The Great Divorce Between Investment and Profitability

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Abstract

We study the cross-sectional relation between investment, profitability, and equity returns over the last century. The correlation between the investment and profitability factors is negative in the data from the 1920s to the late 1970s, and turned positive in the last four decades. The once positive association between firm investment and profitability in the cross-section also became strongly negative since the late 1970s. We ascribe this fundamental change to a downward shift in the discount rates of long-term cash flows, which we document in the data. We develop a model where firms invest in short- and long-term projects. Responding to low discount rates, firms invest more in long-term projects, reversing the cross-sectional relation between contemporaneous investment and profitability. Our model quantitatively accounts for the relation between investment and profitability as well as their corresponding return spreads before and after the late 1970s. Further evidence suggests that the rise of venture capital in the late 1970s may have played an important role in the divorce between investment and profitability.

Keywords: Investment, Profitability, Cash Flow Duration, Long-Term, CMA Factor, RMW Factor, Venture Capital.

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1. Introduction

“Because of our emphasis on the long term, we may make decisions and weigh tradeoffs differently than some companies. [...] We will continue to make investment decisions in light of long-term market leadership considerations rather than short-term profitability considerations or short-term Wall Street reactions.”

— Jeffrey P. Bezos, “Amazon.com 1997 Letter to Shareholders” (page 1)

We document a schism in the late 1970s between the investment and profitability return factors and between their associated firm characteristics: Figure 1 shows that the time-series correlation between the factors flipped from highly negative to positive, while Figure 2 illustrates that the cross-sectional correlation between firm investment and profitability changed from positive to negative.\(^1\) Additionally, Fama and French (2015) and Hou et al. (2015) have shown that both investment and profitability factors are important for explaining the cross-section of stock returns in recent decades, but Linnainmaa and Roberts (2018) present evidence that both factors earned insignificant average returns in the era predating the Compustat database. In this paper, we present a single economic mechanism that links the changes in the correlation between the factor returns, the changes in the correlation between the firm characteristics, and the changes in the average factor returns. We argue that, if firms can choose between immediately profitable short-term projects and long-term projects with delayed profitability, the findings can be explained by a decrease in the relative discount rates of long-term projects after the late 1970s.

Briefly, the intuition is as follows. When discount rates of short- and long-term projects are comparable, firms prefer to invest in short-term projects due to the time value of mon-

\(^1\)Note that the investment factor (CMA) is long low investment firms and short high investment firms, while the profitability factor (RMW) is long high profitability firms and short low profitability firms.
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ey. Thus, firms with high investment are immediately profitable, but do not have significantly different discount rates from firms with low investment and low profitability, generating insignificant investment and profitability return premia. When relative discount rates of long-term projects are very low, firms prefer to invest in long-term projects. Thus, firms with high investment have low immediate profitability and low discount rates, generating significant investment and profitability premia.

We start by showing that the divorce between firm investment and profitability is pervasive in the data. First, we show that the firm investment-profitability correlation flips in each industry sector, which indicates that the change is not driven by changes in the economy’s sectoral composition. Second, it appears in all subsamples split by size, book-to-market ratio, and trading exchange suggesting that the divorce is not driven by these firm characteristics. Third, this change shows up for both tangible and intangible investments. Thus, it cannot be explained by the rising use of intangible capital. Lastly, we document that the divorce is not driven by changes within existing firms and, instead, is primarily due to firm exit and entry.

We argue that the root cause of the divorce between investment and profitability is a downward shift in the relative discount rates of long-term cash flows compared to short-term cash flows. We document this shift by constructing firm-level measures of cash flow duration based on Dechow et al. (2004) and Weber (2018), and find that expected returns are unrelated to duration prior to the late 1970s, but are strongly decreasing in duration in recent decades. We also show that the average cash flow duration of firms has dramatically increased since the late 1970s, which is consistent with low discount rates producing high incentives for investing in long-term projects.

Motivated by the empirical evidence, we develop a model of firm investment that unifies the notions of cash flow duration, investment, and profitability. In the model, firms
invest in short- and long-term projects. Short-term projects generate cash flows immediately after investment. In contrast, long-term projects generate low, or even negative, cash flows initially and are expected to generate highly positive cash flows in the far future. The standard investment theory still applies—a positive productivity shock to a firm increases current profitability and incentivizes investment.\textsuperscript{2} Hence, investment and profitability are still positively related within a firm over time, consistent with the data. However, firms’ choices between the two types of projects can prompt a decoupling of investment and profitability in the cross-section.

We quantitatively evaluate two cases of the model. The first case assumes similar discount rates for short- and long-term projects, consistent with the evidence from before the late 1970s. The second case features high discount rates for short-term projects and low discount rates for long-term projects, consistent with the data in the recent four decades. In the calibration of the first case, short-term projects are more appealing, on average, than long-term projects because immediate cash flows are discounted less than those from the far future. Hence, firm investments primarily focus on short-term projects. This generates the positive relation between investment and profitability in the cross-section. Furthermore, because discount rates do not vary significantly with cash flow duration, they also do not vary with current profitability. This leads to an insignificant profitability premium, consistent with the data before the late 1970s (Linnainmaa and Roberts (2018)).

In the second case of the model, significantly lower long-term discount rates incentivizes firms to invest more in long-term projects, explaining the high average cash flow duration in the economy that we observe after the late 1970s. In the cross-section, firms with higher productivity from long-term projects relative to short-term projects invest more on average. Given that long-term projects yield significantly lower immediate prof-

\textsuperscript{2}Earlier models of firm investment in the asset pricing literature include Berk et al. (1999), Gomes et al. (2003), Carlson et al. (2004), Zhang (2005), Liu et al. (2009), Ai et al. (2013), Belo et al. (2014), Goncalves et al. (2019), among others.
itability than short-term projects, investment and profitability become negatively related in the cross-section. The profitability premium arises naturally as short-term projects have higher discount rates. The investment premium also becomes larger in the second case compared to the first case, as firms with high investment primarily invest in long-term projects, which have low discount rates. In summary, our quantitative exercise shows that a fundamental change in short- versus long-term discount rates provides a unified explanation for not only the interplay between firm investment and profitability, but also their associated equity return spreads during two starkly contrasting periods over the last century.

Why are long-term discount rates lower than short-term discount rates after the late 1970s? A prominent change in US financial markets is the rise of venture capital (VC) following a law change in 1979 that allowed pensions to invest in VC funds. Gompers (1994) documents that, following the law change, “pension fund commitments to venture capital rose dramatically, increasing annual new contributions to venture capital funds from $100-200 during the 1970s to in excess of $4 billion by the end of the 1980s.” The burgeoning investments of venture capital funds in real businesses may have dispersed their investment philosophy of focusing on long-term cash flows into the broader economy.\(^3\) Investors who have stakes in both venture capital and the stock market, such as pension funds, may seek publicly traded firms that are similar to the private firms targeted by VC funds. Other stock market investors may also be inspired to change their views following the success of prominent VC-backed firms. Consistent with these hypotheses, we find that, in the primary market, the profitability of newly IPO’d firms fell dramatically after 1979; we find in the secondary market that the divorce between investment and profitability occurred immediately after 1979 among small-cap, growth, and NASDAQ

\(^3\)For example, Kortum and Lerner (2000) show that higher venture capital spending within an industry leads to an increase in the industry’s R&D spending and patenting.
firms, which are regarded as the “new economy” by Pástor and Veronesi (2009), while the same change occurred almost ten years later among large-cap, value, and NYSE/AMEX firms. In summary, while other factors may have also contributed to our main empirical findings, we believe the rise of venture capital after the late 1970s could have played a major role.

Our paper is related to the empirical asset pricing literature highlighting the importance of investment and profitability in explaining the cross-section of equity returns. Fama and French (2015) and Hou et al. (2015) include profitability- and investment-based factors in linear asset pricing models. Exploring a sample of firms that predates the Compustat database, Linnainmaa and Roberts (2018) show that investment and profitability premia are not significant in the four decades between 1926 and 1969, and they doubt the validity of RMW and CMA as priced factors. Our study sheds light on this debate. First, our empirical findings suggest that the insignificant returns of the RMW and CMA factors in the earlier period and their large returns in the later period can be reconciled by the fundamental change in the relation between firm profitability and investment. Second, we show in our framework that flat discount rates with respect to cash flow duration can explain the insignificant profitability premium in the earlier decades, while downward-sloping discount rates with respect to duration can explain the co-existence of positive profitability and investment premia in recent decades.

The mechanism we use to explain our main findings is related to the recent literature on cash flow duration and expected returns. Using data from the last two decades, van Binsbergen et al. (2012) and van Binsbergen and Kojien (2017) document that the expected returns of the aggregate equity market are decreasing in cash flow horizon. Weber (2018)
finds similar evidence by constructing a firm-level measure of cash flow duration following Dechow et al. (2004). We extend the existing evidence by documenting a downward-sloping term structure for equity returns after the late 1970s, consistent with these prior studies, but a flat term structure prior to the late 1970s. Furthermore, our model provides an economic framework in which the term structure of discount rates has a profound impact on real firm decisions, explaining the stark differences in the relation between firm investment and profitability before and after the late 1970s. Our framework shares certain similarities with Lettau and Wachter (2007) in that both models assume short- and long-term cash flows are subject to different discount rates. While Lettau and Wachter (2007) focus on a risk-based explanation for the value premium in an endowment economy, our study focuses on the impact of heterogeneous discount rates on investment and profitability.

Another related strand of literature, going back at least to Hayes and Abernathy (1980), is about short-termism in firm management. Short-termism refers to an excessive focus on short-term outcomes, such as profits, at the expense of long-term interests. Confronting the idea that short-termism is prevalent among US public firms, Jiang (2018) argues that a short-termist security market should discount distant cash flows more heavily, which contradicts the empirical evidence on the downward-sloping term structure of equity returns discussed above. In a related context, Summers and Balls (2015) argue that the existence of companies with no profits and high valuations casts doubt on the claim that investors are systematically myopic. Recently, Kaplan (2018) emphasizes that the idea of short-termism, mostly developed in the 1970s, has become less relevant due to a number of developments that took place in the early 1980s, e.g. the emergence of corporate finance and the growing role of management consultants. Our findings are highly consistent with these studies, especially Kaplan (2018) and others who argue that short-termism
has declined recent decades.

The paper is organized as follows. Section 2 describes the main empirical evidence. Section 3 presents our model. Section 4 explores potential catalysts from the late 1970s for the change in the relation between investment and profitability. Section 5 concludes.

2. Facts: Relation Between Investment and Profitability

In this section, we first document a pervasive change in the late 1970s in the relationship between investment and profitability which manifested in both stock returns and firm characteristics. Then, to motivate our model mechanism, we present evidence that discount rates for long-term cash flows decreased after the late 1970s.

2.1 Relationship Between Investment and Profitability Factors

Two return factors that have been recently highlighted by the asset pricing literature are the investment factor (CMA) and profitability factor (RMW) (Fama and French (2015) and Hou et al. (2015)). Motivated by Cooper et al. (2008), who find that firm investment negatively predicts stock returns, the CMA factor is a constructed by going long stocks with low asset growth and shorting stocks with high asset growth. The RMW factor goes long stocks with high operating profitability and shorts stocks with low operating profitability and is motivated by the findings of Novy-Marx (2013). Appendix A provides more details about the construction of these factors. In this section, we provide more insight into these two factors by studying their relationship over the past century from 1926-2019.

We obtain data on the investment and profitability factors from two sources. For the sample from July 1963 to May 2019, we download monthly returns of the CMA and RMW factors from Ken French’s website. For the sample from July 1926 to July 1968, we obtain
monthly factor returns from Linnainmaa and Roberts (2018) who construct the historical factor returns by merging accounting information from Moody’s Industrial and Railroad manuals to CRSP.\(^5\)

Figure 1 plots the average monthly returns of the investment and profitability factors using ten-year moving-average windows. We can clearly observe that the two factors move in opposite directions before July 1980, with the correlation between the factors’ average returns being -0.60 over this period. However, the two factor returns converge after July 1980, resulting in a positive correlation of 0.69 in the later period. It is important to note that the investment factor shorts high investment firms and goes long low investment firms, while the profitability factor goes long high profitability firms and shorts low profitability firms. Thus, the negative correlation between factors before 1980 is consistent with a positive cross-sectional correlation between firm investment and profitability, and the positive factor correlation after 1980 is consistent with a negative cross-sectional correlation between firm characteristics. We will present direct evidence on the correlation of firm characteristics in the next section.

Similar to Linnainmaa and Roberts (2018), we observe that the return spreads of CMA and RMW also differ significantly before and after 1980. We note that RMW is small and statistically insignificant between July 1926 and June 1980, with average returns of 0.14% per month and a \(t\)-statistic of 0.12.\(^6\) Similarly, we observe that CMA has a small average return of 0.15% per month and a lackluster \(t\)-statistic of 1.82 during the early period. However, after July 1980, we observe that the return spreads of both factors become significantly larger, with a mean of 0.26% per month (\(t\)-statistic of 2.56) for CMA and a mean

\(^5\)Linnainmaa and Roberts (2018) construct the profitability factor slightly differently from Fama and French (2015) because the historical Moody’s data do not provide firms’ SG&A expenses, a component of operating profitability. Nevertheless, the RMW factors from the two sources are highly correlated in the overlapping period from July 1963 to July 1968. Figure IA.1 in the Internet Appendix plots the graph using data only from Fama and French (2015).

\(^6\)All \(t\)-statistics use Newey-West adjusted standard errors with 3 month lags.
of 0.37% per month (t-statistic of 3.02) for RMW.

[FIGURE 1 ABOUT HERE]

2.2 Relationship Between Firm Investment and Profitability

In this section, we document a change in the cross-sectional relationship between firm investment and profitability during the years 1931 to 2017. We start by constructing measures of firm investment and profitability using the Compustat database following Fama and French (2015).\(^7\) We require firms to appear in both Compustat and CRSP databases and to have at least two years of data in the Compustat database to avoid backfill bias (Fama and French (1993)). The Compustat database starts in 1962, so we extend our sample back to 1931 using data from Linnainmaa and Roberts (2018). In both samples, we remove firms with market capitalization below the 5th NYSE size percentile. This is consistent in spirit with Fama and French (2015) who form value-weighted portfolios to mitigate the influence of micro-cap firms.

Figure 2 plots the cross-sectional correlations of firm investment and profitability in each year. We see that the two firm attributes are positively correlated in every year before 1979, with an average cross-sectional correlation of 0.14 from 1931 to 1978. However, after 1979, investment and profitability are negatively correlated for 34 out of the 39 years from 1979 to 2017, with an average cross-sectional correlation of −0.06. This dramatic change in correlation between firm investment and profitability is consistent with the change between the investment and profitability factors that we observe in Figure 1.

[FIGURE 2 ABOUT HERE]

In the rest of this section, we continue to examine the correlation between firm invest-
ment and profitability in various subsamples during the Compustat sample period. We use these results to emphasize that the change in the correlation is pervasive among all firms. Additionally, some subsample results can provide more insight on the catalyst for the change, which we will discuss in-depth later.

Figure 3 plots yearly cross-sectional correlations between investment and profitability within sectors and shows that the change in correlation is prevalent across all industries. The results in Panels A and E for the agriculture/mining/construction and finance sectors are noisy due to the small number of firms in these sectors, but, even for these sectors, it is clear that the correlation becomes more negative on average after 1979.\(^8\)

Figure 4 shows that the change in correlation occurs in all subsamples split by trading exchange, market capitalization, and book-to-market.\(^9\) Interestingly, the change in correlation between investment and profitability occurs almost exactly in 1979 for NASDAQ, small-cap, and growth firms while this change occurs roughly ten years later for NYSE/AMEX, large-cap, and value firms. We will discuss the implications of these lead-lags for the potential underlying reasons of the change in later sections.

Figure 5 provides additional robustness checks by plotting the relationship between various investment measures and operating profitability with more cross-sectional detail. We sort firms into ten bins by profitability and plot the average investment rate in each bin before and after 1979. Panel A displays the distributions before 1979, and Panel B displays the distributions afterwards. By comparing specifications (1) to (3) in both panels, we can see that asset growth, our main measure of investment, increases monotonically with profitability in the early period and decreases nearly monotonically with profitability in the later period, regardless of industry and size controls. Thus, the reversed correla-

\(^8\)Agriculture/mining/construction only accounts for 6.1% of the total number of observations in the sample; finance and insurance accounts for 6.7% of the sample.

\(^9\)We also show the results are not due to low quality new listings that quickly exit CRSP. Figure IA.2 shows similar results using only firms that have a total lifespan in the CRSP sample of at least 10 years.
tion between firm investment and profitability is not driven by outliers. Specification (4) shows that the reversed correlation is not driven by lumpy investment—low-profitability firms not only invest more this year but also continue to invest more in the next year. Lastly, we observe similar patterns in both tangible and intangible investment. Therefore, the divorce between investment and profitability is not driven by the rising level of intangible capital in the economy.

A natural follow-up question is whether the decoupling of firm investment and profitability arises due to changes within existing firms or due to firm exit and entry. To answer this question, we decompose the cross-sectional correlation of firm investment and profitability into between-firm and within-firm components. To construct the between-firm correlation, we first demean firms’ investment and profitability by year. We then compute the time-series averages of demeaned investment and demeaned profitability for each firm. These time-series averages capture how the firm’s average investment and average profitability compare to other firms. Because these time-series averages are constant through time for each firm, any changes in their cross-sectional correlation between years must be due to the entry and exit of firms from the sample. For example, the correlation can only decrease if entering firms have lower (higher) than average profitability and higher (lower) than average investment, if exiting firms have higher (lower) than average profitability and higher (lower) than average investment, or both occur. Panel A of Figure 6 plots the correlation of the time-series average demeaned investment and profitability in each year. The correlation strongly shifted from positive to negative, suggesting that
exit and entry contributed to the overall shift correlations.

We define the excess investment (profitability) of a firm in a particular year as the difference between the firm’s demeaned investment (profitability) in that year and its time-series average demeaned investment (profitability). It captures how the firm’s investment (profitability) in that year compares to the firm’s average investment (profitability). In other words, it captures the within-firm variation of investment (profitability). Panel B of Figure 6 plots the correlation of excess investment and excess profitability. The results show that, within a firm, investment tends to be high if profitability is high throughout the entire sample, consistent with standard investment theory with persistent firm productivity. In summary, our results in Figure 6 suggest that the decoupling of firm investment and profitability is mainly driven by the exit and entry of firms.

[FIGURE 6 ABOUT HERE]

2.3 Changes in Firm Duration

In this section, we construct a measure of expected equity duration for each firm. Then, we show the return spread between high- and low-duration firms is flat before 1980 and significantly negative after 1980.

2.3.1 Computing Expected Equity Duration

We measure expected equity duration for each firm based on the approach from Dechow et al. (2004) and Weber (2018). Following Dechow et al. (2004) and Weber (2018), we assume a finite forecasting period and the clean surplus approximation for cash flows so
we can write the firm’s cash flow duration as

\[
Dur_{i,t} = \frac{\sum_{s=1}^{T} s \times CF_{i,t+s}/(1 + r)^s}{P_{i,t}} + \left( T + \frac{1 + r}{r} \right) \frac{P_{i,t} - \sum_{s=1}^{T} CF_{i,t+s}/(1 + r)^s}{P_{i,t}},
\]

(1)

and its cash flow as

\[
CF_{i,t+s} = E_{i,t} - (BV_{i,t+s} - BV_{i,t+s-1})
= BV_{i,t+s-1}(ROE_{i,t+s} - \Delta BV_{i,t+s}),
\]

(2)

where \(ROE_{i,t} = \frac{E_{i,t+s}}{BV_{i,t+s-1}}\) is return on equity, \(\Delta BV_{i,t+s} = \frac{BV_{i,t+s} - BV_{i,t+s-1}}{BV_{i,t+s-1}}\) is the change in the book value of equity, \(E_{i,t}\) is the firm’s earnings (measured as earnings before extraordinary items), and \(BV_{i,t}\) is book value of equity.

Given that future cash flows are not available at time \(t\), Dechow et al. (2004) and Weber (2018) measure firm duration at time \(t\) by assuming an autoregressive process for cash flows. We differ from their approach by directly estimating the expected value of duration. Briefly, we first compute realized duration at time \(t\), \(Dur_{i,t}\) using firms’ future earnings and book equity following equation (1). We next follow Hou et al. (2018) and Da (2009) and project realized duration on three variables from equation (1) at time \(t\): market equity, return on equity, and changes in book equity. Specifically, we run cross-sectional regressions of \(\log(Dur_{i,t})\) on the predictive variables in each year:

\[
\log(Dur_{i,t}) = \alpha_t + \beta_{1,t}\log(ME_{i,t}) + \beta_{2,t}ROE_{i,t} + \beta_{3,t}\Delta BV_{i,t} + \varepsilon_{i,t}.
\]

(3)

We then follow Hou et al. (2018) and compute 5-year trailing moving averages of the cross-sectional regression coefficients to obtain \(\bar{\alpha}_t = \frac{1}{5} \sum_{s=0}^{4} \alpha_{t-s}\) and \(\bar{\beta}_{k,t} = \frac{1}{5} \sum_{s=0}^{4} \beta_{k,t-s}\) for \(k = 1, 2, 3\). Finally, we compute the expected log duration for firm \(i\) in time \(t\) as the
fitted value:

$$E_t [\log(Dur_{i,t})] = \alpha_t + \beta_{1,t} \log(ME_{i,t}) + \beta_{2,t} ROE_{i,t} + \beta_{3,t} \Delta BV_{i,t}. \quad (4)$$

Table 1 contains summary statistics for expected cash flow duration and other key measures. Table 2 reports the results of the cross-sectional predictive regressions. Panel A shows the main multivariate regression results from estimating equation (3), and Panel B report results from univariate regressions of duration on each of the three predictors. In both panels, we observe that the coefficients of all predictors have correct signs consistent with equation (1) and are statistically significant: a negative sign for market capitalization, a negative sign for ROE, and a positive sign for change in book equity. Furthermore, we see that the main regression has an average $R^2$ of 11.32% and average Pearson and rank correlations of 0.21 and 0.37, respectively. These statistics indicate that the three variables are indeed highly predictive of firms’ equity duration. As a point of comparison, Hou et al. (2018) find average predictive $R^2$’s below 8.98% and average Pearson and rank correlations below 0.154 and 0.22, respectively, when predicting future investment growth using current log $q$, cash flows, and change in ROE.

2.3.2 Increased Cash Flow Durations after the late 1970s

Panel A of Figure 7 plots the percentage of firms in each year with expected equity duration higher than the full-sample (across all firms and years) median expected equity duration from 1962 to 2008. The figure shows that the percentage of high duration firms was much lower in the pre-1979 period than in the post-1979 period. The time-series av-
verage of the percent of high duration firms is 9.08% in the early period and 58.44% in the later period. Panel B also shows that the distribution of cash flow durations in pre-1979 and post-1979 periods are entirely different; the distribution shifts significantly rightward in the later period.\(^\text{10}\)

2.3.3 Changing Investor Preferences After the Late 1970s: Discount Rates and Duration

Using our measure of expected equity duration, we sort firms into ten portfolios each year. Table 3 shows the time-series averages of the portfolio returns and the time-series averages of the median duration in the pre-1979 and the post-1979 period. Panel A shows that high duration firms earned 0.15% higher monthly returns than low duration firms before pre-1979. However, the difference is not statistically significant. Panel B shows that high duration firms have 1.11\% lower average monthly returns than low duration firms, and the difference is statistically significant.\(^\text{11}\) These findings suggest that, before the late 1970s, investors charged slightly higher discount rates for long-term cash flows compared to short-term cash flows. However, after the late 1970s, investors appear to charge significantly lower discount rates for long-term cash flows compared to short-term cash flows. The change in the relative discount rates for long-term projects with low immediate cash flows will have important implications for explaining the great divorce between firm investment and profitability, which we demonstrate in a model below.

\(^{10}\)Fama and French (2001) document that the proportion of firms paying cash dividends has greatly decreased since the late 1970s, which is consistent with our findings.

\(^{11}\)The later period portfolio returns end in June 2010 because the expected duration calculation requires 10 forward-looking years of size, book equity, and profitability data.
3. Model

In this section, we present a partial equilibrium model of firm investment featuring short- and long-term projects as well as potentially different discount rates for each project type. Section 3.1 describes the model setup and solves for the optimal investment and equity value of a single firm. Section 3.2 describes our calibration for two cases of the model representing the periods before and after the late 1970s as well as our simulation procedure. Section 3.3 provides a set of predictions regarding the interplay between investment, profitability, and stock returns in the cross-section; discusses the quantitative results; and compares them to the empirical evidence.

3.1 Setup

In this section, we present the model for a single firm. The firm is financed only by equity and can invest in two types of projects: type $s$ and type $l$. As we illustrate below, type $s$ projects have shorter cash flow duration compared to type $l$ projects at the time of investment. Both types of investment are available every period, and the capital formed in each period operate as separate projects as in Berk et al. (1999) and Kogan and Papanikolaou (2014). Consequently, the firm is a collection of $N_t$ (the firm’s age) type $s$ and $N_t$ type $l$ projects.

3.1.1 Assets in Place

Let $k_{i,t-\eta,t}$ denote the amount of capital at time $t$ for the type $i$ project that the firm invested in at time $t - \eta$, where $i \in \{s, l\}$. The law of motion for $k_{i,t-\eta,t}$ is given by

$$k_{i,t-\eta,t+1} = (1 - \delta_t)k_{i,t-\eta,t},$$

(5)
where $\delta_i$ is the depreciation rate.

Type $s$ and $l$ projects differ in their productivity. The productivity of the firm’s type $s$ projects at time $t$ is given by $a_{s,t}$, and the cash flow of each type $s$ project is given by $a_{s,t}k_{s,t-\eta,t}$. In contrast, the productivity of a type $l$ project depends on the time since its creation. The type $l$ project that the firm invested in at time $t-\eta$ operates with productivity $a_{l,t-\eta,t} = \lambda_{t-\eta}a_{l,t}$ where $a_{l,t}$ follows a Markov process and

$$
\lambda_{t-\eta} = \begin{cases} 
-1 & \eta < T \\
\theta_{t-\eta} > 0 & \eta \geq T
\end{cases}
$$

(6)

where $\theta_{t-\eta}$ is a realization of the random variable $\tilde{\theta}$ that is iid across time and projects. Hence, the cash flow for a type $l$ project is given by $a_{l,t-\eta,t}k_{l,t-\eta,t}$. We assume that $a_{s,t}$ and $a_{l,t}$ both follow Markov processes that take only positive values.\(^{12}\)

The main difference between type $s$ and $l$ projects is the timing of their cash flows. Type $s$ projects start generating positive cash flows immediately after investment, and their future cash flows follow a downward path, on average, as a result of stationary productivity and depreciating capital. Type $l$ projects, however, generate negative cash flows for $T$ periods after investment. After $T$ periods, their cash flows become positive and the magnitude of cash flows depends on $\theta_{t-\eta}$ which is revealed at time $t - \eta + T$. We interpret the “boom” represented by $\tilde{\theta}$ as the unpredictable success of long term investments, and assume that $\tilde{\theta}$ has a positively skewed distribution that takes positive values in our quantitative analysis. At the time of investment, the size of the boom is unknown and firms face a tradeoff between the expected negative cash flows for the first $T$ periods, and the positive expected gains after the project booms. Economically, type $l$ projects derive their initial value from long-term prospects such as the chance of “long-term market leader-
ship” as emphasized by Jeff Bezos at the beginning of this article, rather than short-term profits.

Firm profits, $\pi_t$, are the sum of profits generated by type $s$ and $l$ projects:

$$
\pi_t = a_{s,t} \sum_{\eta=1}^{N_t} k_{s,t-\eta,t} + \sum_{\eta=1}^{N_t} a_{l,t-\eta,t} k_{l,t-\eta,t}.
$$

(7)

The firm discounts future cash flows from type $s$ projects and post-boom type $l$ projects that have $\eta \geq T$ (which also yield immediate profits) using discount rate $R_s$. Future cash flows from pre-boom type $l$ projects are discounted at rate $R_l$. The values of the firm’s existing projects are given by $V_{s,t}$ and $V_{l,t}$, which correspond to the discounted value of future cash flows from all of its type $s$ and $l$ projects, respectively:

$$
V_{i,t} = \sum_{\eta=0}^{N_t} v_{i,t-\eta,t},
$$

(8)

where $i \in \{s, l\}$, and $v_{i,t-\eta,t}$ is the value of the type $i$ project created $\eta$ periods ago. Using the law of motion for capital in equation (5), the value of a type $s$ project is given by

$$
v_{s,t-\eta,t} = \xi_{s,t} k_{s,t-\eta,t},
$$

(9)

where $\xi_{s,t} = \mathbb{E}_t \left[ \sum_{\tau=1}^{\infty} a_{s,t+\tau} \left( \frac{1-\delta}{R_s} \right)^\tau \right]$.  

The valuation of existing type $l$ projects depends on whether the project is in the pre-boom ($\eta < T$) or the post-boom ($\eta \geq T$) stage. Pre-boom projects have $T - \eta$ more periods with productivity $-a_{l,t}$ and are expected to produce with productivity $a_{l,t}E[\bar{\theta}]$ afterwards. In contrast, post-boom projects have already realized $\theta_{t-\eta}$ and produce with productivity $a_{l,t}E[\bar{\theta}]$ afterwards.

---

13Since our focus is on cross-sectional implications of the model, we abstract from time-series variation in discount rates. See Gormsen (2018) for an analysis of the time variation on short and long duration expected returns.
$\theta_{t-\eta a_{l,t}}$. In sum, the value of a type $l$ project can be written as:

$$v_{l,t-\eta,t} = \begin{cases} 
-\mathbb{E}_t \left[ \sum_{\tau=1}^{T-\eta} a_{l,t+\tau} k_{l,t-\eta,t+\tau} \frac{1}{R_s^{\tau}} \right] + \mathbb{E}[\hat{\theta}] \mathbb{E}_t \left[ \sum_{\tau=T-\eta+1}^{\infty} a_{l,t+\tau} k_{l,t-\eta,t+\tau} \frac{1}{R_s^{\tau}} \right] & \eta < T \\
\theta_{t-\eta} \mathbb{E}_t \left[ \sum_{\tau=1}^{\infty} a_{l,t+\tau} k_{l,t-\eta,t+\tau} \frac{1}{R_s^{\tau}} \right] & \eta \geq T,
\end{cases}$$

(10)

where the valuation takes into account that cash flows from type $l$ projects are discounted at $R_s$ after the boom. Using the law of motion for capital in equation (5), the value of a type $l$ project is given by

$$v_{l,t-\eta,t} = \xi_{l,t-\eta,t} k_{l,t-\eta,t},$$

(11)

where

$$\xi_{l,t-\eta,t} = \begin{cases} 
-\mathbb{E}_t \left[ \sum_{\tau=1}^{T-\eta} a_{l,t+\tau} \left( \frac{1-\delta_i}{R_i} \right)^\tau \right] + \mathbb{E}[\hat{\theta}] \mathbb{E}_t \left[ \sum_{\tau=T-\eta+1}^{\infty} a_{l,t+\tau} \left( \frac{1-\delta_i}{R_i} \right)^\tau \right] & \eta < T \\
\theta_{t-\eta} \mathbb{E}_t \left[ \sum_{\tau=1}^{\infty} a_{l,t+\tau} \left( \frac{1-\delta_i}{R_i} \right)^\tau \right] & \eta \geq T.
\end{cases}$$

(12)

We denote the unit value of type $l$ capital at the time of investment ($\eta = 0$) as $\xi_{l,t} \equiv \xi_{l,0,t}$ for later use.

3.1.2 Growth Opportunities and Investment

In each period, the firm chooses the investment amount in type $s$ and $l$ projects, $k_{s,t,t}$ and $k_{l,t,t}$, respectively. The cost of investment is $k_{i,t,t}$, where $i \in \{s,l\}$. Once invested, the new capital becomes assets in place for the firm. Investment in period $t$ starts generating cash flows in period $t + 1$. The firm chooses optimal investment based on the net present value of projects by maximizing the surplus from investment:

$$\max_{k_{i,t,t}} g_{i,t} = \xi_{i,t} k_{i,t,t} - k_{i,t,t}^{1/\delta_i},$$

(13)
where $i \in \{s, l\}$ and $g_{i,t}$ is the surplus from investing in the type $i$ project. The first order condition of the problem in (13) implies that optimal investment is given by

$$k_{i,t}^* = \left( \frac{\xi_{i,t}}{\beta_i} \right)^{1-\eta_i}. \quad (14)$$

The expression for $\xi_{i,t}$ illustrates that the scale of the firm’s investment in type $s$ and $l$ projects depends on productivities, $a_{s,t}$ and $a_{l,t}$, and discount rates, $R_s$ and $R_l$.

The value of all future growth opportunities from type $i \in \{s, l\}$ projects is then given by

$$G_{i,t} = \mathbb{E}_t \left[ \sum_{\tau=1}^{\infty} g_{i,t+\tau}^* \right]$$

$$= \left( \frac{1}{\beta_i^{1-\eta_i}} - \beta_i^{1-\eta_i} \right) \mathbb{E}_t \left[ \sum_{\tau=1}^{\infty} \frac{\beta_i^{\eta_i-1}}{R_i^\tau} \xi_{i,t+\tau} \right]. \quad (15)$$

### 3.1.3 Firm Equity Returns

The ex-dividend value of the firm $P_t$ is given by the sum of the values of assets in place and growth opportunities:

$$P_t = \sum_{i=s,l} V_{i,t} + \sum_{i=s,l} G_{i,t}. \quad (16)$$

Dividends $D_t$ of the firm are equal to profits net of investments in both type $s$ and $l$ projects:

$$D_t = \pi_t - \sum_{i=s,l} k_{i,0,t}^{\beta_i}. \quad (17)$$

As a result, the equity return of the firm in period $t+1$ is given by

$$r_t = \frac{P_{t+1} + D_{t+1}}{P_t} - 1. \quad (18)$$
3.2 Calibration and Simulation Strategy

In this section, we discuss our calibration and simulation strategy for the baseline quantitative assessment of the model. We discuss the role of the model simulation assumptions in Section 3.3. The model presented in Section 3.1 characterizes the decisions of a single firm conditional on the dynamic variables $a_{s,t}$ and $a_{l,t}$, as well as time-invariant model parameters. In the quantitative assessment of the model, we simulate panels of firms and compute outcomes of interest.

Since our focus is on cross-sectional implications of the model, we assume that the dynamics of $a_{s,t}$ and $a_{l,t}$ are independent across firms, and that only the $R_s$ and $R_l$ parameters are persistently different across firms. The processes $a_{s,t}$ and $a_{l,t}$ for the same firm are also simulated independently. We introduce cross-sectional heterogeneity in discount rates, but fix the difference between $R_s$ and $R_l$ across firms. That is, there are cross-sectional level differences in discount rates but no heterogeneity in long relative to short duration discounts.

Another important feature of our simulation is entry and exit. This is motivated by the evidence in Section 2 highlighting the crucial role of new firms in our findings. We implement this by introducing a constant fraction of new young firms into the panel each period that replace randomly selected existing firms. Allowing for firm entry means that, for some firms, all of their type $l$ projects are in the pre-boom stage, representing firms that are positively valued despite low overall cash flows.

We investigate quantitative model implications under two calibrations. In Case 1, we target several pieces of empirical evidence on investment, profitability, and equity returns in the period up to the late 1970s. In particular, we assume that $R_s$ is slightly below $R_l$ in Case 1. We are interested in the consequences of the downward shift in the relative

\footnote{See Appendix B for details on parameter values.}
discount rates of long-term cash flows from the period before to the period after the late 1970s. Therefore, we keep the firm level parameters in Case 2 identical to Case 1, except we set $R_s$ to be significantly higher than $R_l$. Furthermore, in line with empirical evidence, we assume a slightly higher entry rate in Case 2 compared to Case 1.

### 3.3 Quantitative Model Predictions and Results

In this section, we investigate the model’s ability to explain the empirical facts documented in Section 2. We represent the divorce between investment and profitability in the late 1970s as consequences of a transition from Case 1 to Case 2, resulting in the following five predictions:

**Prediction 1:** The share of firms with longer cash flow duration is higher in Case 2 compared to Case 1.

Our measure of firm cash flow duration in the model is the share of type $l$ capital in the pre-boom stage. In Case 2, $R_l$ is significantly lower compared to both $R_s$ and its value in Case 1. As a result, type $l$ projects are more valuable in Case 2 which results in a higher share of investment and capital in type $l$ projects. Figure 8 confirms that this prediction holds in the model, and the shares of high duration firms in Cases 1 and 2 resemble the corresponding empirical values in the pre- and post-1980 periods.

**Prediction 2:** The cross-sectional correlation between investment and profitability is positive in Case 1 and negative in Case 2.

In our model, there are two sources of variation that drive the correlation between investment and profitability. First, there is a within-firm positive correlation. Consider type $s$ projects. Since investment is increasing in $a_{s, tr}$ which drives profitability and is per-
sistent, highly profitable firms also exhibit high investment. For type \( l \) projects, optimal investment is driven by the tradeoff between the expected losses in the first \( T \) periods and the expected profits after the boom in \( T \) periods (see equations (12) and (14)). In our calibration, the latter is approximately constant because the size of the boom is \( iid \), and the low persistence of \( a_{l,t} \) implies a low degree of dependence of \( T \)-period ahead profits on current productivity.\(^{15}\) As a result, investment in type \( l \) projects is decreasing in \( a_{l,t} \) implying a positive within-firm association between investment and profitability. This is consistent with the empirical evidence in Figure 6 that shows the within-firm correlation between investment and profitability is always positive in the data.

Another driver of the correlation between profitability and investment is a capital composition effect across firms. In Case 1, type \( s \) projects are more attractive than type \( l \) projects. Thus, high investment firms are more likely to have persistently high \( a_{s,t} \), implying high profitability. In contrast, type \( l \) projects are more attractive in Case 2. Thus, high investment firms are more likely to have persistently low \( a_{l,t} \) and a higher share of recently created type \( l \) projects, implying low profitability. Hence, the composition effect induces a negative between-firm correlation between investment and profitability when pre-boom type \( l \) projects are the root cause of high investment rates in the cross-section.

In sum, our model’s ability to explain the positive correlation in Case 1 and the negative correlation in Case 2 hinges on whether the between-firm negative correlation channel is weak in Case 1 and strong enough to dominate in Case 2. Figure 8 confirms that type \( l \) projects are more prevalent in Case 2 which strengthens the negative between-firm correlation channel and certainly suggests a relatively lower correlation in Case 2.

Figure 10 plots the average investment rates by profitability decile in Cases 1 and 2. In Case 1, the model generates a positive association between investment and profitability consistent with the data prior to the 1980s (Panel B). Moreover, the correlation becomes

\(^{15}\)The AR(1) coefficient of \( \log(a_{l,t}) \) is 0.65 and \( T = 10 \) years.
negative in Case 2 consistent with the data in the last four decades. As Figure 8 suggests, pre-boom type \( I \) projects are prevalent enough to induce a negative between-firm correlation between investment and profitability. Note that both the downward shift in \( R_I \) and the entry of new firms are crucial to obtaining the negative correlation. The discount rate channel ensures the dominance of type \( I \) projects in Case 2, while entry increases the amount of new firms with high investment but very low profitability due to their lack of post-boom type \( I \) projects.

**Prediction 3:** The profitability premium is close to zero in Case 1 and significantly positive in Case 2.

In the model, profitability is closely related to the cash flow duration of the firm. Firms with a high share of pre-boom type \( I \) capital have relatively lower profitability and higher cash flow duration. Our calibration in Case 1 features no significant difference between \( R_s \) and \( R_I \) as in the data prior to the 1980s, leading to a lack of expected return variation by duration. As a result, the high-minus-low profitability premium is close to zero in Case 1 as shown in Panel B of Figure 11. Hence, our model attributes the insignificant profitability premium prior to the 1980s documented by Linnainmaa and Roberts (2018) to the uniformity of short- and long-term discount rates.

Panel D of Figure 11 shows, however, that the profitability premium is significantly positive in Case 2, consistent with the data in the last four decades. This result is a direct consequence of the downward shift in the relative value of \( R_I \) compared to \( R_s \). Firms with a high share of capital in pre-boom type \( I \) projects exhibit low profitability, and they are subject to lower average discount rates. In sum, Cases 1 and 2 of our model reconcile the

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16 The model generates a slight smirk in Case 2 (Panel D of Figure 10) due to the positive skewness of \( a_{s,t} \) and \( a_{I,t} \). Firms in high profitability deciles are those with exceptionally high \( a_{s,t} \) leading to high investment in type \( s \) projects despite high \( R_s \).

17 See Online Appendix Figures IA.4-IA.8 for the results without the downward shift in \( R_I \), and Figures IA.19-IA.22 for the case with no entry and exit.
lack of a significant profitability premium prior to the 1980s and the significantly positive profitability premium in the last four decades through the duration channel.

**Prediction 4**: The investment premium is positive in both cases, but it is larger in Case 2.

In our model, there are two sources of the low-minus-high investment premium. The first source is the discount rate variation across firms in our calibration. Firms with a low discount rate exhibit higher investment rates in general, as their valuation of growth opportunities is relatively higher. Since discount rates are directly related to expected equity returns, high investment firms exhibit lower average returns. Akin to the profitability premium, the second source of variation is the difference between $R_s$ and $R_l$. In an economy where high investment is persistently driven by type $s$ (type $l$) projects, expected returns of high investment firms are closer to $R_s$ ($R_l$).

In Case 1, only the first channel is at play because there is no significant difference between $R_s$ and $R_l$ resulting in a small average investment premium as shown in Panel B of Figure 12. In Case 2, the second channel contributes to the investment premium as well. High investment is driven by type $l$ projects which have lower discount rates, $R_l$, while low investment firms have low shares of type $l$ capital. Consequently, Figure 12 confirms that our prediction of a stronger investment premium in Case 2 holds in the model, and that this feature of the model is consistent with the empirical evidence.

**Prediction 5**: The profitability of new entrants is lower in Case 2 compared to Case 1.

In Section 2.3.3, we show that the profitability of new stock market entrants in the data is higher before the late 1970s than in the last four decades. The lower profitability of newly IPO’d firms is consistent with our mechanism. We introduce new young firms into the simulation each period, and all type $l$ projects of these firms are in the pre-boom stage. As a result, new firms are likely to exhibit lower profitability. Moreover, the share
of type \( l \) projects in Case 2 is higher leading to lower average profitability of new entrants compared to Case 1. Figure 9 shows that our model is in line with this prediction and closely matches the average profitability of new entrants in both Cases 1 and 2.

In Appendix IA.2, we discuss comparative statics of the model for four special illustrations. First, we set the average \( R_s \) and \( R_l \) in Case 2 equal to the values in Case 1. We find that Case 1 and Case 2 deliver similar qualitative and quantitative implications in this illustration, ensuring that the discount rate channel is essential for creating differences between cases. Second, we shut off unconditional discount variation across firms. For Case 2, removing firm-level discount rate variation quantitatively dampens the negative correlation between profitability and investment, and it reduces the investment and profitability premia. However, the qualitative conclusions from the baseline simulation are unchanged. Third, we find no significant change in model implications when we set the turnover rate in the stock market and the initial firm size in Case 2 equal to the values in Case 1. Finally, we find that the correlation between investment and profitability in Case 2 does not become negative in simulations without entry and exit. The underlying reason is that firms with low profitability and a high share of pre-boom type \( l \) projects are crucial to generating the negative between-firm correlation discussed in the context of Prediction 2 above.

To summarize, our model captures differences in the interplay between investment, profitability, and equity returns in two major samples over the last century. Differences between Cases 1 and 2 characterized in our five predictions above explain our main empirical findings in Section 2. Furthermore, our long- versus short-term discount rate framework provides a new economic explanation for the behavior of investment, profitability, and their corresponding equity return spreads.
4. Potential Reasons for the Change

The negative correlation between firm investment and profitability after 1979 can be explained by increasing firm investment in long-term projects with low initial profitability compared to short-term projects with high initial profitability. However, firms would only invest more in long-term projects if, on average, the relative value of long- versus short-term projects increased. Thus, the present value relation implies that either investors’ beliefs about expected long-term cash flows increased, their discount rates for long-term projects fell, or both happened to some degree. We provide direct evidence of the discount rate channel by showing that the duration-sorted portfolio return spread became highly negative after 1979, and we show in a quantitative exercise that the discount rate channel can sufficiently explain the changing correlation between firm investment and profitability as well as the change in their corresponding return spreads.

In this section, we explore one possible reason that may have driven the change in investors’ long-term discount rates and their beliefs about long-term cash flows. We argue that the rise of venture capital is a plausible catalyst for these changes. Additionally, we discuss how several other competing explanations, such as changes in executive compensation contracts and firm acquisition motives, are not consistent with our findings.
4.1 The Rise of Venture Capital

Venture capital investments often target firms with long-term potential rather than high current profitability. Additionally, a plausibly exogenous law change in 1979 greatly increased the amount of venture capital investments. More specifically, restrictions on pension funds against investing in venture capital were relaxed by the enactment of the Employee Retirement Income Security Act (ERISA). Gompers (1994) documents that, following the law change, “pension fund commitments to venture capital rose dramatically, increasing annual new contributions to venture capital funds from $100-200 during the 1970s to in excess of $4 billion by the end of the 1980s.” This led to a twenty-fold increase in venture capital funds’ investments in real businesses from $323 million in 1978 to $6 billion by the end of the 1980s (see panel A of Figure 13). The long-term view of venture capital combined with the timing of its rise beginning in 1979 may explain why equity investors started to view long-term projects more favorably.

On its own, the increasing amount of venture capital investing does not sufficiently explain equity investors’ overall shift in preferences towards long-term capital. Venture capital, despite its growth, is still only a small fraction of the overall equity market. More importantly, venture capital funds invest in private firms, whereas we observe a change in the return spread between publicly traded short- and long-term firms. Therefore, venture capital’s impact on discount rates must be from its indirect influence on investors’ views. There are several pieces of evidence that suggest this is the case. First, we show that awareness of venture capital has greatly increased in the general public. Panel B of Figure 13 shows that the number of books published in the United States that mention “venture capital” grew by three-fold from 1978 to the end of the 1980s. Kortum and Lerner (2000)

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18For example, in 1957, Georges F. Doriot, regarded as the “father of venture capitalism,” criticized Digital Equipment Corporation’s president for reporting a profit, arguing that a better use for the money was re-investing it to increase R&D (Gompers (1994)).
present evidence that more venture capital investing within an industry can spur long-term goals like increasing R&D spending and future patenting within the industry.

Second, venture capital funds primarily profit from their investments in portfolio companies through successful exits i.e., when these companies are acquired or have an IPO. Because IPOs are purchased by the broader equity market, if newly listed firms also exhibit low profitability and high investment rates, this would signal a change in the taste of the broader equity market. Panel C and D of Figure 13 show that this is the case. Panel C shows that the investment rate of newly IPO’d firms relative to their industry peers increased dramatically after 1979. Panel D shows that newly IPO’d firms were on average more profitable than other firms in the same industry before 1979, but became less profitable than their industry peers after 1979. Previously, Fama and French (2004) found a similar result and conjectured that the change in new lists could be due to a “decline in the cost of new list equity capital after 1979.” The fact that more firms with low profitability and high investment successfully go public suggests that the stock market became more welcoming to long-duration firms after the late 1970s.

Finally, Figure 4 shows that the correlation between investment and profitability became negative about 10 years earlier among firms that are more similar to the targets of venture capital investment (NASDAQ, small-cap, and growth firms) than among firms that are less similar to venture capital targets (NYSE/AMEX, large-cap, and value firms). The lag between the effect in VC targeted firms and non-VC targeted firms is important because this helps address the concern that the influence went in the other direction i.e., that views of the average equity investor changed first which subsequently drove the rise in venture capital. If this were the case, then we would expect NYSE/AMEX, large-cap, and value firms to experience the shift in correlation before NASDAQ, small-cap, and growth firms. Large firms make up the majority of the equity market’s total value and
thus are more representative of the average investor’s portfolio. Additionally, we would not expect the change to coincide with a plausibly exogenous rise in the level of venture capital investing. The earlier change in correlation among smaller and growing firms indicates that perceptions of long-term investments among venture capitalists diffused into the broader equity market with some delay. Together, these pieces of evidence suggest that the increasing prominence of venture capital may have influenced the broader equity market to view long-term firms more favorably.

Venture capital could have influenced equity investors by raising their perceptions of the profitability of long-term projects, and it could have decreased investors’ discount rates of long-term projects. We provide direct evidence of the discount rate channel, but we do not have direct evidence on whether investors’ beliefs of long-term profitability also changed. Nevertheless, a change in beliefs about long-term profitability is also consistent with our findings. If investors began to believe that long-term projects were highly profitable, this would also increase long-term investment at the expense of current profitability. Furthermore, if investors overestimate the profitability of long-term firms, this may generate low realized returns for high duration firms as these firms will be overvalued.

[FIGURE 13 ABOUT HERE]

4.2 Changes in Executive Compensation

An alternative hypothesis to explain our findings could be that investors always had lower discount rates for long-term projects, and that changes in executive compensation contracts through time better aligned managers with investors’ long-term focus. There is indeed some evidence that stock-based incentive pay has increased after 1980. **Frydman and Saks (2010)** show that stock options and other stock-based incentives, such as restrict-
ed stocks, were a small portion of executive compensation before 1980, but began to be widely used afterwards. At first glance, it seems that this rise in stock-based compensation could explain why firms shifted more investment toward long-term projects without any change in investor beliefs or preferences. However, we argue that the change in executive compensation cannot explain all of our findings on its own. Specifically, we find that returns of high duration and low duration firms were similar before 1980. If investors always held a long-term oriented view, then we would expect high duration firms to have lower expected firms even in the pre-1980 period.

Furthermore, the rise in stock-based compensation may have been a side effect of investors’ increased tolerance of long-term projects. If investors can set compensation contracts, then they would choose compensation contracts to align managers with short-term goals in the early period and with long-term goals in the later period. The compensation contracts we observe in the data are consistent with this. In the early period, investors can directly incentivize managers to pursue short-term profitability with profitability-based bonuses. In the later period, investors can incentivize managers to pursue long-term projects with stock-based compensation, because direct signals of long-term profitability are not timely enough for use in compensation contracts.

### 4.3 Firm Acquisitions

Another potential explanation for the negative correlation between firm investment and profitability is the firm diversification/acquisition motive. Many papers in the firm diversification literature argue that firms are more likely to pursue acquisitions when their existing business(es) are unprofitable. This is because, when a firm is unprofitable, the relative value of re-investing in the firm is low compared to acquiring another firm.\(^{19}\)

\(^{19}\)Maksimovic and Phillips (2002) use this argument to explain the firm diversification discount. Hoberg and Maksimovic (2018) show that firms go through life cycles, and, when firms reach a point of declining...
This could generate a negative relation between firm profitability and investment that is unrelated to discount rate changes. If firms acquire when they are unprofitable, and they expand their balance sheets to finance these acquisitions by issuing equity or debt, then acquiring firms would have low profitability and high asset growth. One direct way to address this concern is to use a measure of firm investment that is not related to mergers and acquisitions. In Figure 5, we find that capital expenditure, which does not increase with acquisitions, also exhibits a change in correlation with profitability after the 1980s. We also note that acquiring firms tend to be large mature firms. However, we find in Figure 4 that the change in the investment-profitability correlation among small growth firms led the change in large mature firms. Second, it is hard for this theory to explain the positive correlation between firm investment and profitability in the pre-1979 period. In order to explain the positive correlation, firms must be more likely to acquire when they are most profitable – when the relative value of acquiring another firm versus re-investing in themselves is lowest. Finally, we directly identify acquirers (based on tickers, 6-digit CUSIP, and names) using the SDC M&A database and show that the change in correlation between profitability and investment remains after excluding these firms (see Figure IA.3).

5. Conclusion

Investment and profitability are highly popular firm attributes used in the financial economics literature. In this paper, we document that the time-series correlation between investment and profitability factors is highly negative from the 1920s to the late 1970s, and highly positive in the last four decades. We show that a corresponding change occurred in the cross-sectional relation between investment and profitability among US public firms. Growth, they search for opportunities to acquire other companies to maintain growth.
We present a single economic mechanism that can explain these novel facts, the insignificance of investment and profitability factors prior to the late 1970s, and their significance since then.

In our model, firms choose between immediately profitable short-term projects and long-term projects with delayed profitability. We show that all our findings regarding the fundamental change in the late 1970s are plausible consequences of a decrease in the relative discount rates of long-term projects. We provide empirical evidence for such a change: expected equity returns in the cross-section are not sensitive to firm cash flow duration prior to the late 1970s, but strongly decreasing in duration during the last four decades. Our mechanism predicts that very low discounts for long-term projects lead to an association of high investment with low contemporaneous profitability as in the data after the late 1970s, especially in the presence of young firms that invest in long-term projects that are still in the low profitability stage. Furthermore, profitability and investment factors are closely linked to differences in discount rates of short- and long-term cash flows explaining the insignificance of these factors prior to the 1980s along with their significance since then. In sum, our framework rationalizes 1) the higher share of long-term capital since the late 1970s, 2) the positive (negative) correlation between firm investment and profitability in the cross-section prior to (after) the late 1970s, 3) the insignificance of the profitability and investment premia prior to the late 1970s, and their significance afterwards, 4) the lower profitability of new public firms after the late 1970s.

We provide evidence that the rise of venture capital starting in the late 1970s is a likely driver of increased investor tolerance towards long-term investments. Its influence is evident in the increasing public awareness of – and investment in – venture capital. Our evidence suggests a spillover to US public firms that completely altered the interpretation of investment and profitability both for asset pricing and for understanding firm behavior.
THE GREAT DIVORCE BETWEEN INVESTMENT AND PROFITABILITY

Appendix

A. Definition of Variables

- **Asset Growth** measures firm investment rate and is defined as the growth rate of total assets: \( \text{asset growth}_t = (\text{at}_t - \text{at}_{t-1})/\text{at}_{t-1} \).

- **Investment Factor** is a portfolio that is long stocks of firms with low asset growth and is short firms with high asset growth. Fama and French (2015) and Hou et al. (2015) construct an investment factor using stock return data since July 1963, and Linnainmaa and Roberts (2018) construct a similar factor using data going back to July 1926.

- **Operating Profitability** measures firm profitability and is defined as revenue minus cost of goods sold, SG&A, and interest expense all normalized by the book value of equity: \( \text{operating profitability}_t = (\text{rev}_t - \text{cogs}_t - \text{xsga}_t - \text{xint}_t)/\text{be}_t \).

- **Profitability Factor** is a portfolio that is long stocks of firms with high operating profitability and is short firms with low operating profitability. Fama and French (2015) and Hou et al. (2015) construct a profitability factor using stock return data since July 1963, and Linnainmaa and Roberts (2018) construct a similar factor using data going back to July 1926. Because SG&A is not available in earlier years, Linnainmaa and Roberts (2018) construct operating profitability without subtracting SG&A.

- **Tangible Investment** is defined as capital expenditure minus sales of PP&E all normalized by lagged net PP&E: \( \text{capital expenditure}_t = (\text{capx}_t - \text{sppe}_t)/\text{ppent}_{t-1} \). Belo et al. (2014) use capital expenditure to predict stock returns.
• **Intangible Investment** is computed following Peters and Taylor (2017) and is defined as R&D expense plus 30% of SG&A expense all divided by lagged intangible capital: intangible investment\(_t\) = \((x_{\text{rd}} + 0.3 * x_{\text{sga}})/k_{\text{int}}^{t-1}\). Peters and Taylor (2017) compute intangible capital by applying the perpetual-inventory method to a firm’s past R&D and SG&A.


• **Size** is firms’ market capitalization as of December of the fiscal year.

**B. Model Calibration and Simulation Details**

We calibrate the model at the annual frequency. Target moments of our calibration are based on the data from the period before the 1980s.

• We set capital depreciation rates \(\delta_s\) and \(\delta_l\) to 10%, close to standard values in the literature.

• We assume that \(a_{s,t}\) and \(a_{l,t}\) evolve independently across firms. Both processes are assumed to follow a Markov chain with 20 nodes that approximates the following process:

\[
\log(a_{i,t+1}) = (1 - \rho_i)\bar{a}_i + \rho_i \log(a_{i,t}) + \sigma_i \epsilon_{i,t+1},
\]

(19)

where the parameters are calibrated to match the investment rate levels in Panel B of Figure 10, and the volatility of profitability which is 21% in the pre-1980 data. This results in \(\bar{a}_s = -1.15, \rho_s = 0.55, \sigma_s = 0.45\) and \(\bar{a}_l = -2.25, \rho_l = 0.65, \sigma_l = 0.45\).

• We choose \(\alpha_s = \alpha_l = 1.2\) resulting in an average investment rate of 16% as in the pre-1980 data.
• We assume that $\tilde{\theta}$ has a lognormal distribution with a mean of 28.75 and a median of 1. This ensures that shadow value of type $l$ capital and investment in type $l$ projects are positive for all values of $a_{l,t}$, while the median post-boom performance of type $l$ projects is worse than type $s$ projects capturing the notion that long duration projects are “unicorns” that are rarely successful, but highly profitable conditional on success.

• We set the discount rates to $R_i = \bar{R}_i + \epsilon^R$, where $\bar{R}_s = 12.5\%$ and $\bar{R}_l = 15\%$ in Case 1, and $\bar{R}_s = 16.5\%$ and $\bar{R}_l = 9.5\%$ in Case 2 consistent with the evidence on duration-sorted portfolio returns in Section 2. $\epsilon^R$ is the firm-specific and time-invariant discount rate component, independently drawn from a demeaned Gamma distribution with skewness -0.8 and variance 0.001 for each firm.

• We set the length of the pre-boom period for long-term projects to $T = 10$ years.

• We assume that 3% (5%) of firms in Case 1 (Case 2) in the panel of firms are replaced by new firms. Both values are close to the IPO rates provided on Jay Ritter’s website. Furthermore, we assume that firms are born with zero capital and enter the stock market 4 (2) years after creation in Case 1 (Case 2).

• For each case, we simulate 150 panels of 5000 firms with length 100 years and use the first 50 years as the burn-in period. Reported results are averages from all simulated panels. We define profitability in year $t$ as $\text{prof}_t = \pi_t / \sum_{i \in \{s,l\}} \sum_{\nu=0}^{N_t} k_{i,t-\nu,t}$, and the investment rate in year $t$ is given by $\text{inv}_t = \sum_{i \in \{s,l\}} k_{i,t,t} / \sum_{i \in \{s,l\}} \sum_{\nu=1}^{N_t} k_{i,t-\nu,t}$.

• Figure 10 uses contemporaneous values for $\text{prof}_t$ and $\text{inv}_t$. Figure 11 and 12 report averages of $r_{t+1}$ from sorts based on $\text{prof}_t$ and $\text{inv}_t$, respectively. For Figure 8, we combine simulations of Case 1 and Case 2 together and compute the median of the
share of pre-boom long duration capital among all firm-year observations. Subsequently, we report the percentage of firms below and above this median in Cases 1 and 2, respectively, consistent with the empirical share of high duration firms in Figure 8.
The Great Divorce Between Investment and Profitability

References


Hou, Kewei, Haitao Mo, Chen Xue, and Zhang, 2018, \( \{q\}^5 \), SSRN Scholarly Paper ID 3191167, Social Science Research Network, Rochester, NY.


Figure 1: Relation Between Investment and Profitability Factors

This figure reports moving averages of monthly percentage returns for the profitability (RMW) and investment (CMA) factors from July 1926 through May 2019. Each point represents the average return for a ten-year window centered on the date indicated by the $x$-axis. The first point corresponds to June 1931 and represents the average return from July 1926 through June 1936. The plots before June 1968 are generated using data from Linnainmaa and Roberts (2018) and the plots after June 1968 are generated using data from Fama and French (2015). Note that the investment factor (profitability factor) is constructed by going long firms with low asset growth (high operating profitability) and shorting firms with high asset growth (low operating profitability). The red vertical line indicates July 1980. The correlation between smoothed CMA and RMW factors is $-0.60$ before July 1980 and $0.70$ afterwards.
Figure 2: Relation Between Firm Investment and Profitability

This figure reports the time series of the cross-sectional correlations between firms’ investment, measured by asset growth, and profitability, measured by operating profitability, in each year from 1931 to 2017. Before 1962, the plot uses measures from Linnainmaa and Roberts (2018) and, after 1962, the plot uses measures constructed following Fama and French (2015). See Appendix A for variable definitions and Section 2.2 for sample construction. The red vertical line indicates the year 1979.
Figure 3: Relation Between Firm Investment and Profitability By Sector

This figure reports the time series of the cross-sectional correlations between firms’ investment, measured by asset growth, and profitability, measured by operating profitability, in each year from 1931 to 2017. This figure reports the time series of the cross-sectional correlations between investment, measured by asset growth, and profitability, measured by operating profitability, within sector subsamples in each year from 1962 to 2017. Industry sectors are defined based on the 1-digit Standard Industry Classification. See Appendix A for variable definitions. The red vertical line indicates the year 1979.
Figure 4: Relation Between Firm Investment and Profitability by Firm Characteristics

This figure reports the time series of the cross-sectional correlations between investment, measured by asset growth, and profitability, measured by operating profitability, in traded exchange (Panels A and B), market capitalization (Panels C and D), and book-to-market ratio (Panels E and F) subsamples in each year from 1962 to 2017. See Appendix A for variable definitions. The red vertical line indicates the year 1979.
Figure 5: Firm Investment and Profitability Before and After Later 1970s

This figure shows the cross-sectional relationship between firm investment and profitability before and after 1979. In each year, firms are sorted into ten bins based on their operating profitability defined following Fama and French (2015). The average investment rate for each bin in each year is computed and then is averaged across all years. The blue bars show the standard errors of the average investment rate across years. Panel A contains results from the 1962 to 1978 sample, and Panel B contains results from the 1979 to 2017 sample. Specification (2) sorts large-cap and small-cap firms separately and weighs firms in each bin using firm size; (3) sorts firms within each SIC 2-digit industry separately; (4) examines firms’ asset growth in the next year; (5) examines firms’ tangible investment; (6) examines firms’ intangible investment. See Appendix A for variable definitions. The red vertical line indicates the year 1979.

Panel A: Early Period (1962-1978)

Panel B: Later Period (1979-2017)
Figure 6: Relation Between Firm Investment and Profitability: Entry & Exit Versus Within-Firm Dynamics

This figure decomposes the cross-sectional correlation between firm investment and profitability into a between-firm component and a within-firm component. To construct the between-firm correlation, we first demean firms’ investment and profitability by year. We then compute the time-series averages of demeaned investment and demeaned profitability for each firm. Panel A plots the correlation of the time-series average demeaned investment and demeaned profitability for each firm. These time-series averages are constant through time for each firm, so any changes in the cross-sectional correlation across years must be due to the entry and exit of firms. We then compute the investment and profitability in excess of their respective firm mean values for each firm-year. Panel B shows the correlation between the excess investment and profitability in each cross-section. See Section 2.2 for more details and Appendix A for variable definitions.
Figure 7: Changes in Firm Duration

Panel A reports the proportion of high-duration firms in each year from 1962-2008. High-duration firms are defined as firms with expected equity duration above 20 years, which is the median duration of our pooled sample. The expected equity duration is computed following section 2.3.1. Panel B shows the distribution of firms’ expected equity durations from 1962 to 1978 and from 1979 to 2008.
Figure 8: Model vs. Data—Share of High Duration Firms

This figure compares the proportion of high duration firm-years in the data with the average proportion of high duration firms from the model simulations. In the data, high duration firms are defined as firms that have higher expected equity duration than the overall sample median duration across firms and years. In both the early and later periods, we compute the proportion of high duration firm-years. In the model simulations, high duration firms are defined as firms that have higher pre-boom long-term capital share (amount of pre-boom capital divided by amount of total capital) than the overall sample median pre-boom long-term capital share across firms and years. In both early and later period simulations, we compute the proportion of high duration firm-years. The model results are computed as the average from 150 simulations. See Appendix B for more details on the model simulations.
Figure 9: Model vs. Data—Profitability of Newly IPO’d Firms

This figure compares the average profitability of new firms in the data (left) and from the model simulations (right). Profitability in the data is measured as operating profitability (see more details in Appendix A). The model results are computed as the average from 150 simulations. See Appendix B for more details of the model simulations.
Figure 10: Model vs. Data—Firm Profitability and Investment Before and After 1979

This figure compares the mean investment by profitability decile in the data (left) and from the model simulations (right). Subfigures (a) and (b) compare data and model results in the pre-1979 period, and subfigures (c) and (d) compare results from the post-1979 period. The data figures are constructed following Figure 5 where investment is measured as asset growth and profitability is measured as operating profitability (see more details in Appendix A). The model results are computed as the average from 150 simulations. See Appendix B for more details of the model simulations.
Figure 11: Model vs. Data—Returns of Portfolios Sorted by Profitability

This figure compares the value-weighted investment decile portfolio annual returns in the data (left) and from the model simulations (right). Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Appendix B for more details of the model simulations.
Figure 12: Model vs. Data—Returns of Portfolios Sorted by Investment

This figure compares the value-weighted profitability decile portfolio annual returns in the data (left) and from the model simulations (right). Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Appendix B for more details of the model simulations.
Figure 13: Rising Venture Capital after 1979

Panel A plots venture capital investments in U.S. companies based on deals from the Thompson One database in each year from 1970 through 2018. The y-axis plots the natural log of VC investment deflated to the 1970 price level. Panel B plots the ratio of the 2-gram “venture capital”, including all upper and lower cases, compared to all 2-grams in English-language books published in the United States in each year from 1960 to 2008. The plotted line is smoothed by taking a 1-year trailing moving averages. The source data are obtained by searching “venture capital” in the Google Books Ngrams Viewer. Panel C and D plot the industry-adjusted investment and profitability of newly IPO’d firms in each year from 1962 to 2017. Newly IPO’d firms are defined as firms within their first 3 years in the CRSP database. Investment and profitability of newly IPO’d firms are adjusted by subtracting the average investment and profitability in the same year and SIC 2-digit classification. The red vertical line indicates the year 1979, which coincides with the enactment of the Employee Retirement Income Security Act that freed pensions to invest in venture capital funds.
**Table 1: Summary Statistics and Correlations**

This table reports time series averages of annual cross-sectional means and standard deviations for firm characteristics and return predictors in Panel A and contemporaneous correlations of these variables in Panel B. \( OP \) is operating profitability computed following Fama and French (2015); \( Inv \) is asset growth; \( Tang.Inv \) is tangible investment defined as capital expenditure divided by total assets; \( Intan.Inv \) is investment in intangible assets following Peters and Taylor (2017); \( Dur \) is expected equity duration; \( BM \) is the book-to-market ratio; and \( Size \) is the market capitalization in millions. Our sample includes firms that appear in Compustat for at least two years with fiscal year ends between 1962 and 2017. We exclude firms with market capitalization below the 5th NYSE size percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OP</th>
<th>Inv</th>
<th>Tang.Inv</th>
<th>Intan.Inv</th>
<th>Dur</th>
<th>BM</th>
<th>Size</th>
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<td>Mean</td>
<td>0.22</td>
<td>0.24</td>
<td>0.36</td>
<td>0.28</td>
<td>18.67</td>
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<td>Mean (1962-1978)</td>
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<td>0.29</td>
<td>0.29</td>
<td>17.25</td>
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<td>Std (1962-1978)</td>
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<td>0.33</td>
<td>0.20</td>
<td>1.39</td>
<td>0.64</td>
<td>1.36</td>
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<td>AutoCorr (1963-1978)</td>
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<td>Mean (1979-2017)</td>
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<td>0.28</td>
<td>19.48</td>
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<td>Std (1979-2017)</td>
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<td>0.71</td>
<td>0.59</td>
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<td>2.92</td>
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<td>AutoCorr (1979-2017)</td>
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<td>0.42</td>
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<td>0.76</td>
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**Panel B: Contemporaneous Correlations**

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<tr>
<th></th>
<th>OP</th>
<th>Inv</th>
<th>Tang.Inv</th>
<th>Intan.Inv</th>
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<td>( OP )</td>
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<td>Inv</td>
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<td>Dur</td>
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<td>-0.22</td>
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Table 2: Expected Duration Cross-Sectional Regressions
This table reports the predictive regression results for estimating firms’ expected equity duration. Panel A reports the main multivariate regression and Panel B reports the univariate regression for each predictor. The dependent variable in each cross-sectional regression is log realized duration $\log(Dur_{i,t})$ where $Dur_{i,t}$ is computed following equation (1) using future cash flows. $\log(ME)$ is the market capitalization. $ROE$ is return-on-equity which is defined as current year earnings before extraordinary items divided by last year’s ending book equity where book equity is computed following Fama and French (1992). $\Delta BV$ is the percent change in book equity: $BV_{i,t}/BV_{i,t-1} - 1$. Our sample includes non-financial and non-utilities firms with common stock traded on the NYSE, Amex, or NASDAQ exchanges in July of the year following the fiscal year-end year. The table displays time-series means of each of the cross-sectional regression coefficients as well as time-series means of the cross-sectional $R^2$ statistics, the cross-sectional Pearson correlations between the expected and the realized durations, and the cross-sectional rank correlations between the expected and realized durations. Newey-West $t$-statistics for the time-series means are reported in parentheses. The sample period is 1962-2008.

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<th>log($ME$)</th>
<th>ROE</th>
<th>$\Delta BV$</th>
<th>$R^2$</th>
<th>Pearson</th>
<th>Rank</th>
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<tr>
<td>$-0.06$</td>
<td>$-0.23$</td>
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<td>11.32</td>
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<td>$(-6.78)$</td>
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<td>(7.33)</td>
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<table>
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<td>(3.25)</td>
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</table>
Table 3: Duration-Sorted Decile Portfolios

This table shows average monthly gross returns for decile portfolios sorted by expected duration from July 1963 to June 1980 in Panel A and from July 1980 to June 2010 in Panel B. Portfolios are rebalanced annually at the end of June in year \( t \) using the expected duration from the fiscal year ending in year \( t - 1 \). All returns are value-weighted. The row labeled \( Dur \) shows the time-series averages of the median durations for each portfolio. In order to be included in the sample, the stock must be a non-financial and non-utilities common stock traded on the NYSE, Amex, or NASDAQ exchanges. Newey-West standard errors for the average portfolio returns are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

<table>
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<th></th>
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<tr>
<td>Dur</td>
<td>15.94</td>
<td>16.53</td>
<td>16.89</td>
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<td>Ret</td>
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<td>0.74**</td>
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<td>(0.41)</td>
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<td><strong>Panel B: After 1979 Sample</strong></td>
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<td>SE</td>
<td>(0.24)</td>
<td>(0.32)</td>
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<td>(0.42)</td>
<td>(0.41)</td>
<td>(0.43)</td>
<td>(0.47)</td>
<td>(0.54)</td>
<td>(0.59)</td>
<td>(0.43)</td>
</tr>
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</table>
IA.1. Additional Empirical Evidence

Figure IA.1: Relation Between Investment and Profitability Factors–FF Sample

This figure reports moving averages of monthly percentage returns for the profitability (RMW) and investment (CMA) factors from July 1963 through May 2019 from Fama and French (2015). Each point represents the average return for a ten-year window centered on the date indicated by the x-axis. The first point corresponds to June 1968 and represents the average return from July 1963 through June 1973. Note that the investment factor (profitability factor) is constructed by going long firms with low asset growth (high operating profitability) and shorting firms with high asset growth (low operating profitability). The red vertical line indicates July 1980. The correlation of monthly returns for CMA and RMW factors is −0.61 before July 1980 and 0.13 afterwards.
Figure IA.2: Relation Between Firm Investment and Profitability of Long-Lived Firms

This figure reports the time series of the cross-sectional correlations between investment, measured by asset growth, and profitability, measured by operating profitability for firms that survive in CRSP sample for ten or more years. See Appendix A for variable definitions. The red vertical line indicates the year 1979.
**Figure IA.3: Relation Between Firm Investment and Profitability By Acquiror Status**

We identify whether a firm is an acquiror by matching the acquirors and acquirors’ parent firms in the SDC Platinum database by ticker, CUSIP, or name to Compustat. We label a firm as an acquiror if it made any acquisitions within 400 days of the Compustat datadate. Acquirors account for 21% of our final sample from 1981 to 2017.

**IA.2. Model Robustness**

In the model, Case 1, representing the early period, and case 2, representing the later period are distinguished by two features. Case 1 has higher discount rates for long-term projects compared to short-term projects, while case 2 has higher discount rates for short-term projects compared to long-term projects. Additionally, case 2 has more young firms as it has a higher firm entry rate and a lower number of burn-in periods for new firms. Finally, both cases have firm-level variation in discount rates. In this section, we demonstrate that the short- versus long-term discount rate channel is the key driver for generating our qualitative results, not the different firm entry rates across cases or firm-level discount rate variation.

We perform a falsification test where the short- and long-term discount rates in case 2 are the same as in case 1 ($R_s = 1.125$ and $R_l = 1.15$), but the entry rate and burn-in in case 2 are still different. If the discount rate channel drives the differences between case 1 and case 2 and not the differences in firm entry parameters, then shutting down the discount rate variation...
rate should generate similar results in both cases. Figures IA.4, IA.5, IA.6, IA.7, and IA.8 show that both cases have nearly identical model simulation results when they have the same discount rates. Therefore, only varying firm entry parameters without decreasing relative discount rates for long-term projects is not sufficient for generating the results we see in the baseline model simulation.

Next, we simulate the model without firm-level discount rate variation ($\epsilon^R_j = 0$). In our model, the purpose of the firm-level discount rate variation is to introduce a source of discount rate variation that is unrelated to the difference between short- and long-term discount rates. This should increase the cross-sectional variance of investment, create an investment return spread in case 1, and steepen the investment return spread in case 2. Therefore, shutting down firm-level discount rate variation should not affect the qualitative results of the model, although it may alter the its quantitative fit. The simulation results with no firm-level discount variation in Figures IA.9, IA.10, IA.11, IA.12, and IA.13 show that this is the case. Figure IA.9 shows that the proportion of high duration firms is still much higher in case 2 compared to case 1. Figure IA.10 shows that new firms are still less profitable in case 2. Figure IA.11 shows that firm investment and profitability are still highly positively correlated in case 1, and they are still negatively correlated in case 2, although the cross-sectional variance of investment is muted. Figure IA.12 shows that the profitability return spread is flat in case 1 and positive in case 2, as in the baseline model. Finally, Figure IA.13 shows that the investment return spread is flat in case 1, as expected, but it is still negative in case 2.

We show that the different firm entry parameters in case 2 do not drive the results by setting the firm entry parameters to be the same as in case 1 (0.03 entry rate and 4 burn-in periods for new firms). The simulated results with the same entry parameters are in Figures IA.14, IA.15, IA.16, IA.18, IA.17, and IA.18. We see that the results with the same
entry parameters are very similar to the baseline model. The primary impact of differing entry parameters is making the firm investment-profitability relationship in case 2 more monotonically decreasing.

Finally, motivated by the evidence in Figure 6 showing that the between firm correlation is key for the negative relationship between investment and profitability, we resimulate the model with no entry or exit. Shutting down entry and exit will ensure that all simulation results are due to within firm dynamics. In order to match the data, we should observe a positive correlation between investment and profitability in both cases, even though long-term discount rates fall in case 2. The simulated results with no exit and entry are in Figures IA.19, IA.20, IA.22, IA.21, and IA.22. Figure IA.20 confirms that, without entry and exit, the cross-sectional correlation between investment and profitability is positive in both cases.
Figure IA.4: **Same Short- and Long-Term Discount Rates: Share of High Duration Firms**

This figure compares the proportion of high duration firm-years in the data with the average proportion of high duration firms from the model simulations, where the simulations have the same short- and long-term discount rates in case 1 and case 2. In the data, high duration firms are defined as firms that have higher expected equity duration than the overall sample median duration across firms and years. In both the early and later periods, we compute the proportion of high duration firm-years. In the model simulations, high duration firms are defined as firms that have higher pre-boom long-term capital share (amount of pre-boom capital divided by amount of total capital) than the overall sample median pre-boom long-term capital share across firms and years. In both early and later period simulations, we compute the proportion of high duration firm-years. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.5: Same Short- and Long-Term Discount Rates: Profitability of Newly IPO’d Firms

This figure compares the average profitability of new firms in the data (left) and from the model simulations (right) with the same short- and long-term discount rates in case 1 and case 2. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.6: Same Short- and Long-Term Discount Rates: Firm Profitability and Investment Before and After 1979

This figure compares the mean (industry-adjusted) investment by profitability decile in the data (left) and from the model simulations (right) with the same short- and long-term discount rates in case 1 and case 2. Subfigures (a) and (b) compare data and model results in the pre-1979 period, and subfigures (c) and (d) compare results from the post-1979 period. The data figures are constructed following Figure 5 where investment is measured as asset growth and profitability is measured as operating profitability. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.7: Same Short- and Long-Term Discount Rates: Returns of Portfolios Sorted by Profitability

This figure compares the value-weighted profitability decile portfolio annual returns in the data (left) and from the model simulations (right) with the same short- and long-term discount rates in case 1 and case 2. Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.8: Same Short- and Long-Term Discount Rates: Returns of Portfolios Sorted by Investment

This figure compares the value-weighted investment decile portfolio annual returns in the data (left) and from the model simulations (right) with the same short- and long-term discount rates in case 1 and case 2. Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
**Figure IA.9: No Firm-Level Discount Rate Variation: Share of High Duration Firms**

This figure compares the proportion of high duration firm-years in the data with the average proportion of high duration firms from the model simulations without firm-level discount rate variation. In the data, high duration firms are defined as firms that have higher expected equity duration than the overall sample median duration across firms and years. In both the early and later periods, we compute the proportion of high duration firm-years. In the model simulations, high duration firms are defined as firms that have higher pre-boom long-term capital share (amount of pre-boom capital divided by amount of total capital) than the overall sample median pre-boom long-term capital share across firms and years. In both early and later period simulations, we compute the proportion of high duration firm-years. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.10: No Firm-Level Discount Rate Variation: Profitability of Newly IPO’d Firms

This figure compares the average profitability of new firms in the data (left) and from the model simulations (right) without firm-level discount rate variation. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.11: No Firm-Level Discount Rate Variation: Firm Profitability and Investment Before and After 1979

This figure compares the mean (industry-adjusted) investment by profitability decile in the data (left) and from the model simulations (right) without firm-level discount rate variation. Subfigures (a) and (b) compare data and model results in the pre-1979 period, and subfigures (c) and (d) compare results from the post-1979 period. The data figures are constructed following Figure 5 where investment is measured as asset growth and profitability is measured as operating profitability. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.12: No Firm-Level Discount Rate Variation: Returns of Portfolios Sorted by Profitability

This figure compares the value-weighted profitability decile portfolio annual returns in the data (left) and from the model simulations (right) without firm-level discount rate variation. Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.

(a) Data: Early Period

(b) Model: Case 1

(c) Data: Later Period

(d) Model: Case 2
Figure IA.13: No Firm-Level Discount Rate Variation: Returns of Portfolios Sorted by Investment

This figure compares the value-weighted investment decile portfolio annual returns in the data (left) and from the model simulations (right) with without firm-level discount rate variation. Sub-figures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.

(a) Data: Early Period

(b) Model: Case 1

(c) Data: Later Period

(d) Case 2: Model
Figure IA.14: Same Entry Parameters: Share of High Duration Firms

This figure compares the proportion of high duration firm-years in the data with the average proportion of high duration firms from the model simulations with the same entry parameters in both cases. In the data, high duration firms are defined as firms that have higher expected equity duration than the overall sample median duration across firms and years. In both the early and later periods, we compute the proportion of high duration firm-years. In the model simulations, high duration firms are defined as firms that have higher pre-boom long-term capital share (amount of pre-boom capital divided by amount of total capital) than the overall sample median pre-boom long-term capital share across firms and years. In both early and later period simulations, we compute the proportion of high duration firm-years. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.15: Same Entry Parameters: Profitability of Newly IPO’d Firms

This figure compares the average profitability of new firms in the data (left) and from the model simulations (right) with the same entry parameters in both cases. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.16: Firm Profitability and Investment Before and After 1979

This figure compares the mean (industry-adjusted) investment by profitability decile in the data (left) and from the model simulations (right) with the same entry parameters in both cases. Subfigures (a) and (b) compare data and model results in the pre-1979 period, and subfigures (c) and (d) compare results from the post-1979 period. The data figures are constructed following Figure 5 where investment is measured as asset growth and profitability is measured as operating profitability. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.17: Same Entry Parameters: Returns of Portfolios Sorted by Profitability

This figure compares the value-weighted profitability decile portfolio annual returns in the data (left) and from the model simulations (right) with the same entry parameters in both cases. Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.18: Same Entry Parameters: Returns of Portfolios Sorted by Investment

This figure compares the value-weighted investment decile portfolio annual returns in the data (left) and from the model simulations (right) with the same entry parameters in both cases. Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.19: No Entry and Exit: Share of High Duration Firms

This figure compares the proportion of high duration firm-years in the data with the average proportion of high duration firms from the model simulations without entry and exit. In the data, high duration firms are defined as firms that have higher expected equity duration than the overall sample median duration across firms and years. In both the early and later periods, we compute the proportion of high duration firm-years. In the model simulations, high duration firms are defined as firms that have higher pre-boom long-term capital share (amount of pre-boom capital divided by amount of total capital) than the overall sample median pre-boom long-term capital share across firms and years. In both early and later period simulations, we compute the proportion of high duration firm-years. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.20: No Entry and Exit: Firm Profitability and Investment Before and After 1979

This figure compares the mean (industry-adjusted) investment by profitability decile in the data (left) and from the model simulations (right) without entry and exit. Subfigures (a) and (b) compare data and model results in the pre-1979 period, and subfigures (c) and (d) compare results from the post-1979 period. The data figures are constructed following Figure 5 where investment is measured as asset growth and profitability is measured as operating profitability. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.21: No Entry and Exit: Returns of Portfolios Sorted by Profitability

This figure compares the value-weighted profitability decile portfolio annual returns in the data (left) and from the model simulations (right) without entry and exit. Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.
Figure IA.22: No Entry and Exit: Returns of Portfolios Sorted by Investment

This figure compares the value-weighted investment decile portfolio annual returns in the data (left) and from the model simulations (right) without entry and exit. Subfigures (a) and (b) compare data and model returns from July 1963 to June 1980, and subfigures (c) and (d) compare returns from July 1980 to June 2018. The model results are computed as the average from 150 simulations. See Internet Appendix IA.2 for the parameter values used in the model simulations.