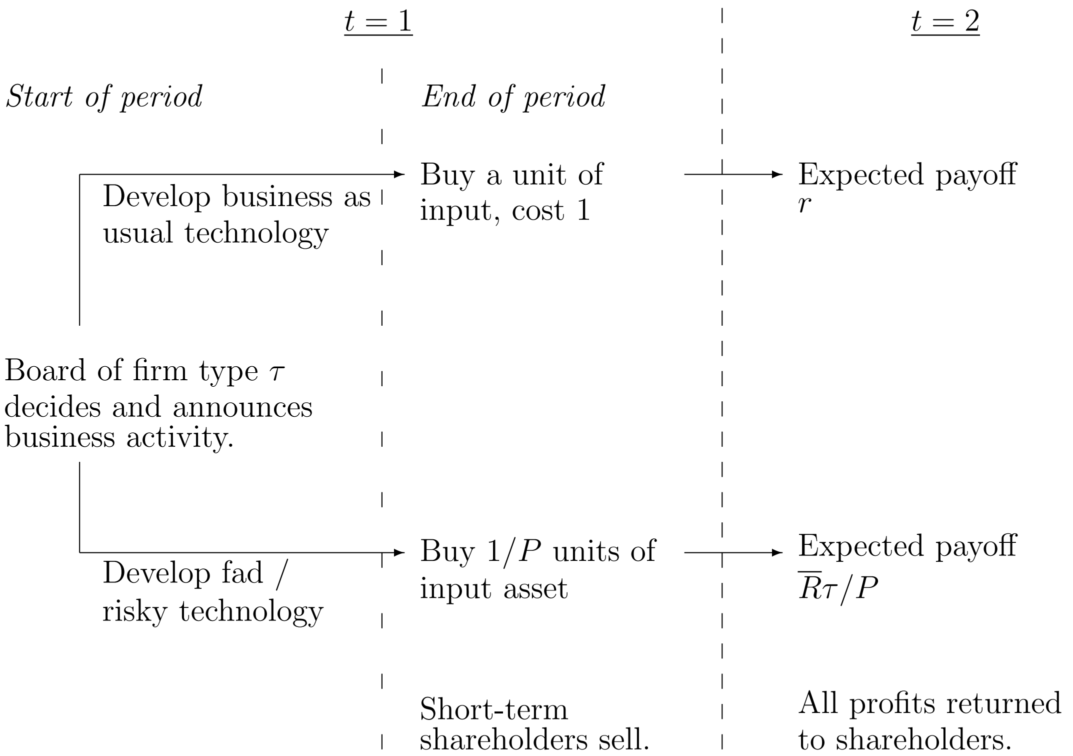


Figure 1: Time line of the model.

Notes: The Board selects the technology the firm develops so as to maximise the expected value of the shareholders who own the firm at the point the decision is made. Short-term shareholders (e.g. because of liquidity shocks) sell after the business decision, but before payoffs are realised. Long-term shareholders hold their shares until the payoffs are realised. Firms are endowed with a unit of capital that they use to buy the required input for the technology chosen. All payoffs are returned to shareholders at the end of $t = 2$. The firm type is private information, the choice of technology and the probability L of short-term ownership are both public information.

at $t = 2$. Hence L measures the time horizon of shareholders in the industry.

The timeline of the entire model is depicted graphically in Figure 1. We restrict attention in the analysis to pure strategy Nash equilibria.

The probability $L \in [0, 1)$ of short-term ownership is common knowledge. In practice chairmen claim to develop an insight for the likely time horizon of shareholders through extensive discussion with owners and observation of the prior behaviour of investors.[7] The objective function of the Board is to seek to maximise the expected value generated for the shareholders who own the firm at the time the business decision is made. Throughout this paper we take L as exogenously determined.

[7]For example, the Chairman of Cadbury, the main U.K. confectionery company until its purchase by Kraft, claimed to be very aware of the time horizon of his investors, and how it changed during the takeover process. See 'The inside story of the Cadbury Takeover.' *Financial Times*, March 12, 2010.

4 Shareholder and Technology Choice Analysis

In this section we solve the model to explore the relationship between short-term shareholders, the price of the input to the risky technology, and the allocation of firms to different technologies. All proofs from this section are contained in Appendix A.

We begin by determining the benchmark price of the input asset, which we can then use to quantify any distortions caused by short-term shareholders. The fundamental value of an asset is the market price established when agents are obliged to subsequently maintain their holdings forever (Allen et al. (1993)). The fundamental value of the input asset can therefore be found when all investors are long-term shareholders, so all firms are long-term value maximisers. If a firm of type τ invests in the business-as-usual technology then it generates an expected long-run payoff of r. If instead it invests in the risky technology then it invests at a scale of $1/P$ and so its expected payoff is $\bar{R}\tau/P$. It is immediate that if a firm of type τ would invest in the risky technology, so would all firms of higher type. Market clearing at the fundamental price P^f requires that the total supply of the input asset is bought. Define the function $q(y)$ as the type for which there exists a mass y of higher type firms: thus $G[q(y)] := 1 - y$.

Lemma 1 *The fundamental price for the input asset exists and is uniquely defined by:*

$$\bar{R}q\big(bP^f\big)\big/\,P^f = r \tag{2}$$

We now analyse the general model where firms are owned by shareholders with a probability L of a liquidity shock and so early sale. A strategy for the Board of each firm is a decision function that maps the privately known firm type and the publicly known shareholder time horizon to a choice between developing the risky or the business-as-usual technology. It follows that, observing the business model chosen, the market can make inferences as to the set of types from which the firm must be drawn. This will affect the price shareholders will receive if they sell early.

The Board seeks to maximise the aggregate expected value of the shareholders. The proportion $1 - L$ of the shareholders will be long-term holders of the stock and see the realised payoffs. The expectation of this payoff is $\bar{R}\tau/P$ as the Board is aware of the true type τ of the firm. The proportion L of shareholders will be short-term owners and sell their holding before the business results are realised. Thus what matters to these shareholders is the market price they receive for their stock. The value of the equity at the point of sale (end of $t = 1$) will be the market's expectation of the firm's payoff at $t = 2$ conditional on all publicly available information. Hence if a firm of type τ develops the risky technology then the Board's objective function at $t = 1$ is given by:

$$V^{\text{risk}}(\tau, L) = (1-L) \cdot \underbrace{\frac{\bar{R}\tau}{P}}_{\substack{\text{Board's anticipated} \\ t=2 \text{ payoff}}} + L \cdot \underbrace{\frac{\bar{R}}{P} \cdot E(\tau | \text{risky chosen})}_{\text{Equity value at end } t=1} \tag{3}$$

The first term on the right side of the equality is the value the Board anticipates the firm will have at $t = 2$. The second term is determined before profits are realised, it is the market's expectations at the end of $t = 1$ about the "type" of a firm that has chosen the risky technology. The objective function (3) follows from the assumption that the Board maximises the expected value of the shareholders who own the firm at the point of taking a business decision. The market's inference as to expected firm payoff depends upon the equilibrium strategy of the Board.

Lemma 2 *The Board's strategy takes a cut-off form: if firm type is above some level $\tilde{\tau}(L)$ then the Board decides to develop the risky technology; otherwise it develops the safe technology.*

The proof of Lemma 2 follows by noting that firms of higher type τ create greater expected value for their long-term shareholders from developing the risky technology than firms with lower type. Short-term shareholders are indifferent between all firm types that select the same technology. This is because firm type is private information and so not priced in until payoffs are realised. The partition of the type space then follows.

This brings us to the first main result of this analysis:

Proposition 1 *In an economy/industry with a probability L of short-term shareholder ownership:*

1. *Short-term shareholders create an upwards price distortion (bubble) in the price of the input asset: $P(L) > P^f$. This bubble becomes more severe the larger is the probability of short-term ownership $(dP(L)/dL > 0)$.*

2. *Inefficiently many firms develop the risky technology: $\tilde{\tau}(L) < \tau^f$. This mis-allocation grows in the probability of short-term ownership, L.*

3. *The input asset price is uniquely defined by:*

$$r = \frac{\bar{R}}{P} q(bP) + L \frac{\bar{R}}{bP^2} \int_{\tau = q(bP)}^{1} 1 - G(\tau)\, d\tau \tag{4}$$

4. *The ex ante cost of equity capital for a representative firm is increasing in the probability of short-term ownership, L.*

The Board of a firm is assumed to maximise the value of the shareholders who own the firm at the time a business decision is being taken. Therefore, in assessing whether to pursue a new risky technology, the Board is concerned with the path of their share price as well as the NPV maximising decision, (3). If an action can be taken that increases the market value of the firm's equity in the short-term then this is desirable as it will increase the payoff of short-term shareholders. As investors do not know the type of the firm, the short-run share price can be increased by pooling with high ability firms. It follows that some firms develop the risky technology so as to alter the information available to investors – even at the cost of some long-term value. Proposition 1 shows that such behaviour has far reaching equilibrium effects: it leads to cross-sectional distortions in technology choices; bubbles in input asset markets; and increases in the cost of capital.[8]

One of the main insights of our paper is that having shareholders with short time horizons in the downstream market should lead to bubbles in the market for the upstream asset, that is to distortions in the price of the input. This is a bubble in the sense defined by Allen et al. (1993) and Allen and Gale (2000), but perhaps not in the common use of the term as this is not a repeated game in which the asset price rises indefinitely. To understand the result suppose that there was no bubble in the price of the input asset which is at its fundamental level, P^f from (2). Each firm that pursues the risky technology will do so at a scale of $1/P^f$. Now consider the Board of a firm of type just below this cut-off level. At the fundamental price P^f for the input asset the NPV of the risky technology is below that of the business-as-usual option. Thus long-term shareholders would lose out slightly from a decision to invest in the risky technology. The NPV would fall in a continuous way as the firm type fell further from the cut-off level. However, if the firm did invest in the risky technology, then the market would infer, mistakenly, that the firm was drawn from the top portion of the type distribution. Hence the market value of the equity at the end of $t = 1$ would jump up discontinuously. This would represent a discontinuous gain for any shareholders who sell early, and so would outweigh the loss to the long-term shareholders in the firm's objective function.[9]

Therefore firms below the efficient cut-off type would be willing to buy the input asset at its fundamental price. This extra demand would force a jump in the price of the input asset. The jump is offset by a reduction in demand due to the higher price, which makes the risky asset less attractive and works against the initial increase in demand. The new equilibrium price is above P^f, but below the initial jump. Hence a bubble is created

[8]Note that, in this model, firms that choose the business-as-usual technology are not affected by the distortions caused by the presence of short-term shareholders. This follows as the price of the input required for the low-risk technology is not altered by reductions in demand. If it were then the comparison between the two technology choices would be exacerbated, strengthening our results.

[9]The $t = 1$ share price is not raised here by the absence of short-sellers (Lamont (2012)). Neither long nor short-term shareholders have privileged information at $t = 1$ as to whether the firm is at the top or bottom end of the ability range with respect to the risky technology. The share price is the market's expected value of the firm's type conditional on all available public information.

in the input asset. Moreover, the Board's willingness to sacrifice long-run value for the sake of a short-term boost in stock price is increasing with the probability of short-term ownership.

The increasing mis-allocation of firms to the risky technology is then an implication of market clearing. As the probability of short-term ownership grows, so the price of the input asset rises. Although an increase in the price of the risky input reduces the incentive to invest in the risky asset, the impact of short-termism on the Board's objective function dominates. Thus as the probability of short-term ownership in the economy or industry increases, the proportion of firms that develop the risky technology grows, moving further away from the first-best.

The mis-allocation effect has an immediate and important consequence for the cost of equity capital. All investors realise that as the probability of short-term ownership in an industry or economy increases, more firms will be drawn into developing the risky technology at the expense of long-run value. Hence, ex ante at the investment stage $(t = 0)$, there is a greater probability that a firm will choose a business line not in its long-term interests. This is a cross-sectional mis-allocation effect that lowers the $t = 0$ expected value of firms. Further, there is also a second equilibrium effect. An increase in the probability of short-term ownership raises the price of the input asset and so lowers the expected value of any firm developing the risky technology. Thus when a firm chooses to pool and boost its short-term share price it imposes a negative externality on other firms through its impact on input prices. Both of these effects lower the value of firms at $t = 0$. A lower market value of the firm at $t = 0$ would mean that if a firm wished to raise equity capital it would need to sell a larger share of its future profits for a given dollar level of investment at $t = 0$. Hence the cost of equity capital rises with the probability of short-term ownership. This result offers support for the policy objective suggested in both the U.K. and the U.S. that shareholders should be encouraged to be long-term holders of a stock.[10]

The cost of capital result in Proposition 1 has empirical bite, and so is testable. In Section 6.2 of the empirical discussion we outline the cross-country implications as hypothesis H1. We survey the available research and conduct a meta-analysis of the statistical evidence, finding some support for H1. However the evidence is not conclusive, opening a door to future empirical cross-country comparisons.

Finally we confirm that in equilibrium the $t = 1$ market price of a firm that selects the risky technology is always greater than the return of the low-risk project:

Claim 1 $\frac{\bar{R}}{P(L)} E\left(\tau \,|\tau > \tilde{\tau}\left(L\right)\right) \; > \; r$ *for all* $L < 1$.

Proof. See Appendix A. ■

[10] See footnote 2 and the discussion that refers to it.

If all investors were short-term ($L = 1$) then all firms would select the technology that maximized the $t = 1$ share price. Equilibrium therefore would require $P(L)|_{L=1}$ to adjust so that the $t = 1$ value from the two technologies are identical. The proof then shows that if the probability of short-termism is reduced, the expected type for a firm that chooses the risky technology increases and the price of the input asset falls; delivering the result.

5 Manifestations of Short-termism

We now extend our results above by relaxing some of the assumptions in our model. In this way we are able to further generalize our results as well as propose additional predictions that may be tested empirically. First we relax our assumption that the risky asset is supplied inelastically. Next we allow that the market might underestimate the level of short-termism among investors. Finally we consider the impact of better information about firms on the extent of distortion in the market. We briefly present the main results of each extension, relegating the technical discussions and all the proofs to Appendix B. The testable empirical hypotheses from these extensions are developed in Section 6.

5.1 Elasticity of Supply of the Input Asset

In our analysis above we assumed a fixed supply of the input asset. Here we extend these results by allowing the supply of the input to respond to changes in market price. In particular we assume an elastic supply function with a constant price elasticity denoted $\zeta \geq 0$.[11]

Proposition 2 *The extent of mis-allocation to the risky technology grows with the elasticity of supply of the input asset,* $(\partial\tilde{\tau}/\partial\zeta < 0)$.

Proof. Contained in Appendix B.1. ■

Proposition 2 states that, holding the proportion $L > 0$ of short-term shareholders in the economy fixed, the mis-allocation of firms to the risky technology grows with the elasticity of supply. To see why, consider the marginal firm type that just elects to develop the risky technology, and consider the thought experiment of increasing the elasticity of supply of the input asset. The increase in elasticity of supply must lead to an increase in the volume of the input asset on the market. If there were no change in the identity of the marginal firm, the price of the input asset would fall to allow the extra supply to be absorbed. The marginal firm will now however benefit from a lower input price and so strictly benefit from developing the risky technology. This is a contradiction to the firm

[11] Formally we study the constant elasticity of supply function, $S(P) = b \cdot \left(P/P^f\right)^{\zeta}$. The full analysis, as noted above, is given in Appendix B.

being marginal, and so more firms will find it profitable to develop the risky technology for the short-run pooling value. Hence the mis-allocation effect is exacerbated.[12]

Proposition 2 complements the theoretical results given as Proposition 1 by demonstrating that the distortion in the number of firms that choose the risky technology due to short-termism is robust to price elasticity in the supply of the input asset. Indeed Proposition 2 generates a theory linking short-term shareholders to increases in the supply and price of the input asset required for the high risk technology. A motivating example that inspired us to pursue this work has been the financial crisis, with the input asset being represented by sub-prime mortgages. We develop this parallel at the end of the empirical discussion in Section 6.2.4.

5.2 Imperfect Capital Markets

Thus far this study assumes that the probability of short-term ownership is observed both by the Board and by the financial markets. In this section we allow for the possibility that the capital markets mis-estimate the probability of short-term ownership for any given firm. We demonstrate that this mis-estimation of the extent of short-term pressure firms are under generates excess returns whose sign varies over time.

Suppose the Board of a firm is aware that a proportion L of the shareholder base wish to maximise the early ($t = 1$) share price. However suppose the financial markets believe that the probability of short-term ownership considered by the Board is L^o. This incorrect belief of the markets is what we mean by the capital markets not being perfect.

Proposition 3 *If the market underestimates the extent of short-term pressure on the Board* ($L > L^o$) :

1. *On average the firm will generate positive excess returns between* $t = 0$ *and* $t = 1$. *This excess return grows with the true probability of short-termism,* L.

2. *However, on average the firm will generate negative excess returns between* $t = 0$ *and* $t = 2$. *This excess return becomes more negative as the true probability of short-termism,* L, *increases.*

Proof. Contained in Appendix B.2. ■

Proposition 3 captures that in our model an under-estimation of the extent of short-termism in a market would generate an $\cap$ shaped path to excess returns. An over-estimation by the market would have the inverse effect. Given market beliefs L^o, the

[12] Though a full welfare analysis is not possible, we are able to show that elasticity in the supply of the input asset has two opposing effects. The reduction in the price of the input due to more elastic supply leads to firms developing the risky technology at greater volume, increasing output and in turn welfare. However, a more elastic supply leads to an increase in the misallocation of firms to the risky technology (Proposition 2), reducing long-run profits, and therefore welfare. The overall implications of elastic supply are therefore a priori ambiguous and likely depend upon the functional forms studied.

$t = 0$ value of a firm reflects the expected returns from the firm's anticipated choice of technology. If the market under-estimates the extent of short-termism, $L > L^o$, then the Board applies greater weight to its short-term value than the market allows for. This would lead to the risky technology, with its greater signalling value, being chosen with a higher probability than expected. The $t = 1$ market value would increase on average as a result, rising above the expected level and generating positive excess returns. This effect is increasing with the market's under-estimation of short-termism. In the long run, however, the technology choice of the firm becomes more distorted than expected. Therefore the realised long-run returns are more often lower than expected, generating negative excess returns on average. This under-performance becomes larger as the mismatch between market beliefs and short-term reality increases.

Proposition 3 generates testable predictions that we develop as hypothesis H2 and test using a meta-analysis of U.S. and German data. This analysis follows in Section 6.2.2.

5.3 Market Learning From Signals As To Firm Type

The information asymmetry between the firm and investors has played a key role in this analysis. The Board sees value in pooling with high ability firms as this alters the information environment of investors and may boost the near-term share price of the firm. One natural question to ask is: would the distortions described above necessarily diminish if investors were better informed about firms' types? In this section we explore the effect of providing investors an informative signal of firm type. We will see that the presence of a positive but noisy signal may amplify the benefit from pooling, exacerbating the distortion caused by the presence of short-term investors.

Suppose that before any investment decisions are made ($t = 0$) shareholders receive a noisy signal about firm i's type, z_i :

Proposition 4 *Suppose that short-term shareholders are present* $(L > 0)$ *. For a range of sufficiently positive signals (*z_i *sufficiently close to the highest type,* 1*), firm misallocation to the risky technology is greater than without a signal and is increasing as the signal becomes more positive.*

Proof. Contained in Appendix B.3. ■

Proposition 4 demonstrates that better information about a firm's type does not necessarily reduce market distortion, and can in fact exacerbate the inefficient allocation to the risky technology. The intuition for these results is rooted in the cause of distortion from our base model. Recall that in our model of short-term owners, firms whose type fell just below the first best cutoff $\left(\tau^f\right)$ would do better to choose the risky technology in order to increase the $t = 1$ share price. By pooling with the higher-type firms and choosing the inappropriate technology these firms send an inaccurate signal to the market about their type, boosting their short-term value. Here we demonstrate that the presence of an additional noisy signal would amplify this effect for a low type firm that, by luck, received a sufficiently positive signal. A high enough signal as to firm type would increase the benefit from pooling with higher-type firms as investors would infer that the firm was well placed to make high future profits. This increases the incentive of a marginal firm to choose the risky technology rather than revealing the inaccuracy of the positive signal to the market. As the signal is noisy this eventuality is always possible.

Proposition 4 can be developed into a testable hypothesis by considering the average performance of firms that receive positive signals as to their ability relative to other firms. We develop this as hypothesis H3 in Section 6.2.3.

6 Empirical Discussion

6.1 The Importance Of Studying Short-Term Shareholders

In the last decade empirical scholars have provided a body of evidence demonstrating that shareholder ownership durations differ across investors and firms, and that the differences appear to affect firm performance. Such evidence provides the foundation for our modelling assumptions; and gives relevance to our results. Gaspar et al. (2005) calculate a churn rate that they use to construct an index of short-term ownership for a sample of U.S. firms. They show that the time horizon of investors has explanatory power for a firm's returns from acquisition decisions. Derrien et al. (2013) follow a similar approach, though they categorise investors as either long or short-term, as we have modeled here. They then calculate an index of short-term ownership for each firm in their sample. This index variable is shown to have explanatory power for firms' investment decisions.

This evidence is all U.S. based. However investor time horizons are also likely to differ substantially across economies. To demonstrate this type of cross-country variation we construct a bespoke dataset of ownership history and propose a direct measure of short-termism for firms. We collected quarterly shareholder ownership data from 2011 and 2012 for the largest 100 firms by market capitalization in Germany, Austria and Switzerland. In addition we constructed a matched sample of 100 U.S. firms that were in identical 2-digit SIC codes in their primary business, and whose size was as near to the Germanic firms as possible. Our proposed measure of short-term ownership over one and two years is then constructed as follows:

$$\begin{bmatrix} \text{Percentage of} \\ \text{Short-termism} \\ \text{over } z \text{ quarters} \end{bmatrix} = \sum_{\substack{j \text{ named} \\ \text{on shareholder} \\ \text{register at} \\ \text{Dec 2012}}} \left\{ \begin{bmatrix} \text{\% common} \\ \text{stock owned by} \\ j \text{ at Dec 2012} \end{bmatrix} - \begin{bmatrix} \text{Minimum \% stock} \\ \text{held by } j \text{ over} \\ \text{prior } z \text{ quarters.} \end{bmatrix} \right\} \quad (5)$$

Equation (5) measures the proportion of common stock that has changed hands over the prior z quarters. Here we do not rely on investors' prior churn behaviour with respect to other stocks, but rather directly capture the issue of interest: what proportion of a firm's shares are actively in play. This measure complements those used in the existing literature and described above (e.g. Derrien et al. (2013), Gaspar et al. (2005)). Equation (5) allows for the fact that investors likely hold a diversified portfolio, the components of which are intended to yield returns over different time horizons. Prior measures have instead assigned a type to individual investors based on prior churn rates, implicitly requiring one to assume that investors maintain constant investment strategies and time frames. Figure 3 in Appendix C provides some intuition for our measure of short-termism. Summary statistics for the data set created are presented in Table 1 in Appendix C.

Using this constructed dataset we analyse to what extent short-termism in share ownership differs between the U.S. and the Germanic countries. We compare short-termism across countries over one year (2012 only) and two years (2011 and 2012). The results of these comparisons are depicted graphically in Figure 2. The Germanic firms experience significantly lower levels of short-termism than their matched U.S. counterparts. Over two years the top 100 Germanic firms have 19.5% short-term held common stock, whereas the companies in the matched U.S. sample have 37.4% short-term held common stock. This difference between the two samples is significant at the 1% level. Thus there is good reason to explore the effect of differing investor time-horizons across economies, and indeed across industries, as this paper does.

6.2 Empirical Predictions and Evidence

6.2.1 Short-term shareholders and higher costs of equity capital

One important implication of our theory is captured in Proposition 1, part 4, which can be expressed as a cross-country empirical hypothesis:

H1. *Firms' cost of equity capital is increasing in the probability of short-term ownership in the economy.*

Our theory predicts that short-term shareholders create pressure on firms to pursue business models that have positive signalling value in the short-term, at the expense of long-run value. This investment distortion increases the demand for the required input asset of the risky business model, raising its price. Hence capital is used less effectively by all firms that enter the riskier business (including those that would "correctly" choose this business model), raising the cost of capital for all firms.

Ideally one would like to test H1 directly by calculating the cost of equity capital across countries and comparing it to the prevalence of short-term investors in those countries. This has not yet been done, perhaps because estimating the equity cost of capital is subject

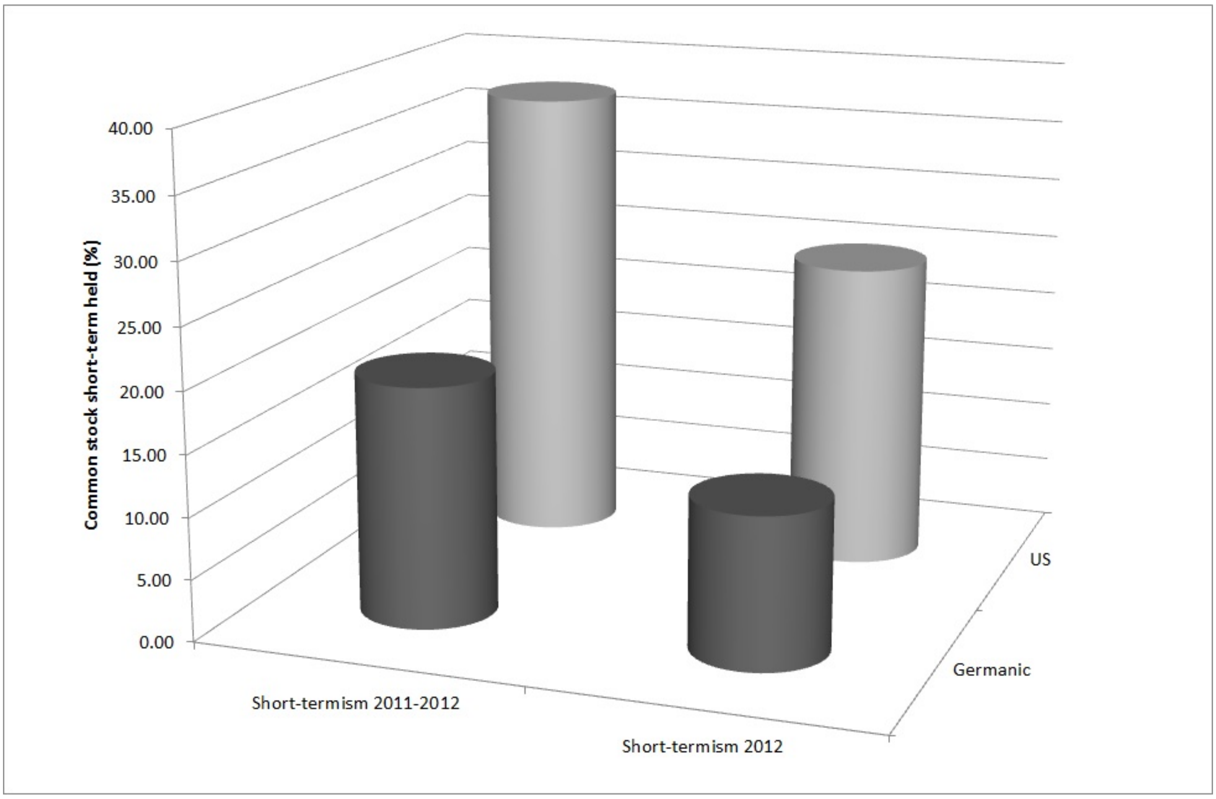


Figure 2: Comparison of Shareholder Short-Termism Between Germany/Switzerland/Austria and matched U.S. Firms

Notes: The graph depicts the mean short-termism amongst 81 of the top 100 firms in Germany, Switzerland and Austria. This is compared against the mean short-termism amongst the matched panel of firms in the United States. Short-termism is measured using construction (5). The data is drawn from CapitalIQ and measures short-termism in the period ending with Q4 2012. The matching is done by 2-digit SIC, followed by firm size. Only firms where ownership data existed for both the Germanic and the U.S. match were kept. The differences in the means are significant at the 1% level.

to significant empirical challenges. Fama and French (1997) document that combining realised returns with standard asset pricing models yields cost of capital estimates that are 'unavoidably imprecise.' There are competing approaches;[13] however in the absence of cross-country studies the direct evidence for or against H1 remains open.

To provide some insight into our hypothesis we instead offer a more innovative approach and consider evidence from mergers and acquisitions (M&A). The purchase of a target company is a purchase of an asset or set of assets; it is also a business model choice. To use data on M&A we must first extend our core model to allow for a merger bid announcement.

In our core model if the only option is the business-as-usual technology then the value of all firms is equal to r. The announcement of a bid for a target company discloses to the market that the buying firm is making a choice between business models. This is

[13]Botosan (1997) uses an accounting based approach; Gebhardt et al. (2001) use a residual income model.

analogous to the $t = 0$ stage of our model. The successful (or otherwise) completion of the acquisition process, which can take several months, would be the $t = 1$ stage.[14] The value of the firm at the merger bid announcement can be denoted $V|_{t=0}$ and is given by (11) in Appendix A as part of the proof of part 4 of Proposition 1.

Proposition 5 *The abnormal market returns (AR) on the firm making the merger bid announcement are:*

$$[AR] = V|_{t=0} - r = \int_{\tau=q(bP)}^{1} \left[\frac{\bar{R}}{P}\tau - r \right] g(\tau)\, d\tau \tag{6}$$

1. *The abnormal returns on the bid announcement decline in the probability of short-term ownership in the economy* $(d[AR]/dL < 0)$.

2. *The abnormal returns on the bid announcement are positive.*

Proof. Contained in Appendix D. ■

Part 1 of Proposition 5 constitutes an empirically testable hypothesis. As Germany/Switzerland enjoy lower rates of short-term ownership than the U.S. (Figure 2), we would expect acquirers in the U.S. to have smaller abnormal returns on the announcement of an acquisition bid than firms in Germany/Switzerland. At present there are no cross-country empirical studies that test this hypothesis. However, through a meta-analysis of the existing literature one can deduce some salient facts. Gaspar et al. (2005) using data covering 1980-1999 find that acquiring companies in the U.S. generate abnormal returns of -0.2% over a $[-1, +1]$ day window.[15] Citing numerous studies using older data Jensen and Ruback (1983) place the abnormal return to a merger announcement as between $+0.15\%$ and -0.05%. Abnormal returns for bidders in countries outside of the U.S. are less widely studied. Martynova and Renneboog (2006) study mergers in continental Europe. They determine a $[-1, +1]$ day CAR to bidding firms of $+0.96\%$ for Austria, $+0.73\%$ for Germany, and $+0.44\%$ for Switzerland. In complementary work Goergen and Renneboog (2004) determine a $[-2, +2]$ day window CAR for bidding companies in continental Europe excluding the U.K. of $+0.9\%$. These results are supportive of Proposition 5 part 1, and so of our model.

However some caution must be exercised. Firstly Mitchell et al. (2004) document that upon bid announcements in the United States, negative price pressure is created by merger arbitrageurs short-selling the acquirer's stock. If such arbitrageurs are more prevalent in the U.S. than in Germany/Switzerland then this would lead to a difference in the returns to bid announcements unrelated to our theoretical model. Secondly, the

[14] The $t = 2$ stage would be when the success or failure of incorporating and running the acquired company becomes apparent.

[15] We focus on the tight $[-1, +1]$ event window as returns to bidders over longer periods are likely affected by differences in takeover rules unrelated to short-termism in the economy.

meta-analysis contains studies that use differing time periods, and do not control for other known effects on bid premia, such as size and market concentration. In addition, it may be that a different mechanism to the one we have modeled connects short-term shareholders with reduced returns for acquirers upon a bid announcement. To motivate their empirical study Gaspar et al. (2005) propose that short-term shareholders may be less effective monitors of management and so acquisitions coming from firms with more short-term shareholders are more likely to be bad acquisitions. Gaspar et al. (2005) do not model their conjecture and so open questions remain with this alternative mechanism.[16] Finally Proposition 5 part 2 predicts that abnormal returns to a merger announcement should be positive. This is not the case in the evidence of Gaspar et al. (2005), though it is in the other studies. However the arbitrageur effect documented in Mitchell et al. (2004) would add a negative bias to returns and so may explain this.

6.2.2 Market underestimation of short-termism and abnormal returns

A second important result of this paper is provided by Proposition 3 which predicts abnormal market returns under the assumption that the market underestimates the extent of short-term pressure acting on a given firm. An immediate challenge to testing this implication of our theory is to determine calendar dates for the point at which a substantive business model choice is being made ($t = 1$ in our model). We therefore turn to data on M&A and again argue that the purchase of a target company is a purchase of an asset or set of assets and is a business model choice.

In our core model, if the market estimates that the proportion of short-term shareholders a firm has is L^o, but the reality is $L > L^o$, then after the firm selects the risky business model, the market assumes that the firm type is drawn from a relatively narrow band of the most able firms: $\tau \in [\tau^o(L^o), 1]$. The reality is that the excess short term pressure has made the risky business model attractive to a larger range of firm types: $[\tilde{\tau}(L, L^o), 1]$. Over the long run the firms will therefore under-perform the market expectation when the business model was chosen $(t = 1)$; yielding negative abnormal returns. This extension of Proposition 3 can be made rigorous:

Proposition 6 *The expected abnormal market returns between end $t = 1$ and $t = 2$ conditional on the risky business model being chosen are:*

$$\left[AR^{risk}\right] = \frac{\bar{R}}{P}\left\{E\left(\tau \left|\tau > \tilde{\tau}(L, L^o)\right.\right) - E\left(\tau \left|\tau > \tau^o(L^o)\right.\right)\right\} \tag{7}$$

1. *Expected abnormal returns between $t = 1$ and $t = 2$ conditional on the risky business*

[16] In particular the short-term shareholders used in the empirical analysis of Gaspar et al. (2005) are professional investors and so their ability to monitor would likely be higher than for many passive owners; further, professional investors would have a strong incentive to not allow management to lower the value of their investment.

model $\left[AR^{risk}\right]$ *decline as the true probability of short-termism,* L*, increases.*

2. *Expected abnormal returns between* $t = 1$ *and* $t = 2$ *conditional on the risky business model* $\left[AR^{risk}\right]$ *are negative.*

Proof. Contained in Appendix D. ■

This allows us to construct an empirically testable hypothesis:

H2. *Under the assumption that the market underestimates the extent of short-term pressure, on average the long-run abnormal returns following a completed acquisition will be more negative the greater the probability of short-term ownership in the economy.*

An empirical test of H2 is a test of both the model and the contention that the market underestimates the extent of short-term pressure acting on firms.[17] If in fact markets accurately account for short-term pressure then this model would predict zero long-run abnormal returns. An explicit test of H2 would require a substantial econometric exercise as the measurement of long-run returns is controversial (Barber and Lyon (1997), Kothari and Warner (1997)). However some indicative evidence can again be gleaned from studying the available statistical evidence. In the U.S. many studies have shown acquirers suffering significant negative abnormal long-run returns following a completed merger. A leading example is Loughran and Vijh (1997) who calculate a five year long-run post acquisition return of -15.9% for their U.S. sample. This figure has been disputed: Andrade et al. (2001) report a three year post acquisition abnormal return in the U.S. of -5.0% for their sample.

Given that Germany/Switzerland have lower rates of short-term ownership than the U.S. (Figure 2), H2 predicts that acquirers in the U.S. should have more negative long-run abnormal returns than acquirers in Germany/Switzerland. At present there are no cross-country empirical studies that test this hypothesis. Indeed we are aware of only one academic study which analyses the long-run abnormal returns to acquirers in Germany: Bühner (1991). This study predates the econometric critique of Barber and Lyon (1997) and so its results must be interpreted carefully. Bühner (1991) finds a long run CAR of -5.98% over a two year horizon running over months [1,24]. This is less negative than the level found by Loughran and Vijh (1997) and so is seemingly consistent with H2.

Overall however the evidence for or against H2 is currently thin as the available empirical studies differ in their time periods, types of firm studied, controls used, and empirical approaches to the estimation of abnormal returns. Thus this hypothesis remains an open question for future empirical research.

[17] Gaspar et al. (2005) suggest that share prices can take many months to account for short-termism amongst owners.

6.2.3 Short-term shareholders and the effect of information

A further testable result of our analysis is provided by Proposition 4 and concerns the effect of noisy information on firm investment decisions and hence returns. One source of noisy information about firms are industry awards, of which there are many in the international business arena. Examples include: the National Retail Federation of the U.S. *Gold Medal* and *International Retailer of the Year*[18]; and the Fragrance Foundation's *Most Popular Men* and *Most Popular Women* awards[19]. In these awards a small number of firms are first selected by judges as a short-list. The short-list is publicly announced. Subsequently the judges select one of these short-listed firms to be the award winner. These awards create a data set of firms who receive the most positive signal (the winners) and a linked set of firms who receive a good but less positive signal (the short-listed losers).

H3. *In the long-run the winners of an award should, on average, under-perform the otherwise-equal short-listed losers of the award. This effect should be most pronounced in economies characterised by short-term shareholders.*

Hypothesis H3 follows from Proposition 4, which argues that otherwise equal firms who received the most positive signals make investment decisions that are, on average, increasingly distorted in the strength of that signal. The winning of an award is a more positive signal than making the shortlist, which is itself a positive signal as to firm type. Hence Proposition 4 implies that the award winners will select the risky technology when it is inappropriate with greater probability. The first part of H4 thus follows: the long-run returns of award winners should lag behind those of their short-listed peer group. The misallocation to the risky business model identified in Proposition 4 arises because of the pressure generated by short-term shareholders. Hence, economies where short-termism is more prevalent should experience greater distortion. Thus H4 makes an international business prediction and so can further be tested in a cross-country study. To the best of our knowledge this hypothesis remains empirically untested.

6.2.4 The global financial crisis

The events of the financial crisis of 2007/2008 and the quote from the Citigroup CEO at the top of this paper are also consistent with the broader mechanisms of the model. Indeed the events that led up to the financial crisis were the driving force behind our writing of this paper. Starting in 2000 banks increasingly made the business decision to enter into the active trading of CDOs, and Citigroup was in lockstep with this crowd.[20]

[18] Won in 2015 by *Home Depot* and *Galaries Lafayette* respectively.

[19] Both won in 2014 by *Victoria's Secret*.

[20] For CDO market growth see Deutsche Bank (2007). For Citi's prominent position in this market see "Merrill, Citigroup Record CDO Fees Earned in Top Growth Market", Bloomberg, available at http://www.bloomberg.com/apps/news?pid=newsarchive&sid=a.FcDwf1.ZG4

This pooling of financial institutions into the market for CDOs led to large increases in abnormal returns to the Finance industry and an unprecedented demand for the required input asset: subprime mortgages. The inputs grew in volume at a rapid pace (subprime mortgages rose from 7.4% of the U.S. mortgage market in 2002, where it had been for at least the prior 5 years, to 23.5% of the whole U.S. mortgage market in 2006).[21] The inputs also grew in price, translating into lower yields, and so lower interest rates for subprime borrowers.[22] That Citigroup for one felt under pressure to conform and engage in this market is evidenced by the quote at the top of the Introduction.

7 Conclusions

We have proposed a theoretical model that explains why well-functioning Boards, while representing their shareholders' wishes, can choose business models for short-term reasons; create bubbles in input assets; and raise the cost of capital for an entire industry. As firm ownership norms differ across countries, so the implications of our analysis become country specific. We have shown that the largest German/Swiss/Austrian firms are under less short-term pressure from shareholders than similar U.S. ones. Hence our study predicts that firms in the U.S. are likely to come under more pressure to invest in new and fashionable technologies than their German equivalents. This creates negative spillovers on all firms through the costs of the input assets required for these business models. The relevance of this analysis to jurisdictions with greater family ownership, such as continental Europe and East Asia (Claessens et al. (2000), Faccio and Lang (2002)), depends on how protected these investors are from liquidity shocks.

Our model is designed to be tractable and to allow for the identification of the key forces that impact the cost of equity and the price of inputs. Here we discuss some possible extensions that can be explored in future research.

Short-termism Differing Across Firms The analysis is robust to the case of an exogenous distribution of shareholder time horizons across firms. For any given probability of short-term ownership, L, one would have a conditional distribution of firm types: $f(L, \cdot)$. For this conditional distribution the results of the analysis would apply. It would be more challenging to endogenise the time horizon of shareholders. This would require the relative asset prices of the firms to be endogenised in the context of shareholders who differ in their beliefs about firms' types.

Informed Trading by Insiders In our model all shareholders were uninformed as to the firm's type. Our theory is robust to allowing for some informed trading, as long

[21] Source: Table 5.2, p70, Financial Crisis Inquiry Commission (2011).

[22] Subprime interest rates dropped consistently after 2000, Figure 1 of Chomsisengphet and Pennington-Cross (2006).

as some uncertainty remains as to the Insider's reason for selling. If Insiders sell early then this contains some bad news, lowering the share price and mitigating the ex ante reason to distort technology choice. But a share premium would remain from the risky technology as the Insider might be selling for exogenous (e.g. liquidity shock) reasons. Hence the economics described in this paper hold.

Shareholder Activism In the model presented all shareholders carry equal weight according to their ownership proportion. Consider now if some of the shareholders are activists who can have a disproportionate impact on the behaviour of the firm. The presence of such activist investors on a firm's shareholder register would, in theory, alter our results in an ambiguous way: activists may have a long-term or a short-term focus. Bebchuk et al. (2015) offer evidence that activist shareholders improve the long-term profitability of firms they own suggesting that the primary effect is dominant.

A Proofs from Section 4

Proof of Lemma 1. The market clearing condition is that firms $\tau \in \left[\tau^f, 1\right]$ invest in the risky technology where the "first-best" cut-off type, τ^f, is determined by the fundamental price and given by

$$\int_{\tau=\tau^f}^{1} \frac{1}{P^f} g(\tau)\, d\tau = b \Rightarrow \tau^f = q\left(bP^f\right) \tag{8}$$

Market clearing requires the borderline firm τ^f to be indifferent between developing the risky and the safe technology. Hence the fundamental price P^f is defined implicitly by the relation in (2).

Rewrite (2) as $rP^f = \bar{R}q\left(bP^f\right)$. The left hand side is increasing in P^f. The right hand side is declining in P^f. Hence any solution to (2) must be unique. We have $\lim_{P^f \to 0} \bar{R}q\left(bP^f\right) = \bar{R} > \left[rP^f\right]_{P^f=0}$ and $\lim_{P^f \to 1/b} \bar{R}q\left(bP^f\right) = 0 < \left[rP^f\right]_{P^f=1/b}$ hence a fundamental price exists by the Intermediate Value Theorem. ■

Proof of Lemma 2. Suppose otherwise that the Board's strategy was not a cut-off type of this form. Then there must exist two firm types $\tau_1 < \tau_2$ such that a firm of type τ_1 would strictly prefer to develop the risky technology whilst the firm with higher type τ_2 would strictly prefer to develop the business-as-usual technology. Hence we would have

$$V^{\text{risk}}(\tau_1, L) > r > V^{\text{risk}}(\tau_2, L) \tag{9}$$

However, from (3), $\frac{\partial}{\partial \tau} V^{\text{risk}}(\tau, L) = (1 - L)\, \bar{R}/P > 0$ as $L < 1$. A contradiction to (9). ■

Proof of Proposition 1. We first determine the equilibrium input asset price in part 3. Using the cut-off property of Lemma 2, market clearing (8) implies firms with type $\tau \in [q(bP), 1]$ will develop the risky technology. Each firm will buy $1/P$ units of the input asset. Applying Bayes rule, the expected type at end $t = 1$ of a firm that develops the risky technology is

$$E\left(\tau \mid \tau \in [q(bP), 1]\right) = \frac{\int_{\tau=q(bP)}^{1} \tau g(\tau)\, d\tau}{1 - G(q(bP))} = \frac{1}{bP}\left\{q(bP)\, bP + \int_{\tau=q(bP)}^{1} 1 - G(\tau)\, d\tau\right\} \tag{10}$$

Using an integration by parts. Market clearing requires that, in equilibrium, firm type $q(bP)$ be indifferent between developing the risky technology and the business-as-usual technology. Hence, substituting (10) into (3) and evaluating at type $q(bP)$ we require:

$$r = (1 - L)\frac{\bar{R}q(bP)}{P} + L\frac{\bar{R}}{bP^2}\left\{q(bP)\, bP + \int_{q(bP)}^{1} 1 - G(\tau)\, d\tau\right\}$$

This can be simplified to yield (4). Existence and uniqueness follow by multiplying (4) through by P, noting the right hand side is declining in P, and applying the Intermediate Value Theorem on prices $P \in \{0, 1/b\}$ in conjunction with assumption (1). This yields part 3.

Now consider part 1. Define the function $W(P)$ equal to the right hand side of (4), so at equilibrium $r = W(P)$. The sensitivity of the market price to the probability of short-term ownership is $dP/dL = -(\partial W/\partial L)/(\partial W/\partial P)$. By inspection we see that $\partial W/\partial L > 0$. For the denominator we explicitly find

$$\frac{\partial W}{\partial P} = q'(bP)\, b\frac{\bar{R}}{P}(1 - L) - \bar{R}\frac{q(bP)}{P^2} - 2L\frac{\bar{R}}{bP^3}\int_{\tau=q(bP)}^{1} 1 - G(\tau)\, d\tau < 0$$

The inequality follows as $q'(\cdot) < 0$. Hence $dP/dL > 0$, and we have the first result.

For part 2 note that firms of type $\tau \in [q(bP), 1]$ develop the risky technology, and as $dP/dL > 0$, this range expands with the probability of short-term ownership.

For part 4 at $t = 0$ the market value of the equity of a randomly drawn firm is given as

$$V = \int_{\tau=0}^{q(bP)} r g(\tau)\, d\tau + \int_{\tau=q(bP)}^{1} \frac{\bar{R}}{P}\tau g(\tau)\, d\tau \tag{11}$$

This follows as firms of type $\tau \in [q(bP), 1]$ will develop the risky technology. To raise one dollar from equity investors at $t = 0$ an entrepreneur must offer a proportion $1/V$ of his firm. The cost of equity capital therefore moves inversely to V. Implicit differentiation of expected firm value yields:

$$\frac{dV}{dL} = \frac{dP}{dL}\cdot\left\{q'(bP)\, bg(q(bP))\left[r - \frac{\bar{R}}{P}q(bP)\right] - \int_{\tau=q(bP)}^{1} \frac{\bar{R}}{P^2}\tau g(\tau)\, d\tau\right\}$$

We have shown $P > P^f$, and so from (2) $r > \bar{R}q(bP)/P$ as $q'(\cdot) < 0$. Given $dP/dL > 0$, we have $dV/dL < 0$ as required. Hence a greater probability of short-term ownership raises the firm cost of equity capital. ■

Proof of Claim 1. In equilibrium at $L = 1$ we must have indifference in $t = 1$ valuation between both technologies. Hence from (3) $r = \left[\frac{\bar{R}}{P(L)} E\left(\tau \left| \tau > \tilde{\tau}(L)\right.\right)\right]_{L=1}$. Now consider lowering L. We have $P'(L) > 0$ from proposition 1 part 1 so the denominator shrinks as L falls. The claim follows if $\frac{d}{dL} E\left(\tau \left| \tau > \tilde{\tau}(L)\right.\right) < 0$. We have

$$\frac{d}{dL}\int_{\tilde{\tau}}^{1} \frac{\tau g(\tau)}{1 - G(\tilde{\tau})} d\tau = \frac{d\tilde{\tau}}{dL} \cdot \frac{g(\tilde{\tau})}{\left[1 - G(\tilde{\tau})\right]^2} \left\{ \int_{\tilde{\tau}}^{1} \tau g(\tau)\, d\tau - \tilde{\tau}\left[1 - G(\tilde{\tau})\right] \right\} < 0$$

as $\frac{d\tilde{\tau}}{dL} < 0$ from Proposition 1 part 2, completing the proof. ■

B Manifestations of Short-termism: Further Details

B.1 Elasticity of Supply of the Input Asset

We first develop the study of an elastically supplied input asset and prove Lemma 3. This then allows us to build up to the proof of Proposition 2.

Suppose that the supply, $S(P)$, of the input asset responds to price according to the constant elasticity of supply function:

$$S(P) := b \cdot \left(\frac{P}{P^f}\right)^{\zeta} \tag{12}$$

The supply function (12) is normalised so that absent short-term shareholders, the fundamental price of the input asset is invariant at the level P^f given by (2) for any elasticity, ζ.[23] Therefore, absent short-term shareholders, the first best situation would have types $\left[\tau^f, 1\right]$ investing in the risky technology. We augment (1) and restrict attention to parameters such that:

$$b < \frac{r}{\bar{R}} \cdot \left(\frac{r}{\bar{R}} P^f\right)^{\zeta} \tag{13}$$

This is sufficient to ensure existence of the equilibrium price for any given elasticity of supply, ζ.

Lemma 3 *In an industry with elasticity of supply ζ and with L short-term shareholders, the critical firm type, $\tilde{\tau}$, that just selects the risky technology satisfies*

$$\frac{r}{\bar{R}} \left[\frac{\left(P^f\right)^{\zeta}}{b}\left(1 - G(\tilde{\tau})\right)\right]^{\frac{1}{1+\zeta}} = \tilde{\tau} + \frac{L}{1 - G(\tilde{\tau})} \int_{\tau=\tilde{\tau}}^{1} 1 - G(\tau)\, d\tau \tag{14}$$

[23] To see this, note that at $P = P^f$ the supply is b and the critical firm type is τ^f, given by (8).

Proof of Lemma 3. If the price of the input is P then market clearing with supply function (12) implies that the critical firm type satisfies

$$\int_{\tilde{\tau}}^{1} \frac{1}{P} g(\tau)\, d\tau = S(P) \Rightarrow \tilde{\tau} = q(P \cdot S(P)) = q\left(bP\left(\frac{P}{P^f}\right)^{\zeta}\right) \tag{15}$$

The critical firm type, given L, is indifferent between the risky and safe payoffs and so satisfies, using (3):

$$\begin{aligned} r &= (1-L)\frac{\bar{R}\tilde{\tau}}{P(\tilde{\tau})} + L\frac{\bar{R}}{P(\tilde{\tau})}\frac{\int_{\tau=\tilde{\tau}}^{1} \tau g(\tau)\, d\tau}{1-G(\tilde{\tau})} \\ &= (1-L)\frac{\bar{R}\tilde{\tau}}{P(\tilde{\tau})} + L\frac{\bar{R}}{P(\tilde{\tau})}\frac{\left[\tilde{\tau} - \tilde{\tau}G(\tilde{\tau}) + \int_{\tilde{\tau}}^{1} 1-G(\tau)\, d\tau\right]}{1-G(\tilde{\tau})} \end{aligned}$$

From (15) we have $G(\tilde{\tau}) = 1 - bP\left(P/P^f\right)^{\zeta}$. Using this to substitute for P yields (14).

The critical type $\tilde{\tau}$ exists by applying the intermediate value theorem to (14) at $\tilde{\tau} \in \{0,1\}$ and using (13). For uniqueness note that the left hand side of (14) is decreasing in $\tilde{\tau}$. Differentiation confirms that the right hand side is increasing in $\tilde{\tau}$. ■

Lemma 3 allows us to establish Proposition 2 demonstrating that the mis-allocation described in Proposition 1 is robust to an elastically supplied input asset.

Proof of Proposition 2. We first confirm the misallocation to the risky-technology: $\tilde{\tau} < \tau^f$ given in (8). Evaluating (14) at τ^f yields:

$$\text{LHS} = \frac{r}{\bar{R}}\left[\frac{\left(P^f\right)^{\zeta}}{b}\left(bP^f\right)\right]^{\frac{1}{1+\zeta}} = \frac{rP^f}{\bar{R}} =_{(2)} \tau^f < \tau^f + \frac{L}{bP^f}\int_{\tau=q\left(bP^f\right)}^{1} 1-G(\tau)\, d\tau = \text{RHS}$$

As the left hand side of (14) is decreasing in $\tilde{\tau}$, while the right hand side is increasing, we must have $\tilde{\tau} < \tau^f$. Next note that as the price is given in (15), so $P > P^f$.

Now we show the result. The critical firm type $\tilde{\tau}(\zeta, L)$ is given by (14). Differentiating with respect to ζ:

$$\begin{aligned} & -\frac{r}{\bar{R}}\left[\frac{\left(P^f\right)^{\zeta}}{b}(1-G(\tilde{\tau}))\right]^{\frac{1}{1+\zeta}} \frac{1}{(1+\zeta)^2}\ln\left[\frac{1-G(\tilde{\tau})}{bP^f}\right] \\ =\ & \frac{\partial \tilde{\tau}(\zeta, L)}{\partial \zeta}\left\{\begin{array}{c} \frac{r}{\bar{R}}\frac{1}{1+\zeta}P^f\left[\frac{1-G(\tilde{\tau})}{bP^f}\right]^{\frac{1}{1+\zeta}}\frac{g(\tilde{\tau})}{1-G(\tilde{\tau})} + (1-L) \\ +L\frac{g(\tilde{\tau})}{[1-G(\tilde{\tau})]^2}\int_{\tau=\tilde{\tau}}^{1} 1-G(\tau)\, d\tau \end{array}\right\} \end{aligned}$$

It follows that

$$\frac{\partial \tilde{\tau}(\zeta, L)}{\partial \zeta} =_{\text{sign}} -\ln\left[\frac{1-G(\tilde{\tau})}{bP^f}\right] =_{(15)} -\ln\left[\left(\frac{P}{P^f}\right)^{\zeta+1}\right] < 0$$

As we have already shown $P > P^f$. ■

B.2 Imperfect Capital Markets

Here we develop the machinery to study mis-estimation by capital markets of the short-term pressure on firms, and build up to the proof of Proposition 3 below.

We use a partial equilibrium analysis, fixing the price of the input asset at P. Given the financial markets' belief about the probability of short-term ownership, L^o, the critical firm type, $\tau^o(L^o)$, that would choose the risky technology would be given implicitly, using (3), by:

$$r = L^o \cdot X_1^{\text{orisk}} + (1 - L^o) \frac{\bar{R}}{P} \tau^o(L^o) \tag{16}$$

The term X_1^{orisk} is the market's $t = 1$ valuation of a firm that has chosen the risky technology. Equation (16) captures the market's awareness that short-term shareholders cause the Board to weight the path of the share price as well as the long-run net present value. The term X_1^{orisk} is given by:

$$X_1^{\text{orisk}} = \frac{\bar{R}}{P} \int_{\tau^o(L^o)}^1 \frac{\tau g(\tau)}{1 - G(\tau^o(L^o))} d\tau \tag{17}$$

Substituting (17) into (16) gives the critical firm type, $\tau^o(L^o)$, expressed implicitly in terms of fundamental parameters $(\bar{R}, P)$ and the market's belief, L^o. We can therefore calculate the $t = 0$ ex ante equity value of a randomly drawn firm as:

$$V_{t=0}^o = rG(\tau^o(L^o)) + \frac{\bar{R}}{P} \int_{\tau^o(L^o)}^1 \tau g(\tau) d\tau \tag{18}$$

We are now in a position to prove Proposition 3 above.

Proof of Proposition 3. Given market beliefs, the critical firm type for the firm is given by $\tilde{\tau}(L, L^o)$ where

$$r = L \cdot X_1^{\text{orisk}} + (1 - L) \frac{\bar{R}}{P} \tilde{\tau}(L, L^o) \Rightarrow \frac{\bar{R}}{P} \tilde{\tau}(L, L^o) = \frac{r - L \cdot X_1^{\text{orisk}}}{(1 - L)} \tag{19}$$

The market value of a firm at time $t = 1$ will be X_1^{orisk} if the firm is drawn from $[\tilde{\tau}(L, L^o), 1]$ and r otherwise. Hence the average $t = 1$ market value is

$$V_{t=1}^o = G(\tilde{\tau}(L, L^o)) r + [1 - G(\tilde{\tau}(L, L^o))] X_1^{\text{orisk}} \tag{20}$$

The excess return between $t = 0$ and $t = 1$ is given by the difference between (20) and (18). The value of the firm at $t = 0$ can be written $rG(\tau^o(L^o)) + [1 - G(\tau^o(L^o))] X_1^{\text{orisk}}$.

Hence the $t = 1$ excess return is

$$V^o_{t=1} - V^o_{t=0} = \left[G\left(\tau^o\left(L^o\right)\right) - G\left(\tilde{\tau}\left(L, L^o\right)\right)\right] \cdot \left(X_1^{\text{orisk}} - r\right)$$

Now note from (17) that $X_1^{\text{orisk}} > \bar{R}\tau^o\left(L^o\right)/P$. Therefore if $\bar{R}\tau^o\left(L^o\right)/P \geq r$ then (16) would yield a contradiction. It follows that $\bar{R}\tau^o\left(L^o\right)/P < r$, and so (16) implies that $X_1^{\text{orisk}} > r$. Also from (19)

$$\frac{d}{dL}\tilde{\tau}\left(L, L^o\right) =_{\text{sign}} -X_1^{orisk}\left(1 - L\right) + \left[r - L \cdot X_1^{orisk}\right] = r - X_1^{orisk} < 0 \tag{21}$$

And so as $L > L^o$ we have $\tilde{\tau}\left(L, L^o\right) < \tilde{\tau}\left(L^o, L^o\right) = \tau^o\left(L^o\right)$. Hence we have shown that $V^o_{t=1} - V^o_{t=0} > 0$. Differentiating we have

$$\frac{d\left[V^o_{t=1} - V^o_{t=0}\right]}{dL} = -g\left(\tilde{\tau}\left(L, L^o\right)\right)\underbrace{\left(X_1^{\text{orisk}} - r\right)}_{>0} \cdot \underbrace{\frac{d}{dL}\tilde{\tau}\left(L, L^o\right)}_{<0} > 0$$

Yielding the $t = 1$ excess returns result.

Now consider the realised values produced at $t = 2$. The market's beliefs will now be irrelevant as the payoffs can be observed. Firms with types in the range $\left[\tilde{\tau}\left(L, L^o\right), 1\right]$ will have developed the risky technology. On average the payoffs realised will be

$$V_{t=2} = G\left(\tilde{\tau}\left(L, L^o\right)\right) r + \int_{\tilde{\tau}\left(L, L^o\right)}^{1} \frac{\bar{R}}{P}\tau g\left(\tau\right) d\tau \tag{22}$$

Compared to $t = 0$ the excess return is given by the difference between (22) and (18). Using that $\tilde{\tau}\left(L, L^o\right) < \tau^o\left(L^o\right)$ this is:

$$\begin{aligned} V_{t=2} - V^o_{t=0} &= -\left[G\left(\tau^o\left(L^o\right)\right) - G\left(\tilde{\tau}\left(L, L^o\right)\right)\right] r + \int_{\tilde{\tau}\left(L, L^o\right)}^{\tau^o\left(L^o\right)} \frac{\bar{R}}{P}\tau g\left(\tau\right) d\tau \\ &= -\int_{\tilde{\tau}\left(L, L^o\right)}^{\tau^o\left(L^o\right)} \left[r - \frac{\bar{R}}{P}\tau\right] g\left(\tau\right) d\tau < 0 \end{aligned}$$

where the inequality follows as we noted $\bar{R}\tau^o\left(L^o\right)/P < r$. Hence the excess return is negative. Differentiating we have

$$\frac{d\left[V_{t=2} - V^o_{t=0}\right]}{dL} = \left(r - \frac{\bar{R}}{P}\tilde{\tau}\left(L, L^o\right)\right) g\left(\tilde{\tau}\left(L, L^o\right)\right) \cdot \frac{d}{dL}\tilde{\tau}\left(L, L^o\right)$$

From (21), $d\tilde{\tau}\left(L, L^o\right)/dL < 0$. Given $X_1^{\text{orisk}} > r$, (19) implies that $\bar{R}\tilde{\tau}\left(L, L^o\right)/P < r$ and so $d\left[V_{t=2} - V^o_{t=0}\right]/dL < 0$ as required. ■

B.3 Market Learning From Signals As to Firm Type

Here we develop a tractable model of the signal of firm type before building up to the proof of Proposition 4.

Recall that in the benchmark model the critical type ($\tilde{\tau}$) indifferent between choosing the risky technology and the risk-free technology is given implicitly by:

$$r - \frac{\bar{R}\tilde{\tau}}{P}(1-L) = L\frac{\bar{R}}{P}E(\tau|\tau \geq \tilde{\tau}) \tag{23}$$

Now suppose that before any investment decisions are made ($t = 0$) shareholders receive a signal about firm i's type, $z_i \in [0, 1]$. We assume that this signal gives the true firm type, τ_i, with probability s, otherwise it contains no information. The market will use Bayes' rule to update their beliefs as to firm i's type:

$$E(\tau_i|z_i) = sz_i + (1-s)\int_0^1 \tau g(\tau)d\tau \tag{24}$$

The presence of the signal will alter the posterior distribution of τ_i and so alter the critical value of τ for firm i to chose the risky technology, to $\tilde{\tau}_i$. If $z_i < \tilde{\tau}_i$ and the firm selects the risky technology regardless then the market knows for sure that z_i is not true, and therefore ignores the signal. If $z_i \geq \tilde{\tau}_i$ and the risky technology is chosen the market's expectation of firm i's type is:

$$E(\tau_i|z_i \geq \tilde{\tau}_i, \tau_i \geq \tilde{\tau}_i) = sz_i + (1-s)\int_{\tilde{\tau}_i}^1 \frac{\tau g(\tau)}{1-G(\tilde{\tau}_i)}d\tau \tag{25}$$

Now we are able to prove Proposition 4.

Proof of Proposition 4. First we show that for sufficiently positive signals, firm misallocation to the risky technology is greater than without a signal. That is $\tilde{\tau}_i < \tilde{\tau}$. The post signal cut off $\tilde{\tau}_i$ is determined implicitly as :

$$r - \frac{\bar{R}\tilde{\tau}_i}{P}(1-L) = L\frac{\bar{R}}{P}E(\tau_i|z_i, \tau_i > \tilde{\tau}_i) \tag{26}$$

Assume the signal is sufficiently strong that $z_i > E(\tau|\tau > \tilde{\tau})$. Evaluate (26) at $\tilde{\tau}_i = \tilde{\tau}$:

$$\begin{aligned}
[\text{LHS of } (26)]_{\tilde{\tau}_i=\tilde{\tau}} &\underset{(23)}{=} L\frac{\bar{R}}{P}\int_{\tilde{\tau}}^1 \frac{\tau g(\tau)}{1-G(\tilde{\tau})}d\tau \\
&< L\frac{\bar{R}}{P}\left\{sz_i + (1-s)\int_{\tilde{\tau}}^1 \frac{\tau g(\tau)}{1-G(\tilde{\tau})}d\tau\right\} = [\text{RHS of } (26)]_{\tilde{\tau}_i=\tilde{\tau}}
\end{aligned}$$

Where the inequality follows as we assumed $z_i > E(\tau|\tau > \tilde{\tau})$. Therefore as both sides of (26) are monotonic with respect to $\tilde{\tau}_i$ we must have that $\tilde{\tau}_i < \tilde{\tau}$ as claimed.

Next we show that the misallocation to the risky technology is increasing in the quality of the signal received. Differentiating (26) with respect to z_i and using (25) yields:

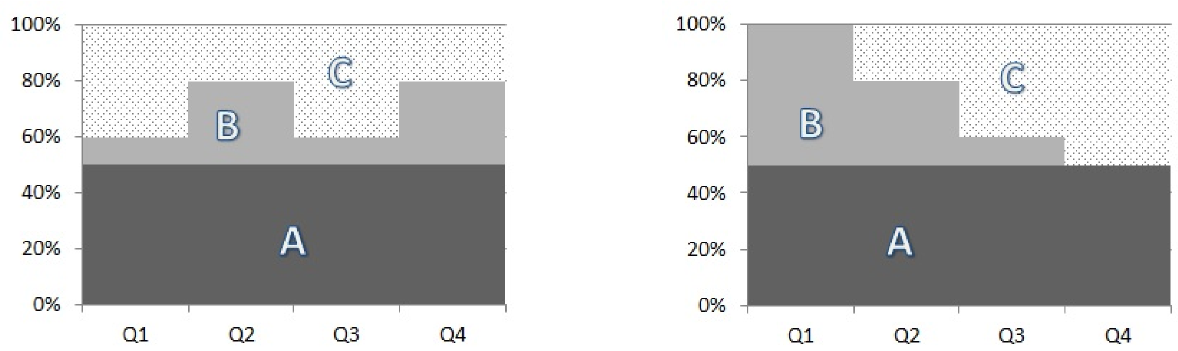
$$\frac{\partial \tilde{\tau}_i}{\partial z_i} = \frac{-Ls}{(1-L) + L(1-s)\frac{g(\tilde{\tau}_i)}{1-G(\tilde{\tau}_i)}\left[E(\tau_i|\tau_i \geq \tilde{\tau}_i) - \tilde{\tau}_i\right]} \quad < \quad 0 \tag{27}$$

demonstrating the result. ■

C Index of Short-termism

Figure 3 explains the short-termism measure constructed in equation (5). The examples presented consider ownership stakes over 4 consecutive quarters for fictitious owners A, B and C who are assumed to own 100% of the shareholder equity of a given company. Panel (a) demonstrates that volatile share ownership leads to stable short-term measures with no double counting. Panel (b) demonstrates that divestments are captured by equation (5) via the purchasing investor.

Summary statistics for the data set created by this index of short-termism are presented in Table 1.



(a) Volatile shareholder ownership example
Notes: Only the 20% of the shares that are oscillated between investors B and C are captured as short-term over the 4 quarters. Using equation (5):

$$\begin{bmatrix} \text{Percentage of} \\ \text{Short-termism} \\ \text{over 4 quarters} \end{bmatrix} = \begin{cases} 50-50 & \text{from } A \\ 30-10 & \text{from } B \\ 20-20 & \text{from } C \end{cases}$$
$$= 20\%.$$

(b) Shareholder B selling early example
Notes: At the end of Q4 the firm is owned solely by A and C. The full 50% bought by C is captured as short-term owned over the 4 quarters. Using equation (5):

$$\begin{bmatrix} \text{Percentage of} \\ \text{Short-termism} \\ \text{over 4 quarters} \end{bmatrix} = \begin{cases} 50-50 & \text{from } A \\ 50-0 & \text{from } C \end{cases}$$
$$= 50\%.$$

Figure 3: Graphical explanation of short-termism measure

Variable	Obs	Mean	Std. Dev.	Min	Max
Germanic Firms					
Market Value (U.S.$mm)[a]	81	33,200	47,900	5,120	244,000
SIC code	81	4320	1800	1311	9997
Short-term %CSO 2011-2012	81	19.5	12.8	2.34	72.3
Short-term %CSO 2012	81	12.3	10.5	0.788	68.1
U.S. Matched Firms					
Market Value (U.S.$mm)[b]	81	17,700	44,300	8.32	293,000
SIC code	81	4330	1800	1311	9997
Short-term %CSO 2011-2012	81	37.4	14.2	8.24	82.4
Short-term %CSO 2012	81	25.0	11.1	5.96	60.5

Table 1: Summary Statistics for Firm and Ownership Data

Notes: Data set constructed as follows: we first identified the 100 firms in the CapitalIQ database located in Germany, Switzerland or Austria with the highest market capitalization in 2014. We removed from the sample firms that had no or incomplete ownership data. This left 89 companies. The U.S. firm match was conducted using the Compustat North American Fundamentals Quarterly Database. The universe of firms' sizes for 2014Q4 was downloaded and the match determined algorithmically by (i) matching the first two digits of the SIC code; then (ii) selecting the firm with the smallest absolute difference in firm size. The ownership data for these U.S. firms is then extracted from CapitalIQ. In 4 cases a manual match was required as the algorithmic match had no ownership data, in 8 cases no match was possible. CSO is Common Stock Ownership. *Short-term %CSO 2011-2012* measures short-termism according to Equation (5). It captures the proportion of the common stock that has changed hands over the 8 quarters prior to Dec 31 2012. *Short-term %CSO 2012* measures short-termism over the 4 quarters prior to Dec 31 2012. [a] Market capitalisation data derived from CapitalIQ. [b] Market capitalisation data derived from Compustat.

D Proofs from Section 6.2

Proof of Proposition 5. Let $g(\cdot)$ be the density of firm types that announce a merger bid at $t = 0$. Using the cut-off property of Lemma 2, market clearing implies firms with type $\tau \in [q(bP), 1]$ will develop the risky technology and so will complete the acquisition. The $t = 0$ market value of the equity of a firm at announcement is therefore given by V in (11). The cumulative abnormal return to the bid announcement is therefore $V - r = V - \int rg(\tau)\, d\tau$ which gives (6).

Part 1 follows as $dV/dL < 0$ (Proposition 1 part 4). For part 2 we use Claim 1:

$$\begin{aligned} r &< \frac{\bar{R}}{P} E(\tau \,|\tau > q(bP)) = \frac{\bar{R}}{P} \frac{\int_{\tau=q(bP)}^{1} \tau g(\tau)\, d\tau}{1 - G(q(bP))} \\ &\Rightarrow r \int_{\tau=q(bP)}^{1} g(\tau)\, d\tau < \frac{\bar{R}}{P} \int_{\tau=q(bP)}^{1} \tau g(\tau)\, d\tau \Rightarrow [AR] > 0 \end{aligned}$$

■

Proof of Proposition 6. Conditional on the risky business model, the market believes the firm's type lies in $[\tau^o(L^o), 1]$. Hence the $t = 1$ value is given by $X_1^{o\text{risk}}$. However types $[\tilde{\tau}(L, L^o), 1]$ choose the risky business model, and so the expected $t = 2$ value conditional on the risky business model is in reality $\frac{\bar{R}}{P}\int_{\tilde{\tau}(L,L^o)}^{1} \frac{\tau g(\tau)}{1-G(\tilde{\tau}(L,L^o))} d\tau$. Subtracting one from the other yields (7). Proposition 3 demonstrates $d\tilde{\tau}(L, L^o)/dL < 0$, so part 1 follows. Proposition 3 demonstrates that $\tilde{\tau}(L, L^o) < \tau^o(L^o)$ given the assumption that $L > L^o$. Hence part 2 follows. ■

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