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Investmentless Growth: An Empirical Investigation

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Abstract

We analyze private fixed investment in the U.S. over the past 30 years. We show that investment is weak relative to measures of profitability and valuation – particularly Tobin's Q, and that this weakness starts in the early 2000's. There are two broad categories of explanations: theories that predict low investment *along with* low Q, and theories that predict low investment *despite* high Q. We argue that the data does not support the first category, and we focus on the second one. We use industry-level and firm-level data to test whether under-investment relative to Q is driven by (i) financial frictions, (ii) changes in the nature and/or localization of investment (due to the rise of intangibles, globalization, etc), (iii) decreased competition (due to technology, regulation or common ownership), or (iv) tightened governance and/or increased short-termism. We do not find support for theories based on risk premia, financial constraints, safe asset scarcity, or regulation. We find some support for globalization; and strong support for the intangibles, competition and short-termism/governance hypotheses. We estimate that the rise of intangibles explains 25-35% of the drop in investment; while Concentration and Governance explain the rest. Industries with more concentration and more common ownership invest less, even after controlling for current market conditions and intangibles. Within each industry-year, the investment gap is driven by firms owned by quasi-indexers and located in industries with more concentration and more common ownership. These firms return a disproportionate amount of free cash flows to shareholders. Lastly, we show that standard growth-accounting decompositions may not be able to identify the rise in markups.

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In his March 2016 letter to the executives of S&P 500 firms, BlackRock's CEO Laurence Fink argues that, "*in the wake of the financial crisis, many companies have shied away from investing in the future growth of their companies. Too many companies have cut capital expenditure and even increased debt to boost dividends and increase share buybacks.*" The decline in investment has been discussed in policy papers [Furman, 2015, IMF, 2014, Vashakmadze et al., 2017]; as well as academic papers (see, for example, Hall [2015], Alexander and Eberly [2016], Fernald et al. [2017]). And it appears to affect not only the U.S. but also Europe and other emerging markets [Bussiere et al., 2015, Buca and Vermeulen, 2015, Dottling et al., 2017, Lewis et al., 2014, Kose et al., 2017].

This paper presents systematic evidence on the extent of the investment puzzle and provides a preliminary assessment of the potential explanations. We clarify some of the theory and the empirical evidence; and test whether alternate theories of under-investment are supported by the data. The main contributions of the paper are to show that: (i) the lack of investment represents a reluctance to invest despite high Tobin's Q; and (ii) this investment wedge is linked to the rise of intangibles, decreased competition and changes in governance that encourage payouts instead of investment.

We emphasize that the goal of our paper is not to establish causality of a particular mechanism. Instead, we present a broad overview of the available evidence and we review the proposed theoretical explanations. We spend much time and effort connecting the results at the firm-level, at the industry-level, and in the aggregate, and we discuss the macro-economic implications of our findings. The goal of our paper is to broadly test a large set of theories regarding investment dynamics. We find that competition and governance are promising explanations but we do not try to establish causality. We address the causality issue using a combination of instrumental variables and natural experiments in two related papers (Gutiérrez and Philippon [2017a] for competition and Gutiérrez and Philippon [2017b] for governance and short-termism).

Approach Throughout the paper, we use Q-theory as a measurement tool to distinguish between two broad types of shocks: (i) shocks that fit the Q equation, and therefore predict low investment *along with* low Tobin's Q; and (ii) shocks that change the Q equation and therefore predict low investment *despite* high Tobin's Q. The first category includes shocks to risk aversion and expected growth. The standard Q-equation holds under these shocks, so the only way they can explain low investment is by predicting low values of Q. The second category ranges from credit constraints to oligopolistic competition, and implies a shift in the first order condition for optimal investment. Such shocks create *a gap* between Q and investment due to differences between average and marginal Q (e.g., market power, growth options) and/or differences between firm value and the manager's objective function (e.g., governance, short-termism).

To differentiate between these two broad types of shocks, we study the relationship between private fixed investment and Q. We find that investment is weak relative to measures of profitability and valuation – particularly Tobin's Q. Time effects from industry- and firm-level panel regressions on Q suggest that this weakness starts around 2000. This is true controlling for firm age, size, and profitability; focusing on subsets of industries; and even considering tangible and intangible investment separately. Given these results, we discard shocks that predict low investment *along with* low Q; and focus on theories that create *a gap* between Q and investment. This still leaves a large set of potential explanations – out of which we consider the following eight (grouped into four broad categories):[1]

- Financial frictions
  1. External finance
  2. Bank dependence
  3. Safe asset scarcity
- Changes in the nature and/or localization of investment
  4. Intangibles
  5. Globalization
- Decreased Competition
  6. Regulation
  7. Market power due to other factors
- Tighter Governance
  8. Ownership and Shareholder Activism

Testing these hypotheses requires a lot of data, at different levels of aggregation. Some are industry-level theories (e.g., competition), some firm-level theories (e.g., ownership), and some theories that can be tested at the industry level and at the firm level. We gather industry investment data from the BEA and firm investment data from Compustat; as well as additional data needed to test each of the eight hypotheses.

For instance, for market power, we obtain (Compustat and Census) measures of firm entry, firm exit, price-cost margins, and concentration (including 'traditional' and common ownership-adjusted Herfindahls[2], as well as concentration ratios defined as the share of sales and market value of the Top 4, 8, 20 and 50 firms in each industry). For governance and short-termism, we use Brian Bushee's institutional investor classification [Bushee, 2001]. The classification identifies Quasi-indexer, Transient and Dedicated institutional investors based on the turnover and diversification of their holdings. Dedicated institutions have large, long-term holdings in a small number of firms. Quasi-indexers have diversified holdings and low portfolio turnover, consistent with a passive buy-and-hold strategy. Transient owners have high diversification and high portfolio turnover. Sample

[1] See Section 2 for a detailed discussion of these hypotheses.

[2] We follow Salop and O'Brien [2000] and Azar et al. [2016b] to compute the common ownership-adjusted Herfindahl, which accounts for anti-competitive incentives due to common ownership. See Section 2 for additional details

Dedicated, Quasi-indexer and Transient institutions include Berkshire Hathaway, Vanguard and Credit Suisse, respectively. See Section 3 for additional details.

Firm- and industry-data are not readily comparable because they differ in their coverage; and in their definitions of investment and capital. As a result, we spent a fair amount of time simply reconciling and understanding the various data sources. The key conclusions are summarized in Section 3 and in the Appendix. The final datasets are not entirely comparable, primarily due to differences between accounting and economic values. But they do exhibit similar trends. And our conclusions are robust across datasets and levels of aggregation.

Conclusions We test whether each of the eight hypothesis is supported by the data through industry- and firm-level panel regressions. We use the Erickson et al. [2014] cumulant estimator to control for 'classical' errors-in-variables problems in Q, and discuss key sources measurement error where appropriate. We find strong support for the Market power, Governance and Intangibles hypotheses:

- **Market power and Governance**: At the industry level, we find that industries with more quasi-indexer institutional ownership and less competition (as measured by higher 'traditional' and common ownership-adjusted Herfindahls, as well as higher price-cost margins) invest less. These results are robust to controlling for intangible intensity, firm age as well as Q. The decrease in competition is supported by a growing literature,[3] though the empirical implications for investment have not been recently studied (to our knowledge). Similarly, the mechanisms through which quasi-indexer institutional ownership impacts investment remain to be fully understood: while such ownership may eliminate empire-building by improving governance (e.g., Appel et al. [2016a]), it may also increase short-termism (e.g., Asker et al. [2014], Almeida et al. [2016], Bushee [1998]) – both of which could lead to higher payouts and less investment. At this point, we are unable to differentiate between these two hypotheses empirically. We simply show that firms with higher passive institutional ownership have higher payouts and lower investment. Relatedly, Gutiérrez [2017] uses industry-level data to study the evolution of labor and profit shares across advanced economies. He shows that labor shares decreased and profit shares increased only in the U.S., while they remained stable in the rest of the World. The rise in markups explains the majority of the decrease in the U.S. labor share since the late 1990s.

  Firm-level results are consistent with industry-level results. They suggest that within each industry-year and controlling for Q, firms with higher quasi-indexer institutional ownership invest less; and firms in industries with less competition also invest less.

[3] For instance, the 2016 issue brief of the Council of Economic Advisers "*reviews three sets of trends that are broadly suggestive of a decline in competition: increasing industry concentration, increasing rents accruing to a few firms, and lower levels of firm entry and labor market mobility.*" (see also Decker et al. [2015] and Grullon et al. [2016]).

- **Intangibles**: The rise of intangibles can affect investment in two primary ways: First, intangible investment is difficult to measure. Under-estimation of I would lead to under-estimation of K, and therefore over-estimation of Q; which could translate to an 'observed' under-investment at industries with a higher share of intangibles. Second, intangible assets might be more difficult to accumulate. A rise in the relative importance of intangibles could therefore lead to a higher equilibrium value of Q even if intangibles are correctly measured. Peters and Taylor [2016] and Alexander and Eberly [2016] study the relationship between Q and intangible investment. Consistent with their work, we find that industries with a rising share of intangibles exhibit lower investment. We find that the rise of intangibles can explain a quarter to a third of the observed investment gap. Yet we are still left with large, persistent residuals after 2000 – residuals that are strongly correlated with increased concentration and quasi-indexer ownership.[4]

None of the other theories (e.g., credit constraints) appear to be supported by the data. They often exhibit the 'wrong' and/or inconsistent signs; or are not statistically significant. Globalization also does not appear to be a primary driver of under-investment. Industries with higher foreign profits invest less in the US, as expected, but firm level investment does not depend on the share of foreign profits.

Macro-implications To conclude, we study the implications of our findings against recent work in the macro-literature. In particular, Fernald et al. [2017] rely on a quantitative growth-accounting decomposition to study the output shortfall in the US following the Great Recession. They conclude that the shortfall is explained by slower TFP growth and decreased labor force participation. Focusing on the capital stock, they argue that "although capital formation has been below par [since 2009], so has output growth, and by 2016, the capital/output ratio was in line with its long-term trend." Their findings have direct implications for our conclusions. Yet the underlying driver (a potential increase in market power) may be confounded in the macro series.

To test this hypothesis, we simulate macro-series under rising mark-ups using the model of Jones and Philippon [2016],[5] and study whether growth-accounting decompositions recover the appropriate shocks. We find that a rise in mark-ups decreases output, capital, labor and K/Y (as expected). 'Measured' TFP decreases slightly when using standard growth approaches (such as those of Fernald et al. [2017] and Fernald [2014]) and adjusting for changes in the capital share.

[4] It is also worth emphasizing, as Peters and Taylor [2016] do, that Q explains intangible investment relatively well, and works even better when both tangible and intangible investments are combined. This is exactly as the theory would predict. Moreover, intangible investment exhibits roughly the same weakness as tangible investment starting around 2000. Properly accounting for intangible investment is clearly a first order empirical issue, but, as far as we can tell, it does not lessen the puzzle that we document. See Döttling and Perotti [2017] for related evidence

[5] Jones and Philippon [2016] explore the macro-economic consequences of decreased competition in a standard DSGE model with time-varying parameters and an occasionally binding zero lower bound. They show that the trend decrease in competition can explain the joint evolution of investment, Q, and the nominal interest rate. Absent the decrease in competition, they find that the U.S. economy would have escaped the ZLB by the end of 2010 and that the nominal rate in 2016 would be close to 2%.

Table 1: Current Account of Non financial Sector

Name	Notation	Value in 2014 ($ billions)		
		Corporate[1]	Non corporate[2]	Business[1+2]
Gross Value Added	$P_t Y_t$	$8,704	$3,177	$11,881
Net Fixed Capital at Rep. Cost	$P_t^k K_t$	$14,813	$6,155	$20,968
Consumption of Fixed Capital	$\delta_t P_t^k K_t$	$1,283	$299	$1,581
Net Operating Surplus	$P_t Y_t - W_t N_t - T_t^y - \delta_t P_t^k K_t$	$1,683	$1,723	$3,406
Gross Fixed Capital Formation	$P_t^k I_t$	$1,626	$367	$1,993
Net Fixed Capital Formation	$P_t^k (I_t - \delta_t K_t)$	$343	$68	$411

Applying the cycle-trend-irregular decomposition of Fernald et al. [2017], we find that the decomposition largely absorbs the rise in market power – and therefore appears unable to separately identify declines in K/Y driven by (long term) changes in market power from those driven by other factors. As a result, such decompositions may confound a rise in market power with a decrease in TFP, and conclude that decreases in output are due to lower TFP rather than higher market power.

The remainder of this paper is organized as follows. Section 1 presents five important facts about the Non financial sector and its investment. Section 2 discusses the theories that may explain under-investment relative to Q and reviews the related literature. Section 3 describes the data used to test our eight hypotheses. Section 4 discusses the methodology and results of our analyses. Section 5 drills-down to provide detailed discussions of three hypotheses: (i) increased concentration, particularly as it relates to 'Superstar' firms; (ii) the rise of intangibles; and (iii) the effect of safe asset scarcity on investment. Section 6 discusses the macro-economic implications of our results; and Section 7 concludes.

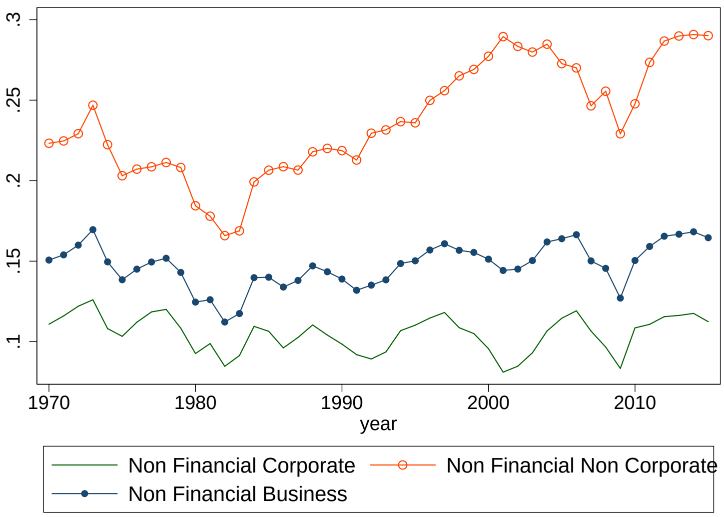
1 Five Facts about US Non financial Sector

We present five important facts related to investment by the US non financial sector in recent years. We focus on the non financial sector for three main reasons. First, this sector is the main source of nonresidential investment. Second, we can roughly reconcile aggregate data from the Financial Accounts of the United States (Financial Accounts) with industry-level investment data from the BEA (which includes residential and non residential investment, as well as investment in intellectual property). Last, we can use data on the market value of bonds and stocks for the non financial corporate sector to disentangle various theories of secular stagnation.

1.1 Fact 1: The Non financial Business Sector is Profitable but does not Invest

Table 1 summarizes some key facts about the balance sheet and current account of the non financial corporate, non financial non corporate and non financial business sectors.

Figure 1: Net Operating Return, by Sector



Note: Annual data, by Non financial Business sector.

One reason investment might be low is that profits might be low. This, however, is not the case. Figure 1 shows the operating return on capital of the non financial corporate, non financial non corporate and non financial business sector, defined as net operating surplus over the replacement cost of capital:

$$\text{Net Operating Return} = \frac{P_t Y_t - \delta_t P_t^k K_t - W_t N_t - T_t^y}{P_t^k K_t} \tag{1}$$

As shown, the operating return for corporates has been quite stable over time while the operating return of non corporates has increased substantially since 1990. For corporates, the yearly average from 1971 to 2015 is 10.5%, with a standard deviation of only one percentage point. The minimum is 8.1% and the maximum 12.6%. In 2015, the operating return was 11.2%, very close to the historical maximum. For non corporates, the yearly average from 1971 to 2015 is 24%, while the average since 2002 has been 27%. The maximum is 29%, equal to the operating return observed every year since 2012. A striking feature is that the net operating margin was not severely affected by the Great Recession, and has been consistently near its highest value since 2011 for both Corporates and Non corporates.[6]

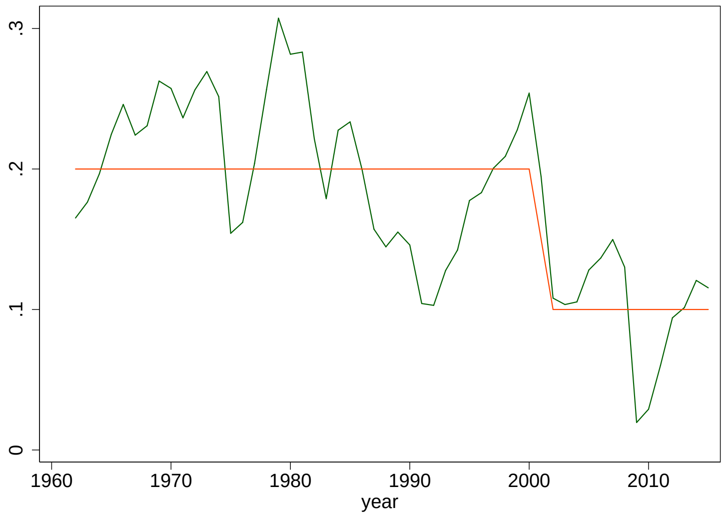
But firms do not invest the same fraction of their operating returns as they used to. Figure 2 shows the ratio of net investment to net operating surplus for the non financial business sector:

$$^{NI}/_{OS} = \frac{P_t^k \left(I_t - \delta_t K_t\right)}{P_t Y_t - \delta_t P_t^k K_t - W_t N_t - T_t^y} \tag{2}$$

The average of the ratio between 1962 and 2001 is 20%. The average of the ratio from 2002 to

[6] Gomme et al. [2011] implement a related calculation of the after-tax return to business capital and find similar conclusions.

Figure 2: Net Investment Relative to Net Operating Surplus



Note: Annual data for Non financial Businesses (Corporate and Non corporate).

2015 is only 10%.[7] Current investment is low relative to operating margins. Similar patterns are observed when separating corporates and non corporates.

1.2 Fact 2: Investment is low relative to Q

Of course, economic theory does not say that $^{NI}/_{OS}$ should be constant over time. Investment should depend on expected future operating surplus, on the capital stock, and the cost of funding new investment; it should rely on a comparison of expected returns on capital and funding costs. The neoclassical theory of investment – developed in Jorgenson [1963], Brainard and Tobin [1968] and Tobin [1969], among others – captures this trade-off.[8]

Consider a firm that chooses a sequence of investment to maximize its value. Let K_t be capital available for production at the beginning of period t and let μ_t be the profit margin of the firm. The basic theory assumes perfect competition so the firm takes μ as given. In equilibrium, μ depends on productivity and production costs (wages, etc.). The firm's program is then

$$V_t\left(K_t\right) = \max_{I_t} \mu_t P_t K_t - P_t^k I_t - \frac{\gamma}{2} P_t^k K_t \left(\frac{I_t}{K_t} - \delta_t\right)^2 + \mathbb{E}_t\left[\Lambda_{t+1} V_{t+1}\left(K_{t+1}\right)\right], \tag{3}$$

where P_t^k is the price of investment goods and γ controls adjustment costs. Given our homogeneity assumptions, it is easy to see that the value function is homogeneous in K. We can then define

[7] Note that 2002 is used for illustration purposes only; the cut-off is not based on a formal statistical analysis.

[8] See Dixit and Pindyck [1994], among others, for a rigorous treatment of the theory of investment with non-convex adjustment costs.

$\mathcal{V}_t \equiv \frac{V_t}{K_t}$ which solves

$$\mathcal{V}_t = \max_x \mu_t P_t - P_t^k (x_t + \delta_t) - \frac{\gamma}{2} P_t^k x^2 + (1 + x_t) \mathbb{E}_t [\Lambda_{t+1} \mathcal{V}_{t+1}], \tag{4}$$

where $x_t \equiv \frac{I_t}{K_t} - \delta_t$ is the net investment rate. The resulting first order condition for the net investment rate is

$$x_t = \frac{1}{\gamma} (Q_t - 1), \tag{5}$$

where

$$Q_t \equiv \frac{\mathbb{E}_t [\Lambda_{t+1} \mathcal{V}_{t+1}]}{P_t^k} = \frac{\mathbb{E}_t [\Lambda_{t+1} V_{t+1}]}{P_t^k K_{t+1}}. \tag{6}$$

Q is the ex-dividend market value of the firm divided by the replacement cost of its capital stock.

Clearly, Q is just one first-order condition satisfied by the firm – with another condition driving demand for the firm's output; and several other conditions needed to close the standard model. As a result, Q is not a causal force of investment. It is simply a useful (endogenous) measure to classify shocks over time. To build our empirical measures of Q, we define

$$Q = \frac{V^e + (L - FA) - Inventories}{P_k K} \tag{7}$$

where V^e is the market value of equity, L are the liabilities (mostly measured at book values, but this is a rather small adjustment, see Hall [2001]), and FA are financial assets. Note that the BEA measure of K now includes intangible assets (including software, R&D, as well as entertainment, literary, and artistic originals). As a result, our measure of Q is lower than in the previous literature. Because financial assets and liabilities contain large residuals, we also compute another measure of Q:

$$Q^{misc} = Q + \frac{A^{misc} - L^{misc}}{P_k K} \tag{8}$$

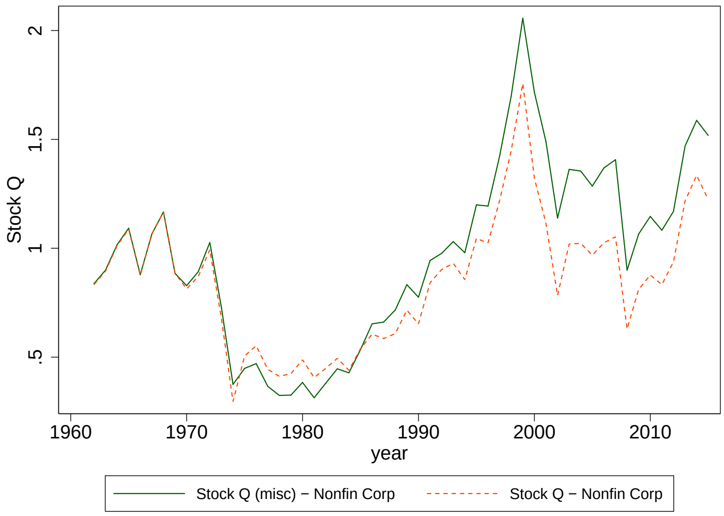
where A^{misc} and L^{misc} are the miscellaneous assets and liabilities recorded in the Financial Accounts. Since $A^{misc} > L^{misc}$, it follows that $Q^{misc} > Q$. It is unclear which measure is more appropriate. Figure 3 shows the evolution of Q for the non financial corporate sector. As shown, Q is high according to both measures, by historical standards. This is consistent with the rapid rise in corporate profits shown in Figure 1 and the rise in net savings (not shown).

This leads us to our main conclusion: investment is low relative to Q. The top chart in Figure 4 shows the aggregate net investment rate for the non financial business sector along with the fitted value for a regression on (lagged) Q from 1990 to 2001. The bottom chart shows the regression residuals (for each period and cumulative) from 1990 to 2015. Both charts clearly show that investment has been low relative to Q since sometime in the early 2000's.[9] By 2015, the cumulative under-investment is more than 10% of capital.[10]

[9] By definition of OLS, the cumulative residual for 2001 is zero, but the under-investment from then on is striking

[10] We focus on the past 25 years because measures of Q based on equity are not always stable and therefore do not fit long time series. This is a well known fact that might be due to long run changes in technology and/or participation in

Figure 3: Two Measures of Q



Note: Annual data. Q for Non financial Corporate sector (data for Non Corporate sector not available)

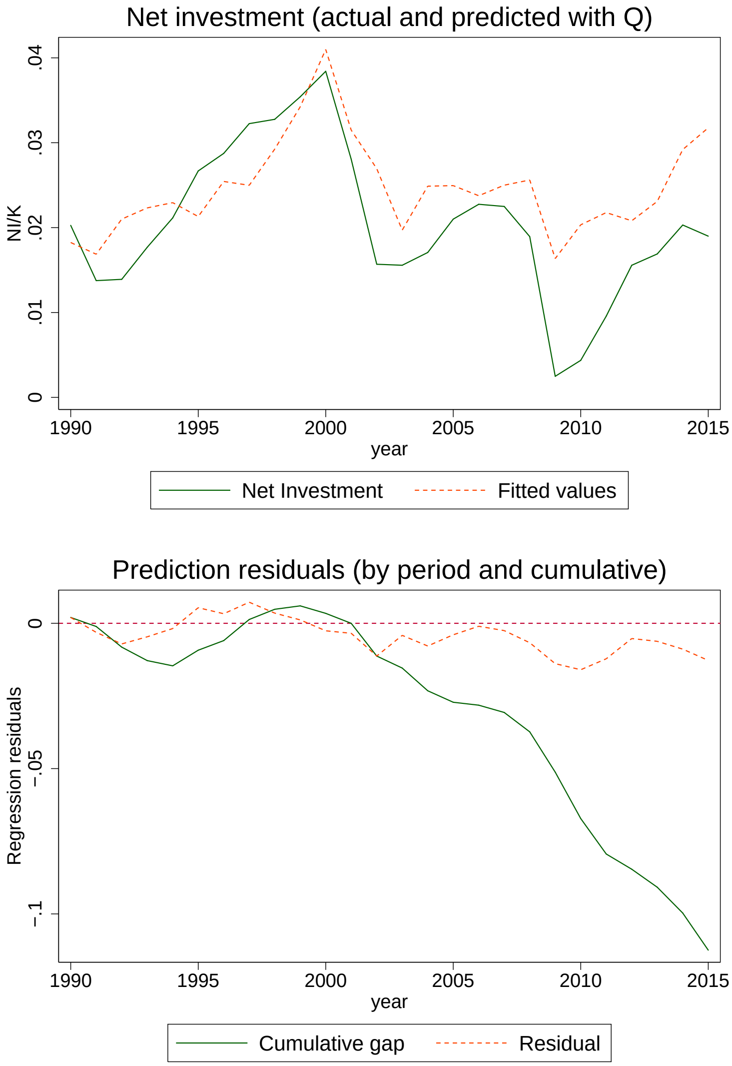
The above regression focuses on aggregate investment. To study under-investment at a more granular level, we estimate panel regressions of industry- and firm-level investment on Q; and study the time effects. Figure 5 shows the results: time effects for the industry regression are shown on the left and for the firm regression on the right. The vertical line highlights the average time effect across all years for each regression.[11] As shown, the time-effects are substantially lower for both Industry- and Firm-level regressions since approximately 2000. In both regressions, time effects were slightly above average in the 1980s; on average in the 1990s and below-average since the early 2000s. Time effects increase in some years at the height of the great recession (when Q decreases) but reach some of their lowest levels after 2013.

These results are robust to including additional measures of fundamentals such as cash flow; considering only a subset of industries; and even splitting tangible and intangible assets (see Figure 16). They are also consistent with results in Alexander and Eberly [2016], who use OLS to study firm-level gross investment (which they define as the ratio of capital expenditures to assets). They are somewhat dampened when controlling for intangible intensity, but they remain material (see Figure 17). We conclude that investment has been low relative to Q since the early 2000's – a decrease that is partially, although not fully explained by the rise of intangibles. The timing of the decrease aligns with Lee et al. [2016], who find that industries that receive more funds have a higher industry Q until the mid-1990s, but not since then. The change in the allocation of capital is explained by a decrease in capital expenditures and an increase in stock repurchases by firms in

equity markets that make it difficult to compare the 2000's with the 1960's. Even in shorter windows, van Binsbergen and Opp [2016] argue convincingly that asset pricing anomalies that affect Q can have material consequences for real investment – particularly for high Q firms. Q is therefore not a perfect benchmark, but it enables us to control for a wide range of factors and provides theoretical support for testing the remaining hypotheses.

[11] Note that the time effects need not be zero, on average, given the impact of adjustment costs in Q theory and the inclusion of a constant in the regression.

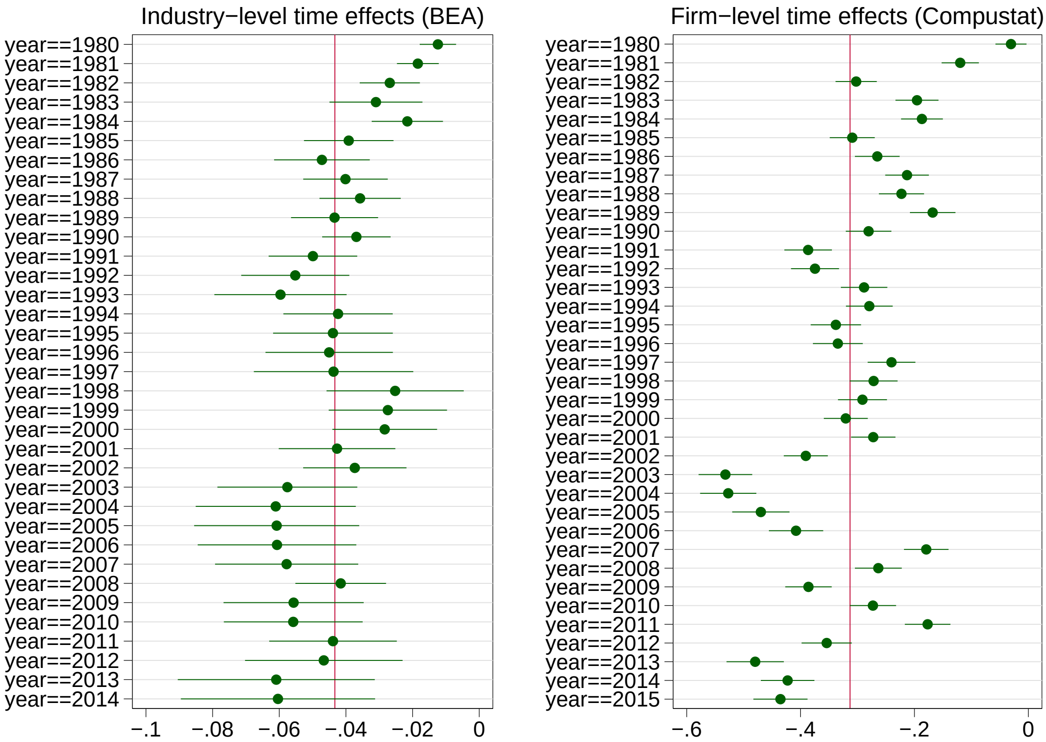
Figure 4: Net Investment vs. Q



Note: Annual data. Net investment for Non financial Business sector.

high Q industries since the mid-1990s.

Figure 5: Time effects from Industry and Firm-level regressions



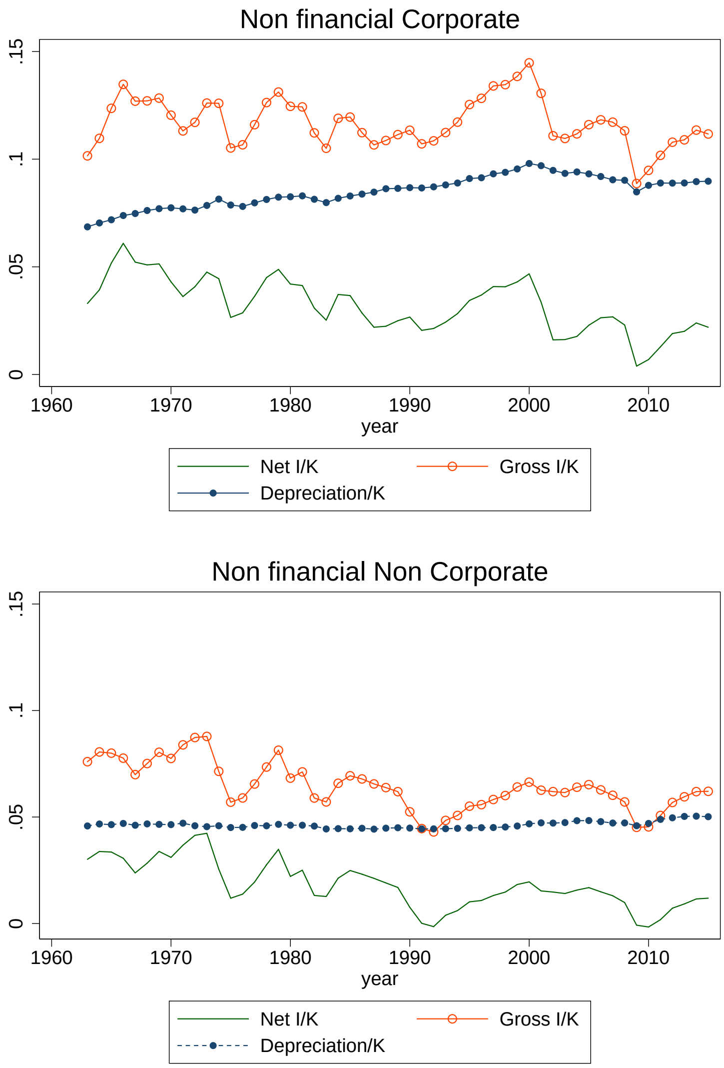
Note: Time fixed effects from errors-in-variables panel regressions (Erickson et al. [2014]) of industry net investment on median Log-Q (left) and Log((CAPX+R&D)/AT) on firm-level Log-Q (right) as well as a control for firm age. All variables are de-meaned over the regression period at the industry- and firm-level, respectively. Industry investment data from BEA; Q and firm investment from Compustat. See Section 4.2.1 for additional details on the regression approach.

1.3 Fact 3: Depreciation and Relative Investment Prices Have Remained Stable Since 2000

The decrease in net investment could be the result of changes in the depreciation rate. To test this, Figure 6 shows the gross investment rate, the net investment rate and the depreciation rate for the non financial corporate sector on the top, and the non financial non corporate sector on the bottom. Note that these series include residential structures, but their contribution is relatively small for non financial businesses. The gross investment rate is defined as the ratio of 'Gross fixed capital formation with equity REITs' to lagged capital. Depreciation rates are defined as the ratio of 'consumption of fixed capital, equipment, software, and structures, including equity REIT' to lagged capital; and net investment rates as the gross investment rate minus the depreciation rate.

In the non corporate sector, depreciation is stable and net investment follows gross investment. The evolution is more complex in the corporate sector. There was a secular increase in depreciation from 1960 until 2000, driven primarily by a shift in the composition of corporate investment (from

Figure 6: Investment and Depreciation Rate for Non financial Business Sector



Note: Annual data. Non financial Corporate sector on the top, Non financial Non corporate sector on the bottom.

structures and equipment to intangibles). As a result, the trend in net investment is significantly lower than the trend in gross investment. Since 2000, however, the share of intangible assets has remained flat such that depreciation has been more stable, and, if anything, it has decreased. The drop in net investment over the past 15 years is therefore due to a drop in gross investment, not a rise in depreciation. Because the corporate sector contributes the lion share of investment, the aggregate figure for the combined non-financial sector resembles the top panel (see Table 1).

Figure 7 shows the relative price of nonresidential investment goods and equipment, defined as the ratio of the 'Fixed investment: Nonresidential (implicit price deflator)' to the 'Personal consumption expenditures (implicit price deflator)'. As shown, the relative price of capital decreased drastically since the 1980s, but has remained relatively stable after 2000. Thus, the recent under-investment is unlikely to be driven by changes in investment prices.

Figure 7: Relative price of investment goods

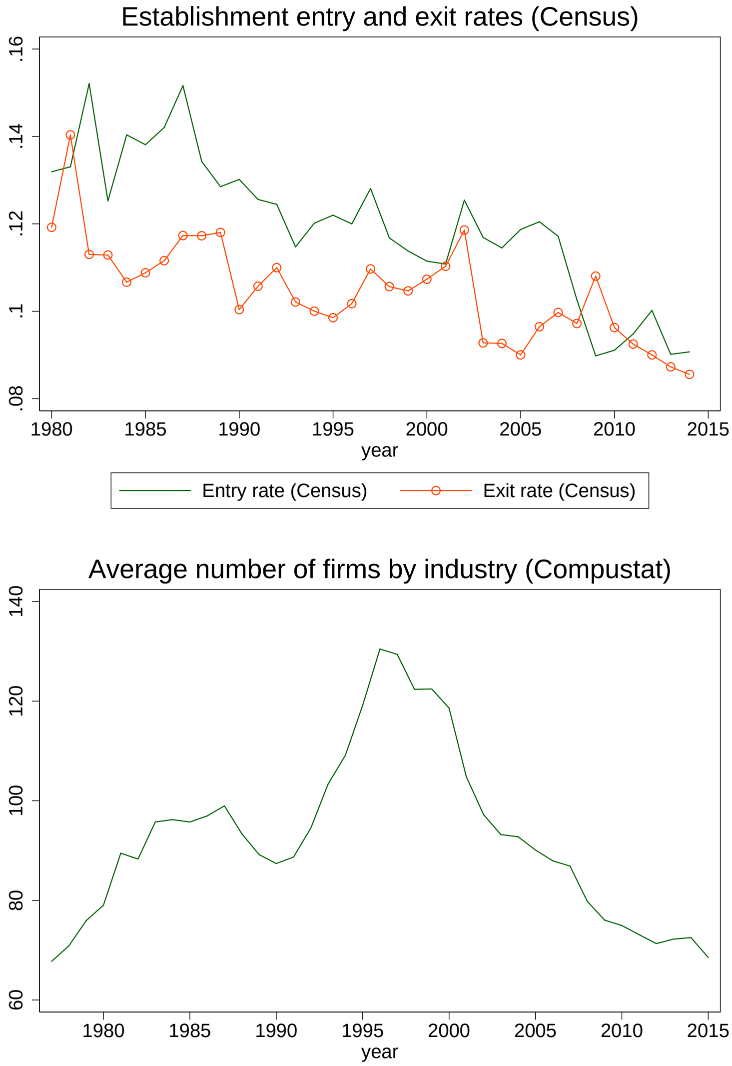
Note: Annual data. Relative price of investment goods defined as the ratio of the 'Fixed investment: Nonresidential (implicit price deflator)' to the 'Personal consumption expenditures (implicit price deflator)'

1.4 Fact 4: Firm Entry has Decreased

Figure 8 shows two measures of firm entry: the establishment entry and exit rates as reported by the U.S. Census Bureau's Business Dynamics Statistics (BDS); and the average number of firms by industry in Compustat. The downward trend in business dynamism has been highlighted by numerous papers (e.g., Decker et al. [2014]), and it has been particularly severe in recent years. In fact, Decker et al. [2015] argue that, whereas in the 1980s and 1990s declining dynamism was observed in selected sectors (notably retail), the decline was observed across all sectors in the 2000s, including the traditionally high-growth information technology sector.

The Census data provides a comprehensive view of entry and exit. This is not the case with Compustat since it covers mostly the large, publicly-traded companies. For instance, in the early 1990s, we see a large increase in Compustat firms, driven primarily by firms going public. Since then, both charts provide strong evidence of a decline in the number of firms. The decrease in Compustat firms is particularly notable once normalizing for GDP: the number of firms in Compustat today is approximately the same as in 1975 yet GDP is 3x larger.

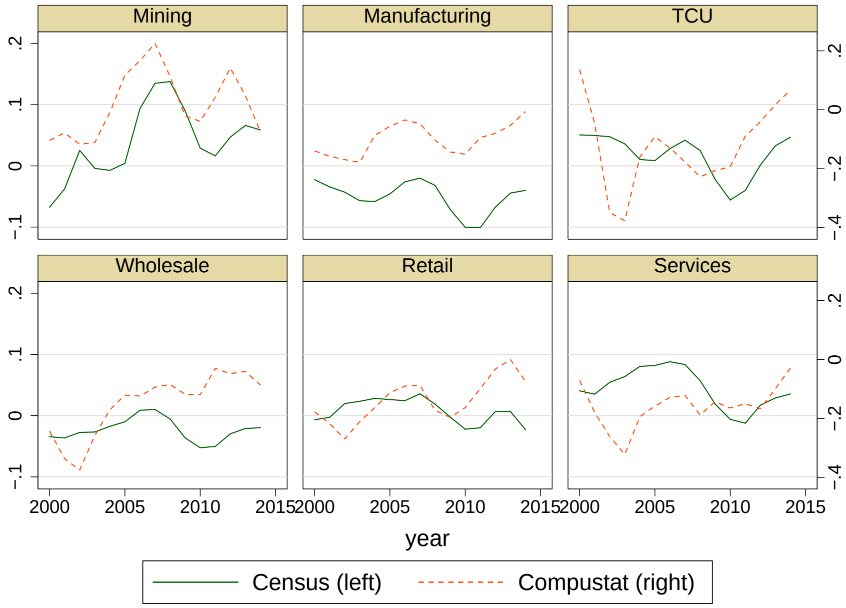
Figure 8: Firm entry, exit and number of firms



Note: Annual data.

The Compustat and Census patterns above appear quite different. However, focusing on the post-2000 period (the main period of interest) and the sectors for which Compustat provides good coverage, we find significant similarities. Figure 9 shows the 3-year log change in the number of firms based on Compustat and the number of establishments based on Census BDS data (excluding agriculture and construction for which Compustat provides limited coverage). As shown, changes in the number of firms are roughly similar across all sectors, including manufacturing, mining and retail which are the main contributors of investment.

Figure 9: Comparison of 3-Year log change in # of establishments (Census) and firms (Compustat), by SIC sector



Note: Annual data. Agriculture and construction omitted due to limited coverage in Compustat

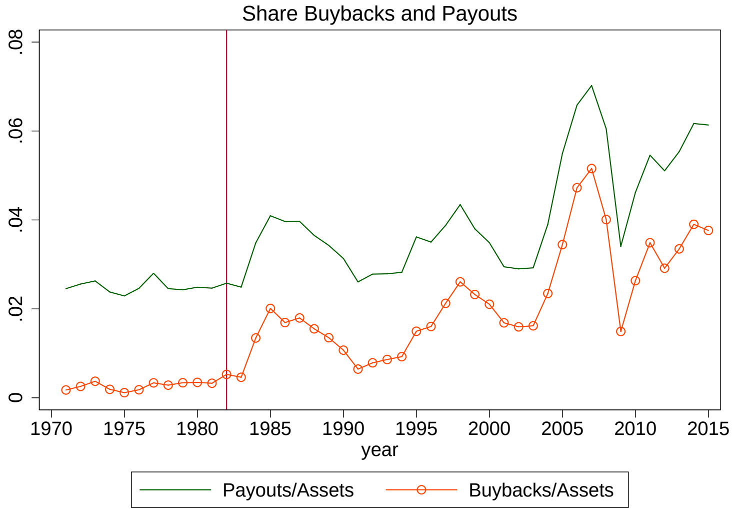
The above discussion is focused on entry, but other measures of concentration and market power (including Census- and Compustat-based Herfindahls, Concentration ratios and Mark-ups) exhibit very similar trends in terms of decreasing competition. See CEA [2016], Grullon et al. [2016], Gutiérrez and Philippon [2017a] and Loecker and Eeckhout [2017], among others, for evidence based on these additional metrics; and Section 2 for a discussion of the implications of rising concentration on investment.

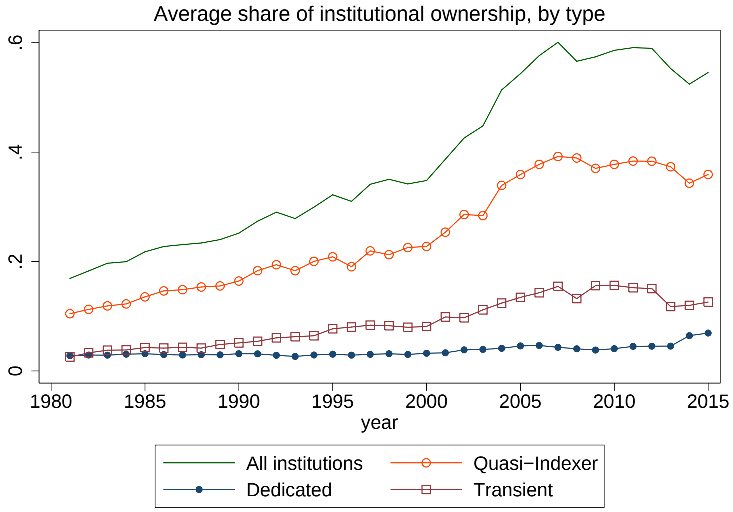
1.5 Fact 5: Institutional Ownership and Payouts Have Increased

The top graph of Figure 10 shows the total buybacks and payouts for US-incorporated firms in Compustat that belong to our industry sample (see Section 3). As shown, there has been a substantial increase in total payouts, primarily driven by share buybacks. The increase starts soon after 1982, when SEC Rule 10b-18 was instituted (noted by the vertical line). Rule 10b-18 allows companies to repurchase their shares on the open market without regulatory limits.

The bottom graph shows the average share of institutional ownership, by type. Again, we see a substantial increase in institutional ownership after 2000. The increase is primarily driven by growth in transient and quasi-indexer institutions. This is not shown in the figure, but the increase is particularly pronounced for smaller firms: since 2000, the dollar-weighted share of quasi-indexer institutional ownership increased from ∼35% to ∼50%, while the median share increased from ∼15% to ∼40%. That is, while the dollar-weighted quasi-indexer ownership increased by about 50%, it more than doubled for the median firm. These two effects closely match the timing of decreasing investments at the aggregate level.

Figure 10: Payouts and Institutional ownership





Notes: Annual data for all US incorporated firms in our Compustat sample. Results are similar when including foreign-incorporated firms. The vertical line in the first graph highlights the passing of SEC rule 10b-18, which allows companies to repurchase their shares on the open market without regulatory limits.

2 What might explain the under-investment?

Section 1 shows that investment is low relative to Q. This section outlines the theories that might explain the investment gap and, in so doing, provides a broad review of the investment literature.

2.1 Theory

The basic Q-equation (5) says that Q should be a sufficient statistic for investment, while equation (6) equates Q with the average market to book value. This theory is based on the following assumptions [Hayashi, 1982]:

- no financial constraints;
- shareholder value maximization;
- constant returns to scale and perfect competition.

The Q-theory has been tested empirically by a large literature. Early results have been somewhat disappointing. With aggregate US data, the basic Q-equation fits poorly, leaves large unexplained residuals correlated with cash flows, and implies implausible parameters for the adjustment cost function. Hassett and Hubbard [1997] and Caballero [1999] provide reviews of the early literature.

Several theories have emerged to explain these failures – namely market power [Abel and Eberly, 1994], non-convex adjustment costs [Caballero and Engle, 1999] and financial frictions [Bernanke and Gertler, 1989]. However, none of these is fully satisfactory. The evidence for constant returns and price taking seems quite strong [Hall, 2003]. Adjustment costs are certainly not convex at the plant level, but it is not clear that this really matters at the industry level or in the aggregate [Thomas, 2002, Hall, 2004], but this is still a controversial issue [Bachmann et al., 2013]. Gomes [2001] shows that Q should capture most investment dynamics even when there are credit constraints. And heterogeneity and aggregation do not seem to create strong biases [Hall, 2004].

A fourth explanation – measurement error in Q – has found strong support in the recent literature. Work in the 1990s and early 2000s emphasizes measurement error in market value of equity as a substantial culprit for the empirical failure of the investment equation [Gilchrist and Himmelberg, 1995, Cumins et al., 2006, Erickson and Whited, 2000]. Erickson and Whited [2000] and Erickson and Whited [2006] in particular use GMM estimators to purge Q from measurement errors. They find that only 40 percent of observed variations are due to fundamental changes, implying that market values contain large 'measurement errors'. Q-theory performs substantially better once controlling for such 'classical' measurement error, and residuals are no longer correlated with cash flows. Recently, Peters and Taylor [2016] emphasizes measurement error in intangible capital, and shows that properly accounting for intangibles substantially improves the performance of Q-theory (although, as we discuss later, this is in part due to their choice of the empirical proxy for traditional Q).

We take these theories – and the implied deviations between Q and investment – seriously. We control for 'classical' errors-in-variables problems using the cumulant estimator of Erickson et al. [2014]; and use empirical proxies for the remaining theories to test whether they can explain (under-)investment. In other words, we use Q-theory as a benchmark and a useful way to sort the explanations into two groups: those where Q-theory fits (e.g. changes in risk premia, expected demand or technology), and those that imply a divergence between Q and investment (e.g., changes in market power). It is clear, however, that Q is an endogenous variable and not an independent driver of investment. The following section details the specific hypotheses (i.e., variations of these theories) that we consider.

The approach we take in this paper does not allow us to to prove a causal relationship between a particular factor and investment. We deal with causality issues in two companion papers. To quickly summarize, Gutiérrez and Philippon [2017a] focuses on market power. It clarifies the deep endogeneity issue coming from endogenous entry; and proposes natural experiments (based on increased competition from China) and instrumental variables to argue that changes in competition cause changes in investment. Gutiérrez and Philippon [2017b] focuses on governance issues. It uses the Russell index threshold as a natural experiment, and predetermined relative quasi-indexer ownership as an IV. It shows that tighter governance causes higher payouts and less investment.[12]

2.2 Hypotheses

We consider the following eight hypotheses (grouped into four broad categories) for explaining low investment *despite* high Q:[13]

- **Financial frictions**

    1. **External finance**: A large literature, following Fazzari et al. [1987], has argued that frictions in financial markets can constrain investment decisions and force firms to rely on internal funds. Rajan and Zingales [1998] show that industrial sectors that are relatively more in need of external financing develop disproportionately faster in countries with more developed financial markets. Acharya and Plantin [2016] argue that weak investment may be linked to excessive leverage encouraged by loose monetary policy. That said, one issue with the external finance story is that, in most calibrated models, the Q-equation fits well even when financial constraints are material, because Q also captures the value of access to finance. See Hennessy and Whited [2007] and Gomes [2001].
    2. **Bank dependence** is a particular form of financial constraint that affects the subset of firms without access to the capital markets. We test whether bank dependent firms are responsible for the under-investment (see, for instance, Alfaro et al. [2015]). This hypothesis is supported by recent papers such as Chen et al. [2016], which shows that reductions in small business lending has affected investment by smaller firms.[14]

[12] Gutiérrez and Philippon [2017b] also studies the interaction between governance and competition in causing under-investment. At the firm-level, it shows that governance matters most for firms in non-competitive industries: they tend to buy back more shares and invest less. At the industry-level, anti-competitive effects of common ownership disproportionately affect industries that 'appear' competitive according to traditional measures but actually are not (due to common ownership).

[13] We also considered changes in R&D expenses as a proxy for lack of ideas (i.e., differences between *average* and *marginal* Q). Firms increasing R&D expenses are likely to have better ideas and therefore a higher marginal Q. So we test whether under-investing industries (and firms) exhibit a parallel decrease in R&D expense. We do not find support for this hypothesis, but this is inconclusive: under some theories, a rise in R&D may actually imply lower marginal Q (e.g., if ideas are harder to identify). We were unable to find a better measure for (lack of) ideas, so we cannot rule out this hypothesis.

[14] We should say from the outset that our ability to test this hypothesis is rather limited. Our industry data includes all firms, but investment is skewed and tends to be dominated by relatively large firms. Our firm-level data does not cover small firms.

3. **Safe asset scarcity:** Safe asset scarcity and/or changes in the composition of assets may affect corporations' capital costs (see Caballero and Farhi [2014], for example). In their simple form, such variations would impact Q but would not cause a gap between Q and investment. However, a gap may appear if safe firms are unable or unwilling to take full advantage of low funding costs (due to, for example, product market rents). See Section 5.3 for additional discussion and results relevant to this hypothesis.

- **Changes in the nature and/or localization of investment**

4. **Intangibles:** The rise of intangibles may affect investment in several ways: first, intangible investment is difficult to measure. Under-estimation of I would lead to under-estimation of K, and therefore over-estimation of Q; and would translate to an 'observed' under-investment at industries with a higher share of intangibles. Alternatively, intangible assets might be more difficult to accumulate (higher adjustment cost). A rise in the relative importance of intangibles could then lead to a higher equilibrium value of Q even if intangibles are correctly measured.

   Fortunately, the relationship between Q and intangible investment has been thoroughly studied by Peters and Taylor [2016] (PT). They propose a new proxy of Q that aims to correct for measurement error by explicitly accounting for intangible capital.[15] PT show that Q explains intangible investment relatively well, and works even better when both tangible and intangible investments are combined. This is exactly as the theory would predict. PT also show that intangible capital adjusts more slowly to changes in investment opportunities than tangible capital, which is consistent with higher adjustment costs.

   Intangibles can also interact with information technology and competition. For instance, Amazon does not need to open new stores to serve new customers; it simply needs to expand its distribution network. This may lead to a lower equilibrium level of tangible capital (e.g., structures and equipment), thus a lower investment level on tangible assets. Generally, this would still be consistent with Q theory since the Q of the incumbent would fall. Amazon would then increase its investments in intangible assets. Whether the Q of Amazon remains large then depends mostly on competition; which interacts substantially with intangible assets since the latter can be used as a barrier to entry.

   Relatedly, Alexander and Eberly [2016] and Döttling et al. [2016] link the rise of intangibles to the decrease in investment. In particular, Alexander and Eberly [2016] study firm-level data with a focus on changes in industry composition; while Döttling et al. [2016] argue that the lower investment of intangible-intensive firms is related to the way intangible capital is produced. Skilled workers co-invest their human capital, such that firms require lower upfront outlays and external financing. According to them, the rising importance of intangible and human capital may be a driving force behind some secular

[15] Our results are robust to using this new proxy of Q (known as 'total Q') instead of our base measure of Q described in the data section. Only the significance of QIX ownership decreases slightly at the industry-level

trends in the US economy since the 1980s [Döttling and Perotti, 2017]. They both show that high intangible firms exhibit lower tangible investment.

5. **Globalization**. It is important to emphasize that our firm-level and industry-level data are consolidated differently. NIPA and BEA measures of private investment capture investment by US-owned as well as foreign-owned firms in the US. They would not include investment in China by a US Retail company. We may therefore observe lower US private investment if US firms with foreign activities are investing more abroad, or if foreign firms are investing less in the US. At the firm level (in Compustat) however, consolidated investment would still follow Q.

- **Competition**

6. **Regulations & uncertainty:** Regulation and regulatory uncertainty may affect investment in two ways. First, increased uncertainty due to regulation may restrain investment if economic agents are uncertain about future payoffs (though this might be priced in) [Bernanke, 1983, Dixit and Pindyck, 1994].[16] Second, increased regulation and decreased antitrust enforcement may stifle competition. Grullon et al. [2016] and Woodcock [2017] provide evidence of decreased enforcement since the 1980s. Bessen [2016] provides evidence that political factors are the primary drivers of increased profitability since 2000; and Faccio and Zingales [2017] show that competition and investment in the mobile telecommunication industry are heavily influenced by political factors. Gutiérrez and Philippon [2017a] show that industries with increasing regulation have become more concentrated; and Dottling et al. [2017] compare concentration trends between the U.S. and Europe and find that concentration has decreased in Europe in industries that are very similar in terms of technology. They link these patterns to decreasing anti-trust enforcement in the U.S. compared to stronger enforcement and decreasing barriers to entry in Europe.

7. **Market power:** Market power affects firms' incentives to invest and innovate. With respect to investment, Abel and Eberly [1994] show that market power induces a gap between average and marginal Q which can lead to a gap between average Q and investment. With respect to innovation, we know that its relation with competition is non-monotonic because of a trade-off between average and marginal profits. For a large set of parameters, however, we can expect competition to increase innovation and investment because firms in industries that do not face the threat of entry might have weak incentives to invest [Aghion et al., 2014]. Controlling for competition is difficult, however, because of endogenous entry and exit. Gutiérrez and Philippon [2017a] develop a simple model to study the determinants of the econometric bias.

[16] Increases in firm-specific uncertainty may also lead to lower investment levels due to manager risk-aversion [Panousi and Papanikolauo, 2012] and/or irreversible investment [Dixit and Pindyck, 1994, Abel and Eberly, 2005]. We test this hypothesis using stock market return and sales volatility; and find some, albeit limited support.

More broadly, the hypothesis of rising market power is supported by a growing literature arguing that competition may be decreasing in several economic sectors [CEA, 2016, Decker et al., 2015] and is prevalent even at the product market level [Mongey, 2016]. The decrease in competition was first discovered in flow quantities (firm volatility, entry, exit, IPOs, job creation and destruction,..). For instance, Haltiwanger et al. [2011]write: "It is, however, noticeable that job creation and destruction both exhibit a downward trend over the past few decades." CEA [2016] is among the first to document that the majority of industries have seen increases in the revenue share enjoyed by the 50 largest firms between 1997 and 2012. We refer the reader to Gutiérrez and Philippon [2017a] for a more comprehensive literature review.[17]

Beyond the traditional measures of concentration, the rapid increase in institutional ownership (see Figure 10) coupled with the increased concentration in the asset management industry may have introduced substantial anti-competitive effects of common ownership.[18] Such anti-competitive effects are the subject of a long theoretical literature in industrial organization, which argues that common ownership of natural competitors may reduce incentives to compete. For instance, Salop and O'Brien [2000] develop an oligopoly model in which firms maximize a weighted sum of their shareholders' portfolio profits, where shareholder weights are proportional to the fraction of voting shares held by that shareholder. Because they maximize total shareholders' portfolio profits, firms place some weight on their (commonly owned) competitors' profits; and therefore optimally increase markups with common ownership. Azar et al. [2016a] and Azar et al. [2016b] show that this effect is empirically important using the U.S. Airline and the U.S. Banking industries as test cases.[19]

- **Governance**

[17] Grullon et al. [2016] study changes in industry concentration, and find that "more than three-fourths of U.S. industries have experienced an increase in concentration levels over the last two decades;" and that firms in industries that have become more concentrated have enjoyed higher profit margins, positive abnormal stock returns, and more profitable M&A deals. Blonigen and Pierce [2016] study the impact of mergers and acquisitions (M&As) on productivity and market power, and find that M&As are associated with increases in average markups. Autor et al. [2017a] and Autor et al. [2017b] link the increase in concentration with the rise of more productive, superstar firms. And Barkai [2017] shows that the profit share of the US non financial corporate sector has increased drastically since 1985. Relatedly, Loecker and Eeckhout [2017] show that firm-level mark-ups have increased drastically since the 1980s. Last, as noted above, Dottling et al. [2017] compare concentration (and investment) trends between the U.S. and Europe. They find that concentration has increased in the U.S. while it has remained stable (or decreased) in Europe. They also find that industries that have concentrated in the U.S. decreased investment more than the corresponding industries in Europe.

[18] For instance, Fichtner et al. [2016] show that the "Big Three" asset managers (BlackRock, Vanguard and State Street) together constitute the largest shareholder in 88 percent of the S&P500 firms, which account for 82% of market capitalization.

[19] It is worth noting that the exact mechanisms through which common ownership reduces competition remain to be identified; but they need not be explicit directions from shareholders. They may result from lower incentives for owners to push firms to compete aggressively if they hold diversified positions in natural competitors; or from the ability of board members elected by and representing the largest shareholders to minimize breakdowns of cooperative arrangements and undesirable price wars between their commonly owned firms. See Salop and O'Brien [2000] and Azar et al. [2016b] for additional details.

8. **Ownership and Shareholder Activism:** beyond the anti-competitive effects of common ownership discussed above, ownership can affect management incentives through governance and effective investment horizon (short-termism).

   Regarding short-termism, some have argued that equity markets can put excessive emphasis on quarterly earnings; and that higher stock-based compensation incentivizes managers to focus on short term share prices rather than long term profits [Martin, 2015, Lazonick, 2014]. In support of this hypothesis, Almeida et al. [2016] show that the probability of share repurchases is sharply higher for firms that would have just missed the EPS forecast in the absence of a repurchase; and Jolls [1998], Fenn and Liang [2001] show that firms that rely more heavily on stock-option-based compensation are more likely to repurchase their stock than other firms. Given the rise of institutional ownership, and the shift towards stock-based compensation, an increase in market-induced short-termism may lead firms to increase payouts and cut long term investment. On the other hand, Kaplan [2017] argues against sustained short-termism by studying the time series of corporate profits and valuations together with venture capital and private equity investments.

   The effect of Governance on investment has been studied in a large literature. Jensen [1986] argues that conflicts of interest between managers and shareholders can lead firms to invest in ways that do not maximize shareholder value.[20] This is supported by Harford et al. [2008] and Richardson [2006], who show that poor governance is associated with greater industry-adjusted investment. Thus, improvements in governance driven by changes in ownership may lead to lower investment levels.

   We focus on the effect of institutional ownership on governance, investment and payouts. This is the subject of several papers. Kisin [2011] finds that exogenous changes in mutual fund ownership affect corporate investment according to the preferences of individual funds. Aghion et al. [2013] find that greater dedicated ownership incentivizes higher R&D investment; while Bushee [1998] finds that higher transient ownership increases the probability that managers reduce R&D investment to reverse an earnings decline.

   Appel et al. [2016a] focus on passive owners, and find that such owners influence firms' governance choices (they lead to more independent directors, lower takeover defenses, and more equal voting rights; as well as more votes against management). Appel et al. [2016b] find that larger passive ownership makes firms more susceptible to activist investors (increasing the ambitiousness of activist objectives as well as the rate of success); and Crane et al. [2016] show that higher (total and quasi-indexer) institutional ownership causes firms to increase their payouts. But the evidence is not clear-cut: Schmidt and Fahlenbrach [2016] find opposite effects for some governance measures (including the

[20] This does not necessarily imply that managers invest too much; they might invest in the wrong projects instead. The general view, however, is that managers are reluctant to return cash to shareholders, and that they might over-invest.

likelihood of CEOs becoming chairman and appointment of new independent directors), and an increase in value-destructing M&A linked to higher institutional ownership.
In the end, it is unclear whether higher payouts and increased susceptibility to activist investors are evidence of tighter governance or increased short-termism. The reason is that the two hypotheses differ more in their normative implications than in their positive ones. Investment decreases in both cases. Under tighter governance it goes from excessive to (privately) optimal. Under short-termism, it goes from optimal to lower than optimal.[21]

We emphasize that these hypotheses are not mutually exclusive. For instance, there is a growing literature that focuses precisely on the interaction between governance and competition [Giroud and Mueller, 2010, 2011]. As a result, our tests do not map one-to-one into hypotheses (1) to (8); some tests overlap two or more hypotheses (e.g., measures of firm ownership affect both governance and competition). We report the results of our tests and discuss their implications for the above hypotheses in Section 4.

3 Data

Testing the above theories requires the use of micro data. We gather and analyze a wide range of aggregate-, industry- and firm-level data. The data fields and data sources are summarized in Table 2. Sections 3.1 and 3.2 discuss the aggregate and industry datasets, respectively. Section 3.3 discusses the firm-level investment and Q datasets; and 3.4 discusses all other data sources, including the explanatory variables used to test each theory. We discuss data reconciliation and data validation results where appropriate.

3.1 Aggregate data

Aggregate data on funding costs, profitability, investment and market value for the US Economy and the non financial sector is gathered from the US Financial Accounts through FRED. These data are used in the aggregate analyses discussed in Section 1; in the construction of aggregate Q; and to reconcile and ensure the accuracy of more granular data. In addition, data on aggregate firm entry and exit is gathered from the Census BDS; and used in aggregate regressions similar to those reported in Section 4.

[21] Some papers provide qualitative support for governance but the evidence is inconclusive. Crane et al. [2016] refer to Chang et al. [2014] which argues that increasing passive institutional ownership leads to share price increases, but that could happen under short-termism as well. Other studies such as Asker et al. [2014] show that public firms invest substantially less and are less responsive to changes in investment opportunities than private firms. Bob Hall noted that private equity ownership has grown rapidly, and now counts for a modest share of non-public businesses. To the extent that private equity improves governance (or increases short-termism), this may lead to lower investment. Kaplan and Stromberg [2008] reviews related evidence showing that firms transitioning to private-equity ownership decrease capital expenditures. We leave testing for this hypothesis for future work.

Table 2: Data sources

	Data fields	Source	Granularity
Primary datasets	Aggregate investment and Q	US Financial Accounts	Sector
	Industry-level investment and operating surplus	BEA	~NAICS L3
	Firm-level financials	Compustat	Firm
Additional datasets	Sales Concentration	Census	NAICS L3
	Entry/Exit; firm demographics	Census	SIC L2
	Occupational Licensing	PDII Survey	NAICS L3
	Regulation index	Mercatus	NAICS L3
	Industry-level spreads	Egon Zakrajsek	NAICS L3
	NBER-CES database	NBER-CES	NAICS L6
	Institutional ownership	Thomson Reuters 13F	Firm
	Institutional investor classification	Brian Bushee's website	Institutional Investor

3.2 Industry investment data

3.2.1 Dataset

Industry-level investment and profitability data – including measures of private fixed assets (current-cost and chained values for the net stock of capital, depreciation and investment) and value added (gross operating surplus, compensation and taxes) – are gathered from the Bureau of Economic Analysis (BEA).

Fixed assets data is available in three categories: structures, equipment and intellectual property (which includes software, R&D and expenditures for entertainment, literary, and artistic originals). This breakdown allows us to (i) study investment patterns for intellectual property separate from the more 'traditional' definitions of K (structures and equipment); and (ii) better capture total investment in aggregate regressions, as opposed to only capital expenditures.

Investment and profitability data are available at the sector (19 groups) and detailed industry (63 groups) level, in a similar categorization as the 2007 NAICS Level 3. We start with the 63 detailed industries and group them into 47 industry groupings to ensure investment, entry and concentration measures are stable over time. In particular, we group detailed industries to ensure each group has at least ~10 firms, on average, from 1990 - 2015 and it contributes a material share of investment (see Appendix I: Industry Investment Data for details on the investment dataset). We exclude Financials and Real Estate; and also exclude Utilities given the influence of government actions in their investment and their unique experience after the crisis (e.g., they exhibit decreasing operating surplus since 2000). Last, we exclude Management because there are no companies in Compustat that map to this category. This leaves 43 industry groupings for our analyses, whose total net investment since 2000 is summarized in Table 17 in the appendix. All other datasets are mapped into these 43 industry groupings using the NAICS Level 3 mapping provided by the BEA.

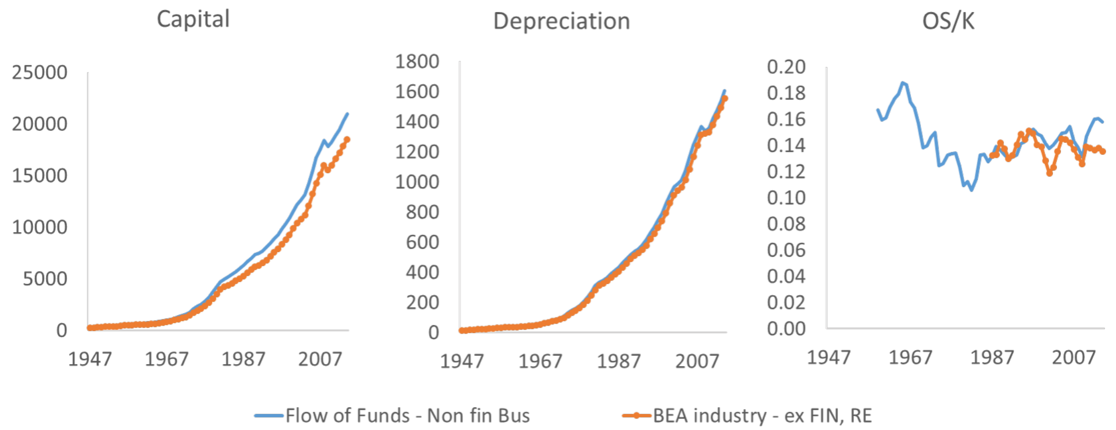
We define industry-level gross investment rates as the ratio of 'Investment in Private Fixed Assets' to lagged 'Current-Cost Net Stock of Private Fixed Assets'; depreciation rates as the ratio of 'Current-Cost Depreciation of Private Fixed Assets' to lagged 'Current-Cost Net Stock of Private Fixed Assets'; and net investment rates as the gross investment rate minus the depreciation rate. Investment rates are computed across all asset types, as well as separating intellectual property from structures and equipment.

The Gross Operating Surplus is provided by the BEA, while the Net Operating Surplus is computed as the 'Gross Operating Surplus' minus 'Current-Cost Depreciation of Private Fixed Assets'. OS/K is defined as the 'Net Operating Surplus' over the lagged 'Current-Cost Net Stock of Private Fixed Assets'.

3.2.2 Data validation

In order to ensure industry-level figures are consistent with aggregate data, we reconcile the two datasets. We first note that industry-level figures include all forms of organization (financials and non financials, as well as corporates, non corporates and non businesses). A breakdown between financials and non financials or corporates and non corporates by industry is not available. Thus, a full reconciliation can only be achieved at the aggregate level or considering pre-aggregated BEA series (such as non financial corporates). But these do not provide an industry breakdown. Instead, we note that aggregating capital, depreciation and operating surplus across all industries except Financials and Real Estate yields very similar series as the aggregated non financial business series from the Financial Accounts (see Figure 11). The remaining differences appear to be explained by non-businesses (households and non profit organizations) but cannot be reconciled due to data availability. Regardless, the trends are sufficiently similar to suggest that conclusions based on industry data will be consistent with the aggregate-level under-investment discussed in Section 1.

Figure 11: Reconciliation of Financial Accounts and BEA industry datasets



Notes: Financial Accounts data for non financial business sector; BEA data for all industries except Finance and Real Estate. Remaining differences – particularly for OS/K – appear to be driven by non-businesses (households and non profit), which are included in the BEA series but not in the Financial Accounts series.

3.3 Firm-level investment and Q data

3.3.1 Dataset

Firm-level data is primarily sourced from Compustat, which includes all public firms in the US. Data is available from 1950 through 2016, but coverage is fairly thin until the 1970s. We exclude firm-year observations with assets under $1 million; with negative book or market value; or with missing year, assets, Q, or book liabilities.[22] In order to more closely mirror the aggregate and industry figures, we exclude utilities (SIC codes 4900 through 4999), real estate (SIC codes 5300 through 5399) and financial firms (SIC codes 6000 through 6999); and focus on US incorporated firms (see Section 3.3.2 for additional discussion).

Firms are mapped to BEA industry segments using 'Level 3' NAICS codes, as defined by the BEA. When NAICS codes are not available, firms are mapped to the most common NAICS category among those firms that share the same SIC code and have NAICS codes available. Firms with an 'other' SIC code (SIC codes 9000 to 9999) are excluded from industry-level analyses because they cannot be mapped to an industry.

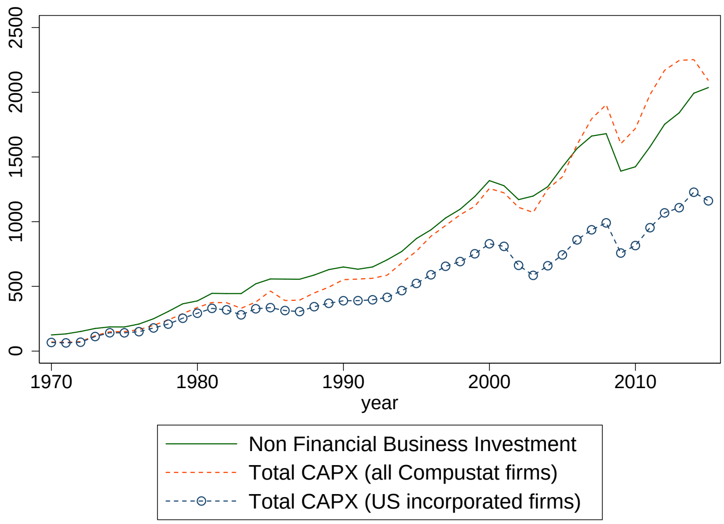
Firm-level data is used for two purposes: first, we use firm-level data to analyze the determinants of firm-level investment through panel regressions (see Section 4 for additional details). Second, we aggregate firm-level data into industry-level metrics and use the aggregated quantities to explain industry-level investment (e.g., by computing industry-level Q). We consider the aggregate (i.e., weighted average), mean and median for all quantities, as well as direct and log-transformed measures of investment and Q. We report the specification/transformation that exhibits the highest statistical significance for each variable. In particular, we use the median log-transformed Q for industry-level regressions on net investment; firm-level log-transformed Q for firm-level regressions on log-gross investment; and Q for firm-level regressions on net investment. Results are generally consistent across variable transformations, but using the one that provides the best fit for Q is conservative when testing alternate hypotheses.

3.3.2 Data validation

The sample of Compustat firms that we study represents a wide cross-section of firms in the US. It covers the largest firms in each industry which, as argued by Grullon et al. [2014], "account for most of the variation in aggregate net fixed private nonresidential investment." Asker et al. [2014] estimate that public firms account for 41% of sales and 47% of aggregate fixed investment. Still, this set of firms is not perfectly representative of aggregate and industry-level patterns (see, for example, Davis et al. [2006]). These differences are, in fact, a primary reason why we study aggregate-, industry- and firm-level investment separately and compare results across levels of aggregation. Otherwise studying Compustat firms would suffice. We find that our main conclusions are robust across datasets and levels of aggregation, suggesting that our choice of datasets is not driving the

[22] These exclusion rules are applied for all measures except firm age, which starts on the first year in which the firm appears in Compustat irrespective of data coverage

Figure 12: Comparison of Financial Accounts and Compustat CAPX ($B)



Note: Annual data. Note that figures for 'all Compustat firms' are before the application of any exclusion criteria (e.g., they include Financials). The qualitative conclusions remain the same after applying our exclusion criteria.

results. Nonetheless, we performed a substantial data validation exercise to ensure Compustat provides reasonable proxies of industry-level variables such as Q.

Investment. We begin by noting that Compustat captures investment by public firms, while official GDP statistics capture all investment that occurs physically in the US irrespective of the listing status or country of the firm making the investment. To address this issue, Figure 12 plots the gross fixed capital formation for non financial businesses (from the Financial Accounts) versus total capital expenditures (CAPX) for two sets of Compustat firms: all firms in Compustat, irrespective of country of incorporation, and all domestically incorporated firms. Simply summing up CAPX for all firms results in a series that roughly tracks, and sometimes exceeds, the official Financial Accounts estimates. However, this Compustat series exhibits a much stronger recovery after the Dotcom bubble and the Great Recession than the official estimates: total CAPX accounts for 85% of investment from 1980 to 2000, on average; but 117% from 2008 to 2015. Focusing on US incorporated firms largely resolves the differences: the new series accounts for 63% of investment from 1980 to 2000 and 59% from 2008 to 2015, on average. 60% is much closer to the 47% share of pubic firm investment estimated by Asker et al. [2014] – the remainder may be investment abroad.[23] In order to more closely mirror US aggregate figures, we restrict our sample to US incorporated firms for the remainder of our analyses. None of the qualitative conclusions in this paper are sensitive to the inclusion of all firms irrespective of country of incorporation.

Coverage. We are interested in using Compustat firm-level data to reach conclusions about industry-level investment. Thus, we need to understand whether Compustat firms in a given industry provide a good representation of the industry as a whole. We define the following two measures

[23] More broadly, these results suggest that foreign-incorporated firms are investing more than US-incorporated firms, but this investment is occurring outside the US.

of 'coverage': the ratio of Compustat total CAPX to BEA Investment by industry, and the ratio of Compustat total PP&E to BEA Capital. Table 17 in the Appendix shows the coverage for the 43 industries under consideration.

We find that our Compustat sample provides good coverage for the majority of material industries. Coverage is generally lower for PP&E than CAPX: the ratio of total Compustat CAPX to BEA investment is ~60%, compared to ~25-30% for PP&E. The difference is explained by more aggressive asset depreciation in accounting standards compared to national accounts. For instance, the weighted average PP&E depreciation rate in Compustat is nearly 2x higher than the corresponding depreciation rate in the BEA.

Nonetheless, Compustat provides at least 10% coverage across both metrics for 29 industries, which account for 55% of total net investment from 2000 to 2015. The most material sectors for which Compustat does not provide good coverage are Health Care, Professional Services and Wholesale Trade. Low coverage levels increase the noise in Compustat estimates, but are not expected to bias the results. We therefore include all industries in our analyses, and confirm that qualitative results remain stable when including only industries with >10% coverage across both metrics and > 25% coverage under CAPX.

3.3.3 Investment definition

We consider three investment definitions.

First, the 'traditional' gross investment rate is defined as in Rajan and Zingales [1998] (among others): capital expenditures (Compustat item CAPX) at time t scaled by net Property, Plant and Equipment (item PPENT) at time $t-1$. Net investment for this definition is estimated by assuming that industry-level depreciation rates from the BEA apply to all firms. We use BEA depreciation rates because depreciation figures available in Compustat exclude depreciation included as part of Cost of Goods Sold – hence are incomplete. Using BEA depreciation measures is unlikely to alter our conclusions since we are interested in aggregate quantities. The net investment rate is therefore defined as the gross investment rate minus the BEA-implied depreciation rate for structures and equipment in each industry.

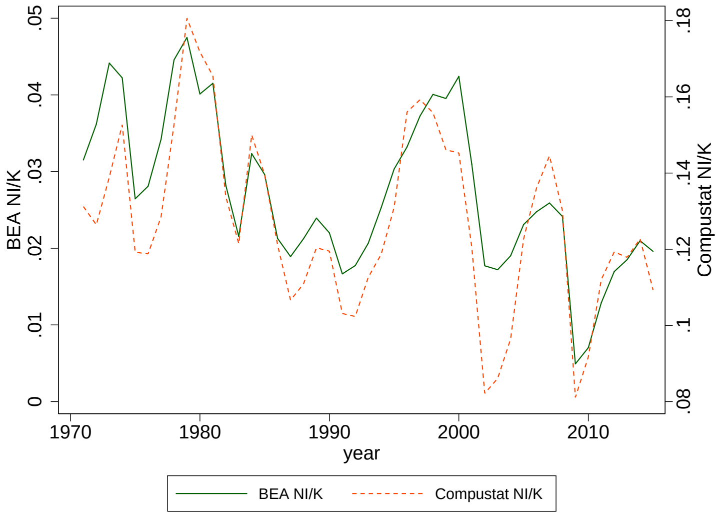
Our second definition focuses on intangible investment by measuring the ratio of R&D expenses to assets (Compustat XRD / AT).[24] We consider only the gross investment rate (i.e., do not subtract depreciation) because a good proxy for R&D depreciation is not available. We acknowledge that R&D expenses are a fairly narrow and noisy measure of intangible investment (e.g., the BEA also capitalizes software, entertainment and artistic originals). Unfortunately, we were unable to identify a better proxy for intangible investment – other measures such as those used in Peters and Taylor [2016] yield substantially higher intangible capital estimates than those of national accounts.

Last, we define the firm-level total gross investment in tangible and intangible assets as (CAPX + XRD) / AT. We again consider only gross investment due to a lack of robust depreciation.[25]

[24] XRD is set to zero if missing

[25] In order to ensure robustness, we also test two alternate definitions: (i) a broader definition of investment con-

Figure 13: Comparison of Compustat and BEA net investment rates



Note: Annual data. BEA and Compustat NI/K for selected sample.

The resulting firm-level net investment figures closely mirror the BEA official estimates. Figure 12 shows the BEA official net investment rate along with the aggregate net investment rate for our Compustat sample (adjusted to mirror the BEA industry mix). The Compustat series is higher because of the differences in definitions (e.g., PP&E covers only a portion of capital and is depreciated more quickly in accounting standards), but the trends are very similar from each other.

3.3.4 Q definition

Our primary proxy for firm-level Q is the ratio of market value to total assets

$$Q^{used} = \frac{ME + LT + PSTK}{AT} \tag{9}$$

where ME denotes the market value of equity; LT denotes total liabilities; PSTK denotes preferred stock; and AT denotes total assets. The market value of equity (ME) is defined as the total number of common shares outstanding (item CSHO) times the closing stock price at the end of the fiscal year (item PRCC_F). This and small variations of the market-to-book ratio have been widely used in the literature as proxies for Q. Current assets (such as cash and marketable securities) are included in both the numerator and denominator, hence the recent rise of cash holdings has a relatively limited effect on Q.

Another popular definition (used in Peters and Taylor [2016], for example) is $Q^{alt} = (ME +$

structed from the statement of cash flows (capital expenditures plus increase in investments minus sale of investments over the sum of PP&E, Investment and Advances (equity) and Investment and Advances (other) (Compustat (CAPX + IVCH - SIV)/(PPE+IVAEQ+IVAO); and (ii) investment over market value, in which case Q is omitted from the regression equations. Definition (i) aims to capture a broader set of long term investment activities than just capital expenditures. We use the total BEA-implied depreciation rate to compute net investment under these two alternate definitions. All qualitative conclusions are broadly robust to using either of them as our measure of investment.

$DLTT + DLC - ACT)/PPEGT$, where DLTT and DLC denote long term and current debt liabilities, respectively; ACT denotes current assets, including cash, inventory and marketable securities; and PPEGT denotes gross PP&E (before depreciation). This definition explicitly excludes current assets to isolate the market and book value of the output-producing capital (i.e., long term capital). However, considering only PP&E in the denominator can be troublesome – particularly for high intangible firms that carry limited PP&E on their balance sheet. The distribution of Q can be quite skewed and fairly volatile. Peters and Taylor [2016] address this issue by including an estimate of the value of intangible capital in the denominator. Namely, they propose

$$Q^{tot} = \frac{ME + DLTT + DLC - ACT}{PPEGT + K^{Int}} \tag{10}$$

where K^{Int} measures intangible capital based on granular capital accumulation and depreciation assumptions.

Neither of these measures is perfect. They are all affected by differences between accounting rules and economic values; as well as measurement error for both the numerator and denominator. Indeed, as noted above, a large literature has developed precisely on this topic.[26] A detailed analysis of all the sources of measurement error and their implications is outside the scope of our paper. We aim to mitigate these limitations by following a three-pronged approach: first, we use the available tools in the literature to control for (classical) measurement error (namely the cumulant estimator); Second, we explicitly test those theories that predict a wedge between Q and investment; and (iii) we ensure that our results are robust to using two prominent measures of Q: we present results using Q^{used} throughout the paper, and confirm that our conclusions are robust to using Q^{tot}. We find material differences between Q^{used}, Q^{alt} and Q^{tot} for high intangible firms and intangible investment so we discuss the implications in Section 5.2.

Figure 14 compares the aggregate, mean and median Q^{used} across all firms in our Compustat sample, against the measure of Q constructed for non financial corporates using the Financial Accounts. As shown, the aggregate and mean Q^{used} from Compustat closely mirror the series from the Financial Accounts. The median Q^{used} is substantially lower than aggregate Q in the early 2000s because the increase in aggregate Q was driven by few firms with extremely high valuations.

3.4 Explanatory Variables

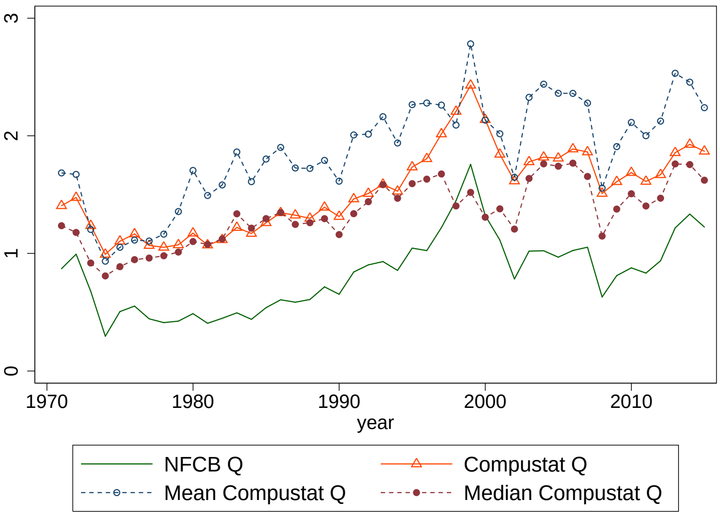
Last, a wide range of additional variables are gathered and/or computed to test our eight theories of under-investment.

3.4.1 Financial Frictions

External finance constraints. For external finance constraints, we are interested in the amount of investment that cannot be financed through internal sources, i.e., the cash flow generated by the business. We follow Rajan and Zingales [1998] and define a firm's dependence on external finance as

[26] See Erickson and Whited [2006] for a comparison of alternate measures of Q.

Figure 14: Comparison of Compustat and Financial Accounts Q



Note: Annual data. Financial Accounts Q for Non financial Corporate sector due to data availability. Compustat Q for selected sample.

the ratio of cumulative capital expenditures (item CAPX) minus cash flow from operations divided by capital expenditures over the 10-year prior period (to avoid over-weighting a particular year). Cash flow from operations is defined as the sum of Compustat cash flow from operations (item FOPT) plus decreases in inventories (item INVCH), decreases in receivables (item RECCH), and increases in payables (item APALCH).[27] The dependence on external equity finance is defined as the ratio of the net amount of equity issues (item SSTK minus item PRSTKC) to capital expenditures; and the dependence on external debt finance as the ratio of the net amount of debt issues (item DLTIS minus item DLTR) to capital expenditures.[28] We use these metrics to test whether firms or industries with high dependence on external finance are under-investing.

Bank dependence. Since financial constraints may differ between bank-dependent firms and firms with access to capital markets, we follow Kashyap et al. [1994] (and others) and define a borrower as bank-dependent if it does not have a long-term issuer rating from S&P. We test whether bank-dependent firms or industries are under-investing but we note that our test is limited because we have few small firms in our sample. These small firms do not account for much CAPX or R&D in the aggregate, but they do account for a significant share of employment, so one should not interpret our results as dismissing the importance of bank dependence.

Safe asset scarcity. For safe asset scarcity, we gather firm-level S&P corporate bond ratings (available in the CRSP-Compustat Merged database) and industry-level corporate bond spreads. The former is used for firm-level analyses, and aggregated to the industry level based on the share of

[27]This definition is used for cash flow statements with format codes 1, 2, or 3. For format code 7 we use the sum of the following items: ibc, dpc, txdc, esubc, sppiv and fopo

[28]Note that debt finance dependence is not computed by Rajan and Zingales

firms rated AA to AAA. The latter was kindly provided by Egon Zakrajsek, and measures the simple average corporate bond spread across all bonds in a given NAICS Level 3 code. This dataset was used in Gilchrist and Zakrajsek [2011]. Not all industries are covered by the bond spread dataset.

3.4.2 Measurement Error

Intangibles. For Intangibles, we compute three types of metrics. First, we compute the investment rate for tangible and intangible assets separately (as described above) and use these to (i) test for under-investment in intangible assets and (ii) test whether the hypotheses supported for total investment also hold for intangible assets. Second, we compute the industry-level share of investment in intangibles (as % of total investment) and the share of intangible capital (as % of total capital). We use these to study intangible intensity over time and across industries. Last, we compute the firm-level ratio of intangibles to assets and intangibles excluding goodwill to assets (Compustat (INTAN-GDWL)/AT); and use these ratios to test for measurement error in intangibles. See Section 5.2 for additional details. Because goodwill is available only after 1988, we use the ratio of intangibles to assets in regressions from 1980, and exclude goodwill in regressions after 1990. We prefer to exclude goodwill because it primarily measures M&A activity, not formation of intangible capital.

Globalization. For Globalization, we use Compustat item PRETAX INCOME - FOREIGN to identify industries and firms with substantial foreign activities. This field contains the income of a company's foreign operations before taxes. It is reported only by some firms,[29] yet there are no other indicators of the extent of a firm's foreign operations available in Compustat [Foley et al., 2007]. For industry-level analyses, we compute the industry share of foreign income as the ratio of total PRETAX INCOME - FOREIGN to total PRETAX INCOME (i.e., across all firms in a given industry and year). For firm-level analyses, we consider three transformations of foreign activities given the potential for missing data: one omitting all firms with missing PRETAX INCOME - FOREIGN; one setting missing PRETAX INCOME - FOREIGN equal to zero; and one with an indicator for populated PRETAX INCOME - FOREIGN. We use these measures to test whether industries with substantial foreign activities are over-investing relative to Q.

3.4.3 Competition

Regulation and Uncertainty For regulation and uncertainty, we consider two measures.

As a measure of the amount and change in regulations affecting a particular industry, we gather the Regulation index published by the Mercatus Center at George Mason University. The index relies on text analysis to count the number of relevant restrictions for each NAICS Level 3 industry from 1970 to 2014. Note that most, but not all industries are covered by the index. See Al-Ubaydli and McLaughlin [2015] for additional details. When necessary, we aggregate the regulation index

[29] Security and Exchange Commission regulations stipulate that firms should report foreign activities separately in each year that foreign assets, revenues or income exceed 10% of total activities

from NAICS level 3 industries into BEA industries by taking the median number of restrictions across all firms in an industry.

Second, as a proxy for barriers to entry, we gather the share of workers requiring Occupational Licensing in each NAICS Level 3 industry from the 2008 PDII.[30]

Market power and demographics. For concentration and firm demographics we use three different sources: Compustat, the US Census Bureau and Thomson-Reuters' Institutional Holdings (13F) Database.

From Compustat, we compute four measures of market power (i) the log-change in the number of firms in a given industry as a measure of entry and exit; (ii) sales Herfindahls[31], (iii) the share of sales and market value held by the top 4, 8 and 20 firms in each industry, and (iv) the price-cost ratio (also known as the Lerner index). We use Compustat item SALE for measures of sales concentration and market value as defined in the computation of Q above for measures of market value concentration. To compute the Lerner index, we follow Grullon et al. [2016] and define the Lerner Index as operating income before depreciation minus depreciation (OIBDP - DP) divided by sales (SALE). We also compute (iv) age (from entrance into Compustat) and (v) size (log of total assets) as measures of firm demographics. The Lerner index differs from the Herfindahl and Concentration ratios because it does not rely on precise definitions of geographic and product markets; rather it aims to measure a firm's ability to extract rents from the market.

From the U.S. Census Bureau, we gather industry-level establishment entry/exit rates and demographics (age and size); and industry-level measures of sales and market value concentration. The former are available in the Business Dynamics Statistics (BDS) for 9 broad sectors (SIC Level 2) since 1977. The latter are sourced from the Economic Census, and include the share of sales held by the top 4, 8, 20 and 50 firms in each industry; and are available for a subset of NAICS Level 3 industries for 1997, 2002, 2007 and 2012. Where necessary, we aggregate concentration ratios to our 43 BEA industry groupings by taking the weighted average by sales across NAICS level 3 industries. We use only NAICS Level 3 segments that can be mapped consistently to BEA categories over time.

The main benefit of the census data is that it covers all US firms (public and private). But the limited granularity/coverage poses significant limitations for its use in regression analyses. We mapped the 9 SIC sectors for which census entry/exit data are available to the BEA investment categories and analyzed sector-level investment patterns. However, limited conclusions could be reached given the very broad sectors: Q exhibited significant measurement error leading to unintuitive coefficients. Because of this, we only use Census entry/exit data to validate the representativeness of relevant Compustat series. For instance, Figure 9 above shows that from 2000 onward, changes in the number firms in Compustat roughly resemble those of the US as a whole.

The census concentration data is available at a more granular level (down to NAICS Level 6), but only for a subset of years and industries. We use these metrics to test whether more concentrated

[30] The 2008 PDII was conducted by Westat and analyzed in Kleiner and Krueger [2013]. It is based on a survey of individual workers from across the nation.

[31] Market value Herfindahl also considered, but Sales Herfindahl performs better and is therefore reported.

industries exhibit lower investment; and to compare nationwide concentration measures with those computed from Compustat. Census and Compustat measures of concentration are found to be fairly correlated, and both are significant predictors of industry-wide (under-)investment. We use Compustat as the basis of our analyses because the corresponding measures are available for all industries and all years; but we also report some regression results using Census-based concentration measures.

Last, to account for anti-competitive effects of common ownership, we compute the modified Herfindahl. We use Compustat as well as Thomson-Reuters' Institutional Holdings to compute this (see the next subsection). The Modified Herfindahl – described in Salop and O'Brien [2000] and Azar et al. [2016b] – is defined as[32]

$$MHHI = \sum_j s_j^2 + \sum_j \sum_{k \neq j} s_j s_k \frac{\sum_i \beta_{ij}\beta_{ik}}{\sum_i \beta_{ij}^2} \tag{11}$$

$$= HHI + HHI_{adj} \tag{12}$$

where s_j and s_k denote the share of sales for firms j, k in a given industry; and β_{ik} denotes the ownership share of investor i in firm j. The first term is the traditional Herfindahl, while the second term is a measure of the anti-competitive incentives due to common ownership. Theoretical justification for this measure can be derived using the modified Herfindahl-Hirschman Index (MHHI) in a Cournot setting. See Salop and O'Brien [2000] and Azar et al. [2016b] for additional details. We consider the combined $MHHI$ in most of our tests; but also separate HHI and HHI_{adj} to assess their impact independently in some cases.

We make two assumptions to compute this measure empirically: first, because ownership data is only available for institutional investors, we compute β_{ij} as the ownership share of investor i in firm j relative to total institutional ownership reported in the 13F database, not total ownership. This is not expected to substantially influence the results because ownership by non-institutional investors is likely limited and restricted to a few firms, which does not induce common ownership links. Second, following Azar et al. [2016b], we restrict the data to holdings of at least 0.5% of shares outstanding. In computing the $MHHI$, we manually combine funds that belong to some of the largest institutions yet are reported separately.[33] We also use the NBER-CES dataset to study the Superstar Hypothesis as a potential driver of concentration (see Section 5.1).

[32] According to the theory, it would better to compute $MHHI = HHI + \sum_j \sum_{k \neq j} s_j s_k \frac{\sum_i \gamma_{ij}\beta_{ik}}{\sum_i \gamma_{ij}\beta_{ij}}$, where γ_{ij} denotes the control share of investor i in firm j. However, because data on the total number of voting shares per company is not readily available, we assume $\gamma_{ij} = \beta_{ik}$ (i.e., we consider total ownership rather than voting and non-voting shares separately).

[33] In particular, we manually search for funds within BlackRock, Capital Research, Dimensional Fund Advisors, Fidelity, State Street and Vanguard. This list may not be complete, but it captures the largest owners – which in turn drive the MHHI values.

3.4.4 Governance

For governance, we gather data on institutional ownership from Thomson-Reuters' Institutional Holdings (13F) Database. This data set includes investments in all US publicly traded stocks by institutional investors managing more than $100 million.

We define the share of institutional ownership as the ratio of shares owned by fund managers filing 13Fs on a given firm over total shares outstanding.[34] We also add Brian Bushee's permanent classification of institutional owners (transient, quasi-indexer, and dedicated), available on his website. This classification is based on the turnover and diversification of institutional investor's holdings. Dedicated institutions have large, long-term holdings in a small number of firms. Quasi-indexers have diversified holdings and low portfolio turnover – consistent with a passive, buy-and-hold strategy of investing portfolio funds in a broad set of firms. Transient owners have high diversification and high portfolio turnover.

Quasi-indexers are the largest category, and account for ∼60% of total institutional ownership. This category includes 'pure' index investors as well as actively managed investors that hold diversified portfolios and benchmark against these indices. Quasi-indexer ownership is therefore heavily influenced by index position and participation. Still, quasi-indexers maintain some discretion on which firms to invest in: beyond their requirements to track and/or benchmark against particular indices, their investment decisions are aimed at maximizing alpha (see, for example, Wurgler [2011]). Indeed, we can infer investor preferences by studying the characteristics of stocks with higher quasi indexer ownership. For instance, firms with lower leverage seem to have higher quasi indexer ownership after controlling for other firm- and industry- characteristics.

Bushee [2001] shows that high levels of ownership by transient institutions are associated with significant over-weighting of the near-term earnings component of firm value. And Asker et al. [2014], shows that firms with more transient ownership exhibit lower investment sensitivity to Q. Appel et al. [2016a,b], Aghion et al. [2013] and Crane et al. [2016] all use Bushee's classifications when studying the implications of institutional ownership on governance, payouts and/or investment. The classification is available from 1981 to 2015.[35]

3.4.5 Other measures

In addition to the above metrics tied to specific theories, we compute the ratio of goodwill (item GDWL) to assets as a measure of past M&A activity; the ratio of share repurchases (item PRSTKC), dividends (item DVT) and payouts (PRSTKC + DVT) to assets as measures of payouts. These additional variables cut across several hypothesis. Acquisitions clearly have an impact on competition, but can also be a sign of weak governance (a view supported by a large literature) or a sign of short-termism (since combining capital and labor into new units is much more time consuming

[34] We use CRSP's total shares outstanding instead of Thomson Reuters since the latter are available only in millions for some periods.

[35] We also considered the GIM index of Gompers et al. [2003] as a proxy for managerial entrenchment; and the industry-level Earnings Response Coefficient, which measures the sensitivity of stock prices to earnings announcements. However, we did not find a strong relationship between these measures and investment.

Table 3: Summary of data fields by potential explanation

Potential explanation		Relevant data field(s)
Financial Frictions	**1. External finance constraints**	Firm- and industry-level Rajan-Zingales (1998) external finance dependence (aggregate, equity and debt)
	2. Bank dependence	Firm-level bank-dependence indicator (firms missing S&P rating)
	3. Safe asset	Industry-average spread
		Firm-level Corporate Bond ratings
Investment Composition	**4. Intangibles**	Separate CAPX vs. Intangible investment rates (firm- and industry-level)
		Share of intangible investment and capital (as % of total)
		Intangibles/assets and Intangibles ex. goodwill/assets
	5. Globalization	Share of foreign profits, as proxy for foreign activities
Competition	**6. Regulation & uncertainty**	Mercatus industry-level regulation index (restriction count)
		Share of workers with Occupational Licensing (PDII)
		Sales and stock market return volatility
	7. Concentration	Change in number of firms (Compustat and Census BDS)
		Share of total sales/market value of top X firms (Compustat and Economic Census)
		Lerner index; i.e., price-cost margin (Compustat)
		Traditional Herfindahl (Compustat)
		Modified Herfindahl, i.e., common-ownership adjusted (Compustat)
Governance	**8. Ownership**	Firm-level share of institutional ownership (Thomson Reuters)
		Firm-level share of Quasi-indexer, Dedicated and Transient ownership (Bushee (2001), updated through 2015)

than buying existing units of production). Similarly, high payout ratios can be a sign of strong governance, short-termism, or low competition.

Table 3 summarizes the data fields considered for each explanation. Investment rates as well as measures of external finance dependence; measures of intangibles; R&D expense; the ratio of operating surplus to capital; cash flow to assets; and foreign pretax income are all winsorized at the 2% and 97% level by year to control for outliers. Buybacks and payouts are capped at 10% of assets, and Q^{used} is capped at 10 while Q^{alt} is capped at 15.

4 Results

Armed with the requisite industry- and firm-level data, we can analyze the determinants of aggregate, industry and firm-level under-investment. We start by showing that the aggregate-level investment gap is explained by low competition and high quasi-indexer institutional ownership. We then discuss industry- and firm-level panel regression results, which confirm (i) that the observed aggregate-level under-investment appears consistently at the industry- and firm-level; and (ii) that industries with more quasi-indexer institutional ownership and less competition (as measured by the traditional and modified Herfindahl as well as the Lerner index) invest less. We report summary results in the body of the document, and detailed regression output in the Appendix.

As discussed above, OLS regressions of Q suffer from two problems: the slopes on Q are biased due to measurement error in Q; and the corresponding R^2 depends on the extent of measurement error. To correct for 'classical' measurement error, all industry- and firm-level panel regression results reported in the paper are based on the cumulant estimator of Erickson et al. [2014] (unless otherwise noted). Qualitative results are robust to using simple OLS, but coefficients on Q and other parameters are smaller (as expected). In addition to the unbiased slopes produced by the estimator, we report the R^2 of the regression, labeled ρ^2. Note that this errors-in-variables estimator requires de-meaned data (and does not compute fixed effects internally). We therefore de-mean all industry-/firm-level variables over the corresponding regression period before running the regressions.

4.1 Aggregate-level results

We start by regressing the aggregate net investment rate for the non financial business sector (from the Financial Accounts) on aggregate Q (from Compustat), along with additional explanatory variables $\boldsymbol{X}$.

$$\frac{NI_t}{K_{t-1}} = \beta_0 + \beta Q_{t-1} + \boldsymbol{\gamma} \boldsymbol{X} + \varepsilon_t \tag{13}$$

Table 4 shows the results of these regressions for our 'core' explanations: industry concentration and quasi-indexer ownership. We report results using the median sales Herfindahl across all industries as our measure of concentration, but alternate measures such as Census- and Compustat-based firm entry and exit rates, changes in the number of firms, and average concentration ratios (% of sales by top 4, 8, 20 firms) are also significant predictors with appropriate signs.

Columns 1 through 3 include regressions from 1980 onward while columns 4 to 6 include results from 1990 onward. As shown, Q exhibits a substantially better fit since 1990, hence we focus on this period for most of our analyses. Measures of competition and quasi-indexer ownership are fairly stable across regressions. Columns 2 and 5 show that an increase in the sales Herfindahl is correlated with lower investment. Columns 3 and 6 add quasi-indexer institutional ownership, and show that increases in such ownership are correlated with lower investment. Quasi indexer ownership is not significant after 1990, but this is likely due to the limited data in the aggregate. This measure exhibits strong significance in the cross-section. Note that the R^2 in column 6 is 80%, suggesting a very high correlation between these measures and investment.

These results are based on time series regressions of fairly persistent series. To control for the over-estimation of T-values, Table 18 in the appendix reports moving average regression results with 1 and 2 year lags. The coefficients are very similar and often significant.

Table 4: Aggregate Net Investment: OLS Regressions†

	(1)	(2)	(3)	(4)	(5)	(6)
	Net I/K					
	≥1980	≥1980	≥1980	≥1990	≥1990	≥1990
Agg. Compustat Q (t-1)	0.002	0.003	0.012**	0.023**	0.016**	0.019**
	[0.48]	[1.13]	[3.03]	[4.56]	[4.53]	[4.69]
Median Sales Herfindahl(t-1)		**-0.516****	**-0.270***		**-0.386****	**-0.253***
		[-6.74]	**[-2.18]**		**[-5.77]**	**[-2.26]**
Mean % QIX own (t-1)			**-0.038+**			**-0.024**
			[-2.02]			**[-1.46]**
Observations	36	36	34	26	26	26
R^2	1%	58%	67%	47%	78%	80%

Notes: Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01. Investment from US Financial Accounts; Q, Herfindahl and Ownership across all US incorporated firms in Compustat.

† The Financial Accounts measure of Q, as well as alternate Census and Compustat measures of competition (including changes in number of firms, concentration ratios, and firm entry and exit) are also significant under most specifications. We focus on Compustat Q and Herfindahls for consistency with the rest of the paper.

4.2 Industry and Firm-level results

4.2.1 Testing under-investment

In order to test our more granular hypotheses, we now move to industry- and firm-level data. We start by documenting that the observed under-investment at the aggregate-level persists at the industry- and firm-level. In particular, we perform errors-in-variables panel regressions of the following form across industries j:

$$\frac{\ddot{NI}_{jt}}{K_{jt-1}} = \beta_0 + \beta med\, \ddot{log}(Q_{j,t-1}) + \alpha med\, \ddot{log}(Age_j) + \eta_t + \varepsilon_{jt} \tag{14}$$

and firms i

$$log\left(\frac{\ddot{CAPX_{it}} + XRD_{it}}{AT_{it}}\right) = \beta_0 + \beta log(\ddot{Q}_{i,t-1}) + \alpha log(\ddot{Age}_i) + \eta_t + \varepsilon_{it} \tag{15}$$

where β_0 represents a constant and η_t represents year fixed effects. The symbol $\ddot{}$ denotes de-meaned variables at the industry- or firm-level, as noted in each table.We include age controls for conservatism, but results are consistent without them. As shown, industry regressions are based on net investment across all asset types, while firm regressions consider $log\left((CAPX + R\&D)/AT\right)$ to include tangible and intangible investment.

We omit the regression results for brevity (which exhibit the expected signs) and instead focus on the time fixed effects. The results are shown in Figure 5. The left (right) chart shows the time effects for the industry (firm) panel regression. The vertical line highlights the average time effect across all years for each regression. As shown, the time-effects are substantially lower for both industry- and firm-level regressions after approximately 2000. Time effects are above average in most years in the 1980s; on average in the 1990s and below-average since 2002. Time effects increase at the height of the great recession (when Q decreased drastically) but reach some of their lowest levels after 2013. Note that time effects need not be zero on average, given the impact of adjustment costs in Q theory and the inclusion of a constant in the regression.

These results confirm that the decline in investment is observed conditional on Q, and consistent across industries and firms. They are also robust to including additional financial measures (e.g., OS/K) in the regression or including only a subset of industries.

4.2.2 Testing hypotheses

Having established the observed under-investment relative to fundamentals since 2000, we now test our eight theories. We do so by expanding the above errors-in-variables panel regression to include additional measures for each theory:

$$\frac{\ddot{NI}_{jt}}{K_{jt-1}} = \beta_0 + \beta \ddot{Q}_{jt-1} + \boldsymbol{\gamma} \ddot{\boldsymbol{X}}_{\boldsymbol{jt-1}} + \boldsymbol{\alpha}\, \ddot{\boldsymbol{Y}}_{\boldsymbol{jt-1}} + \eta_t + \varepsilon_{jt} \tag{16}$$

where, again, β_0 and η_t represent a constant and year fixed effects, respectively. The double dots above each variable denote a within-transformation over the corresponding regression period. $\ddot{\boldsymbol{X}}_{\boldsymbol{jt-1}}$ denotes our 'core' explanations, which are included in all regressions. These include the modified Herfindahl and the share of quasi-indexer institutional ownership; as well as controls for firm age. We use the modified Herfindahl as our base measure of competition because it controls for anti-competitive effects of common ownership as well as traditional measures of concentration. $\ddot{\boldsymbol{Y}}_{\boldsymbol{it-1}}$ denotes the additional measures for each hypotheses, including measures of financial constraints, globalization, etc. These measures are first included individually and then simultaneously (if significant) to assess their correlation with cross-sectional investment levels. Note that including year fixed effects implies that we no longer see under-investment relative to Q. Instead, these regressions identify cross-sectional differences in investment, including which variables explain under-/over-investing relative to Q.

Varying transformations of investment and Q are used throughout the paper, as noted in each Table/Figure. In particular, the dependent variable in industry-level regressions is the BEA net investment rate, and Q is the median Log-Q across all Compustat firms in a given industry.[36] Firm-level regressions include net investment (based on CAPX/PPENT) on Q, as well as log-transformed XRD/AT on log-transformed Q. We use log transformation for gross investment measures due to skewness. And choose the transformation of Q that yields the highest statistical significance.

Table 5 summarizes industry- and firm-level error-corrected regression results across all hypotheses. Tick-marks (✓) identify those variables that are significant and exhibit the 'right' coefficient. Crosses (✗) identify variables that are not significant or exhibit the 'wrong' coefficient.A minus sign after a tick-mark (✓-) highlights that the variable is significant but not robust across periods, against the inclusion of other predictor variables or against changes in the specification.

[36]We also considered the weighted average and mean Q but median Q exhibits higher T-stats

Detailed regression results underlying this summary table are included in Tables 19 to 23 in the appendix. Specifically, Table 19 includes industry-level results for all variables except measures of competition and ownership, which are included in Tables 20 and 21, respectively. Table 22 shows firm-level errors-in-variables results for all explanations except governance and short-termism, which are shown in Table 23. Last, Tables 24 to 27 show the same results as Tables 19 to 23 but from 2000 onward, to demonstrate that results remain generally stable and robust over the more recent period (although coefficients are not always significant given the short fitting period).

Note that, for brevity, we include only the most significant variables/transformations for each type of measure in our reported results (e.g, we exclude the less significant transformations of foreign profits for Globalization, and the industry-average spread for safe asset scarcity). Qualitative results are robust to using the alternate definitions of firm-level investment; including only industries with good Compustat coverage; and (almost always) allowing for measurement error in $MHHI$ and Lerner index in addition to Q.

As shown, we find strong support for measures of competition, intangibles and ownership; some support for globalization (at the industry-level); and no support for the remaining hypotheses. Several measures of competition appear to be significant at the industry- and firm-level – including the traditional and modified Herfindahl as well as concentration ratios and the Lerner index. Similarly, all measures of ownership except Dedicated ownership appear to be strongly correlated with industry- and firm-level under-investment (see Table 23). We emphasize quasi-indexer ownership throughout the paper because it exhibits high levels of significance across all specifications and robustness tests; and because of its rapid growth since 2000. But the significance of the Transient and total institutional ownership measures suggest that under-investment may actually be linked to the financialization of the economy, rather than growth of a particular type of ownership. That said, we find a positive and significant relationship between Dedicated ownership and investment suggesting that not all types of ownership are correlated with lower investment. [37]

Among the remaining hypotheses, we find some support for intangibles and globalization. Industries with a higher share of intangible assets tend to invest less, and high intangible firms invest less within each industry. Industries with higher foreign profits also exhibit lower US investment. This is expected, given their larger foreign operations. However, since this result is not significant at the firm-level (where we include all investment irrespective of the location), the under-investment in the US does not appear to be driven by US firms investing disproportionately more abroad, but rather by all firms investing less.

We highlight that these results cannot discard the theories for all subsets of firms. For instance, other papers have documented that reductions in bank lending affect investment by smaller firms

[37] Our conclusion for ownership somewhat contrasts with Bena et al. [2016] and Aghion et al. [2013]. Bena et al. [2016] study the relationship between foreign institutional ownership (proxied by additions to the MSCI World Index), investment and innovation across 30 countries. They find that foreign institutional ownership can increase long-term investment in fixed capital, innovation, and human capital. Aghion et al. [2013] find that greater dedicated and transient ownership incentivizes higher R&D investment, while quasi-indexer ownership has no effect. We find positive results for Dedicated ownership but negative and strongly significant results for transient and Quasi-indexer ownership. Differences are likely due to the time periods: Aghion et al. [2013] focus on the 1991-2004 period.

Table 5: Summary of Industry and Firm-level results

Potential explanation		**Relevant data field(s)**	Significance: Industry	Significance: Firm
Financial constraints	**1. External finance**	RZ external finance dependence ('99)	✗	✗
	2. Bank dependence	Missing S&P rating ('99)	✗	✗
	3. Safe asset	Industry spread ('99)	✗	✗
		Firm-level ratings ('99)	✗	✗
Measurement error	**4. Intangibles**	Intangibles ex. goodwill/assets	✓-	✓†
		Share of intangible investment	✓	✓†
	5. Globalization	% foreign profits	✓	✗
Competition	**6. Regulation & uncertainty**	Regulation index	✗	✗
		Occupational Licensing	✗	✗
	7. Concentration	ΔLog #of firms	✗	✗
		% sales/market value of top X firms	✓	✗
		Lerner index (Compustat)	✓	✗
		Herfindahl (Compustat)	✓	✓
		Modified Herfindahl (Compustat)	✓	✓
Governance	**8. Ownership**	Share of Institutional ownership	✓	✓
		Share of QIX ownership	✓	✓
		Share of DED ownership	✗	✗
		Share of TRA ownership	✓	✓

Notes: Table summarizes industry- and firm-level errors-in-variables regression results across all potential explanations. Tick-marks (✓) identify those variables that are significant and exhibit the 'right' coefficient. Crosses (✗) identify variables that are not significant or exhibit the 'wrong' coefficient. A minus sign after a tick mark (✓-) highlights that the variable is significant but not robust to inclusion of additional variables, sensitive to treatment of measurement error or to alternate regression periods. See Appendix for detailed regression results and the text for caveats and discussions of the limitations of our results (e.g., in the case of bank dependence).

† At the firm-level, intangibles are correlated with under-investment in the cross-section of firms, but not within firms. See Section 5.2 for discussion.

(e.g.,Chen et al. [2016]). We do not observe such an effect in our sample, using the lack of corporate bond ratings as a proxy for bank dependence. Still, our results are not inconsistent with the existing literature. Industry-level investment tends to be dominated by relatively large firms (which are rarely bank-dependent); and our firm-level data does not cover small firms. What our results suggest is that under-investment by small firms is unlikely to account quantitatively for the bulk of the aggregate investment gap. Finally, another caveat is that bank lending matters for business formation [Alfaro et al., 2015]. A decrease in bank lending can then, over time, lead to an increase in concentration.

The remainder of this section discusses the results in more detail. Section 4.2.3 and 4.2.4 discuss the primary industry and firm-level regression results, respectively. Section 5 then discusses three hypotheses in more detail: Section 5.1 focuses on the potential for 'superstar' firms to be driving the rise in concentration; section 5.2 discusses the implications of rising intangibles on investment; and section 5.3 provides additional analysis and support for discarding the safe asset scarcity hypothesis. Detailed results are included in the Appendix.

4.2.3 Industry Results

Table 6 shows the results of error-corrected industry regressions for our 'core' explanations. We include the modified Herfindahl in columns 1 and 2, and separate the traditional and common ownership components in columns 3 and 4. As shown, all measures of concentration are significant from 1980 and 1990 onward. The differences in the magnitude of coefficients relative to the Aggregate results of Table 4 are driven by a larger coefficient on Q due to measurement error correction. Measures of quasi-indexer ownership are also significant.

4.2.4 Firm Results

Table 7 shows firm-level regression results including the modified Herfindahl and quasi-indexer ownership. Columns 1 to 3 regress net investment (defined as CAPX/PPE minus depreciation), and columns 4 to 6 regress Log(R&D/Assets). Given the use of a log-transformation, firm-year observations with zero or missing R&D are omitted from the regression. Results are robust to using RD/AT directly, while including those firms with zero R&D expenses.

Columns 1, 2, 4 and 5 include year fixed effects. In columns 1 and 4, all variables are de-meaned within each industry; while variables are de-meaned within each firm in columns 2 and 5. As shown, quasi-indexer institutional ownership and concentration are significant predictors of investment. Firms with more quasi-indexer institutional ownership and firms in industries with higher modified Herfindahls invest less. Note that the coefficients on quasi indexer ownership and modified Herfindahls are similar to those recovered in industry-regressions (when using net investment).

Columns 3 and 6 de-mean all variables within each industry-year, and exclude the measure of concentration because it would be absorbed into the means. As shown, quasi-indexer institutional ownership is significant, suggesting that, within each industry-year and controlling for Q, firms with more quasi-indexer institutional ownership invest less.

Table 6: Industry regressions: 'Core' explanations

Table shows the results of industry errors-in-variables panel regressions of Net I/K over the periods specified. All variables are de-meaned at industry level over the regression period (i.e., we apply a 'within' transformation). NI/K from BEA; remaining variables primarily from Compustat. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)
	Net I/K			
	≥1981	≥1990	≥1981	≥1990
Median Log-Q (t-1)	0.170**	0.163**	0.173**	0.275**
	[14.633]	[16.812]	[14.894]	[6.610]
Mean % QIX own (t-1)	-0.091*	-0.118**	-0.092*	-0.125*
	[-2.276]	[-3.068]	[-2.269]	[-2.454]
Mod-Herfindahl (t-1)	**-0.056***	**-0.056***		
	[-2.556]	**[-2.394]**		
Herfindahl (t-1)			**-0.054***	**-0.093****
			[-2.417]	**[-2.614]**
CO Herf adjustment (t-1)			**-0.063***	**-0.104***
			[-2.373]	**[-2.373]**
Observations	1,445	1,110	1,445	1,110
Age Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry de-meaned	YES	YES	YES	YES
ρ^2	0.38	0.39	0.381	0.499

Table 7: Firm regressions: 'Core' explanations

Table shows the results of firm-level errors-in-variables panel regressions of Net CAPX/PPE and Log-R&D/assets over the periods specified. Data primarily sourced from Compustat. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)
	Net CAPX/PPE			Log-R&D/Assets		
	≥1990	≥1990	≥1990	≥1990	≥1990	≥1990
Q (t-1)	0.120**	0.223**	0.138**			
	[59.779]	[51.793]	[59.732]			
Log-Q (t-1)				1.082**	0.940**	1.093**
				[51.468]	[24.118]	[51.145]
% QIX own MA2(t-1)	**-0.067****	**-0.120****	**-0.072****	**-0.731****	**-0.483****	**-0.719****
	[-6.417]	**[-6.671]**	**[-6.381]**	**[-9.081]**	**[-7.405]**	**[-8.903]**
Mod-Herfindahl (t-1)	**-0.055***	**-0.074****		**-0.286+**	**-0.404****	
	[-2.251]	**[-2.753]**		**[-1.833]**	**[-3.739]**	
Observations	77,772	77,772	77,772	40,696	40,696	40,696
Age controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	YES	YES	NO
Industry de-meaned	YES	NO	NO	YES	NO	NO
Firm de-meaned	NO	YES	NO	NO	YES	NO
Industry-Year de-meaned	NO	NO	YES	NO	NO	YES
ρ^2	0.218	0.267	0.221	0.241	0.169	0.24

Table 8: Firm regressions: Buybacks and Payouts

Table shows the results of firm-level errors-in-variables panel regressions of Buybacks/assets and Payouts/assets over the periods specified. Data primarily sourced from Compustat. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)
	Buybacks/Assets			Payouts/Assets		
	≥1990	≥1990	≥1990	≥1990	≥1990	≥1990
Log-Q (t-1)	-0.173**	0.019**	-0.066**	-0.618**	0.035**	-0.341**
	[-14.878]	[3.543]	[-9.411]	[-33.272]	[8.206]	[-29.640]
% QIX own MA2(t-1)	**0.015****	**0.010****	**0.014****	**0.016****	**0.010****	**0.006****
	[10.143]	**[6.092]**	**[9.947]**	**[9.748]**	**[6.133]**	**[3.174]**
Other controls (market cap, OS/K, etc.)	...	...	...	...	...	...
Observations	66,699	66,699	66,699	66,699	66,699	66,643
Age controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	NO	YES	YES	NO
Industry de-meaned	YES	NO	NO	YES	NO	NO
Firm de-meaned	NO	YES	NO	NO	YES	NO
Industry-Year de-meaned	NO	NO	YES	NO	NO	YES
ρ^2	0.148	0.0648	0.122	0.129	0.0653	0.162

Where do the excess funds go? Share buybacks and payouts. As shown in Table 8, firms with more quasi-indexer ownership do more buybacks and have higher payouts. This is true including year, as well as industry (columns 1 and 4), firm (columns 2 and 5) and industry-year (column 3 and 6) fixed effects; and controlling for a wide range of financials such as market value, cash flow, profitability, leverage, sales growth, etc.

Some recent literature highlights that weak governance affects primarily firms in noncompetitive industries. We discuss these interactions in Gutiérrez and Philippon [2017b], where we show that ownership leads to under-investment only in noncompetitive industries. This aligns with the results in Giroud and Mueller [2010, 2011].

5 Detailed discussion of selected hypotheses

This section 5 provides detailed discussions of three prominent hypotheses: 'Superstar' firms, intangible capital, and safe asset scarcity. We discuss the potential for concentration to be driven by the rise of 'Superstar' firms but do not find evidence consistent with the 'Superstar' hypothesis in the 2000's. Next, we provide a detailed discussion of the the rise of intangible assets, and its implications for investment and the measurement of Q. Finally, we provide additional evidence that safe asset scarcity is not likely to be the explanation for low investment in recent years.

5.1 Superstar Firms

As noted above, Autor et al. [2017a] and Autor et al. [2017b] link the increase in concentration (and decrease in labor share) to the rise of more productive, superstar firms. According to this hypothesis, the efficient scale of operation has increased so that better firms account for a larger share of industry output – thereby increasing concentration. Because 'superstar' firms are more productive, industries that become more concentrated should also become more productive. And, importantly, they may require less investment.

To test this hypothesis, we estimate the relation between changes in concentration and productivity across NAICS Level 6 Manufacturing industries. We measure changes in concentration using the U.S. Economic Census over the available five-year periods (1997, 2002, 2007 and 2012) as well as cumulatively from 1997 and 2002 to 2012. We measure changes in productivity using the NBER-CES Manufacturing Industry Database over the same periods as measures of concentration, except that the last observation ends on 2009 (the last year available in the NBER CES database). The NBER-CES database includes industry-level TFP; output and value-added per worker; and output and value-added per unit of capital.

We find positive correlations between concentration and value-added per worker, which would be true under essentially any model of increasing market power. The relation between concentration and TFP, however, is inconsistent. We find positive and significant correlations before 2002, but an insignificant and sometimes negative correlation after 2002. These results broadly match the qualitative discussion in Autor et al. [2017a]. They report that "industries that became more concentrated ... were also the industries in which productivity—measured by either output per worker, value-added per worker, TFP, or patents per worker—increased the most." But the lack of correlation between concentration and TFP after 2000 suggests that other factors may be affecting recent dynamics.[38]

Relatedly, Dottling et al. [2017] compare concentration trends between the U.S. and Europe. They find that concentration has increased in the U.S. yet decreased or remained stable in Europe in industries that are very similar in terms of technology. Such differences in concentration patterns suggest that technological factors are not the only driver of concentration. Gutiérrez [2017] compares labor and profit share trends across advanced economies (excluding Real Estate). He finds that the labor (profit) share decreased (increased) only in the US, while they remained stable in the rest of the world.

Grullon et al. [2016] and Gutiérrez and Philippon [2017a] also discuss alternate hypotheses for the rise of concentration, including (i) decreased antitrust enforcement; (ii) competitive barriers to entry and incumbent innovation; (iii) omission of private firms in Compustat-based measures; (iv) the presence of foreign firms; (v) consolidation in unprofitable industries; and (vi) aging demographics. Gutiérrez and Philippon [2017a] provide evidence that US industries in which Regulation has increased the most have also become more concentrated.

[38]Note that our analyses differ from those of Autor et al. [2017a] in terms of time periods, levels of granularity and approaches. In particular, Autor et al. [2017a] consider NAICS Level 4 industries, over longer periods of analysis (1982 to 2012). In Autor et al. [2017b], they provide evidence that the relationship between lower labor shares and increased concentration remains significant after 2000, but no such evidence is provided for measures of productivity. And a rise in mark-ups due to market power after 2000 would also lead to a decrease in the labor share, so this evidence is inconclusive.

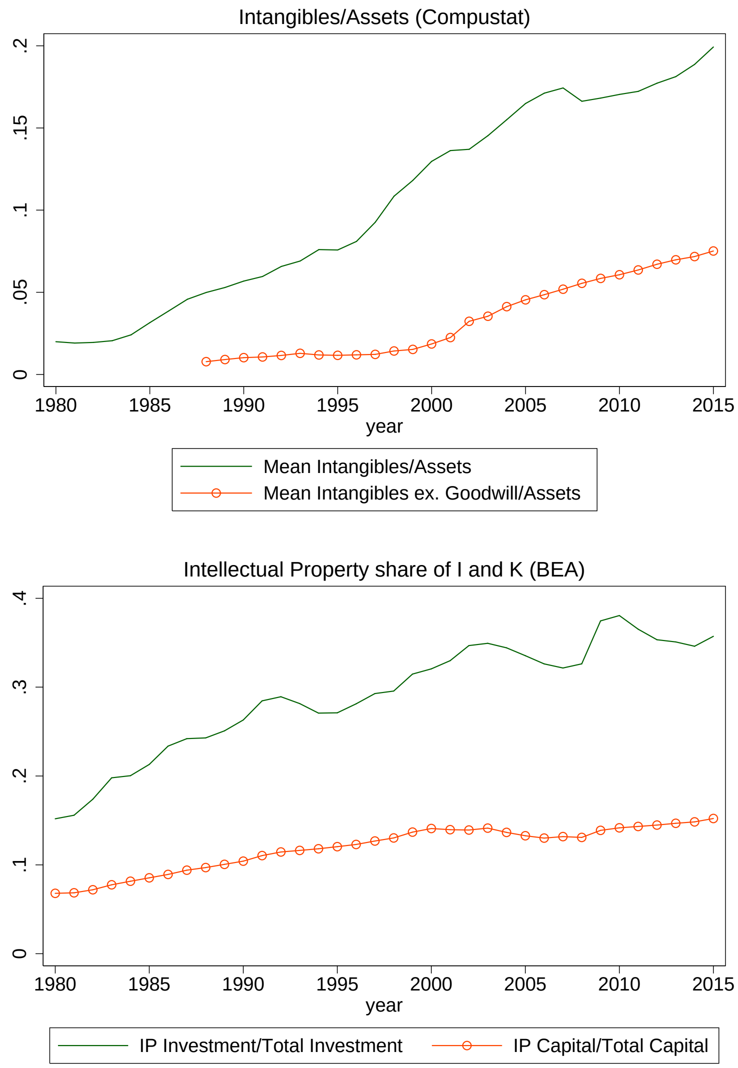
5.2 Intangibles

Next, we discuss the role of the rise in intangible assets for investment dynamics and capital accumulation.

5.2.1 The Rise of Intangibles.

To begin with, the top graph of Figure 15 shows the ratio of intangibles to assets (with and without goodwill) for all US-incorporated firms in Compustat. As shown, the share of intangibles has been increasing rapidly since 1985, and experienced its largest increase in the late 1990s. The rise is primarily driven by goodwill, such that total intangibles are primarily a measure of past M&A activity rather than a true shift in the asset mix. Intangibles excluding goodwill remained low until the 2000s but have increased rapidly since then, to ~7% of assets. The bottom graph shows the share of intellectual property capital and investment reported by the BEA (as a percent of total capital and investment, respectively). As shown, both series experienced a substantial increase from 1980 to about 2000, but have remained relatively stable since. The share of intangible investment (capital) was 14% (35%) on 2002 compared to 15% (36%) on 2015. The movement in the share of investment is mainly because of a shift away from Equipment and Structure investment at the height of the Great Recession.

Figure 15: Intangibles and IP investment



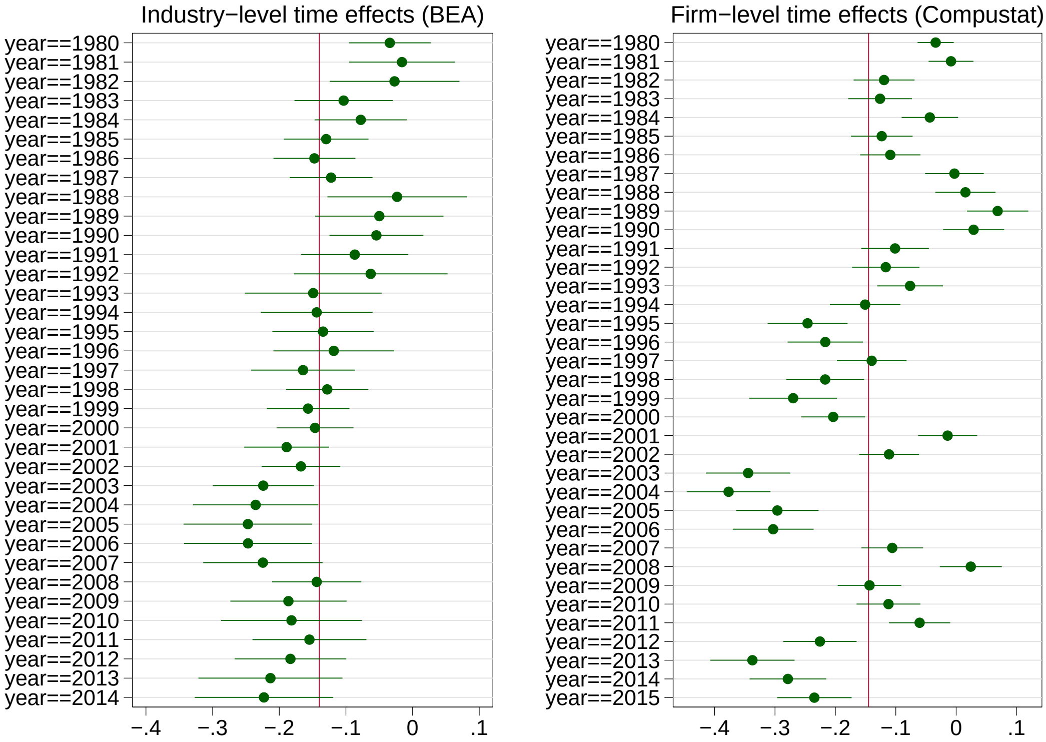
Notes: Annual data. Top chart includes all US incorporated firms in our Compustat sample. Bottom chart based on BEA-reported figures for the industries in our sample (see Section 3).

The rise of intangibles may affect investment in two ways: first, intangible investment is difficult to measure. This can be seen, for instance, in the very different trends between the share of intangibles in BEA data and the intangibles excluding goodwill in Compustat. If intangible investment is under-estimated, K would be under-estimated, and therefore Q would be over-estimated. Second, intangible assets might be more difficult to accumulate. A rise in the relative importance of intangibles could lead to a higher equilibrium value of Q even if intangibles are correctly measured.

5.2.2 Intangible Assets and Q

Adjustment costs might differ for intangible assets than for tangible assets. This could affect both the equilibrium value of Q and the dynamics of capital accumulation. To test this idea we consider

Figure 16: Time Effects from Intangible Asset Regressions



Note: Time fixed effects from errors-in-variables panel regressions (Erickson et al. [2014]) of industry net intangible investment on median Log-Q (left) and firm-level log(R&D/AT) on firm-level Log-Q (right), as well as a control for firm age. All variables are de-meaned at the industry- and firm-level, respectively. Industry investment data from BEA; Q and firm investment from Compustat. Regressions follow the same approach as Figure 5.

asset types separately. To begin with, Figure 16 shows the time effects from industry- and firm-level regressions of intangible investment on Q (i.e., the same analysis as in Figure 5, but using net investment in intellectual property as the industry level dependent variable, and the ratio of R&D expenses to assets as the firm-level dependent variable). Time effects exhibit very similar patterns as those observed above for total investment. In particular, time effects were above average in the 1980s, on-average in the 1990s and below average since 2000. Both time effects increase at the height of the Great recession but again reach some of their lowest levels after 2013.

It may be, however, that the effect of competition and quasi-indexer ownership applies only for tangible investment. In that case, our conclusions would only apply to a subset of asset types. We test this by replicating the core industry-level regressions above, but separating tangible and intangible assets; and by analyzing firm-level investment in R&D. Industry-level results are shown in Table 9. Quasi-indexer ownership exhibits significantly negative coefficients for all assets and non-IP assets; and negative but insignificant coefficients for IP. The modified Herfindahl is significant across all asset types. Note that the t-stat on Q is the largest for all assets, which is consistent with Peters and Taylor [2016]'s result that Q explains explains total investment better than either

Table 9: Industry regressions, by asset type

Table shows the results of industry errors-in-variables panel regressions of Net I/K since 1990, split by asset type. All variables are de-meaned at industry level over the regression period (i.e., we apply a 'within' transformation). NI/K from BEA; remaining variables primarily from Compustat. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)
	Net I/K		
Mean	All fixed assets[1+2]	Excluding IP[1]	IP[2]
Median Log-Q (t-1)	0.163**	0.190**	0.166+
	[16.812]	[7.870]	[1.940]
Mean % QIX own (t-1)	**-0.118****	**-0.114****	**-0.368**
	[-3.068]	**[-2.869]**	**[-1.340]**
Mod-Herfindahl (t-1)	**-0.056***	**-0.083****	**-0.143+**
	[-2.394]	**[-2.950]**	**[-1.754]**
Observations	1,110	1,110	1,109
Age controls	YES	YES	YES
Year FE	YES	YES	YES
Industry de-meaned	YES	YES	YES
ρ^2	0.39	0.427	0.194

physical or intangible investment separately. Firm-level results are shown in Table 7 above. As shown, increased concentration and quasi-indexer ownership leads to under-investment in R&D.

We conclude that intangible assets are potentially more difficult to accumulate. However, the most striking result is that Q-theory works best when we combine tangible and intangible investment, suggesting that they are complementarily and jointly accumulated. Moreover, our results on the role of competition and governance apply to both types of assets.

5.2.3 Missing Intangibles

Denote net investments in tangible and intangible assets by $NI^T$and NI^I, such that total investments are $NI = NI^T + NI^I$. Assume that tangible capital is perfectly measured but intangible capital is under-estimated by a factor α – that is, assume that intangible investment is consistently under-estimated across all industries. This is a simplifying assumption, but it highlights the main reason for concern. Under this assumption, *measured* investment is given by

$$\hat{NI} \equiv \hat{NI}^T + \hat{NI}^I \tag{17}$$

$$= NI^T + \alpha NI^I \tag{18}$$

The under-estimation of investment leads to under-estimation of capital $\hat{K}$ and, since $\hat{Q}$ is the ratio of market value to replacement cost of capital, it leads to over-estimation of Q. Thus, a regression of the form

$$\frac{\hat{NI}_{it}}{\hat{K}_{i,t-1}} = \beta \hat{Q}_{i,t-1} + \gamma \frac{\hat{K}^I}{AT_{i,t-1}} + \mu_i + \eta_t + \varepsilon_{it} \tag{19}$$

would yield a negative and significant coefficient γ. More complex measurement errors would yield different structures, but broadly the negative coefficient should remain. Industries with higher dependence on intangibles would appear to be under-investing due to an over-estimation of Q and an under-estimation of investment.

We first test this at the industry-level, in two ways. First, we run measurement-error corrected regressions at the industry level, using BEA measures of investment (which includes intellectual property investment) and the traditional Compustat Q. The results are shown in columns 1 and 2 of Table 10. As shown, the coefficient on intangibles is significant and negative, suggesting that industry-years with a larger share of intangibles exhibit more under-investment relative to the traditional Q.

Second, we replace the Compustat Q with the 'total Q' of Peters and Taylor [2016]. Total Q aims to correct for measurement error in intangibles by recognizing R&D and part of SG&A expenses as investments. This procedure reduces the measurement error in Q due to intangibles, and should therefore reduce the explanatory power of $\frac{\hat{K}^I}{AT_{i,t-1}}$. The results are shown in column 3. Interestingly, intangibles are no longer significant, although they retain the negative sign. Note, however, that our 'core' hypotheses of competition and quasi-indexer ownership remain significant, and the addition of intangibles in the regression has limited effect on the coefficients or the R^2 (when using the Compustat Q; coefficients change when using total Q due to differences in the series).

The concern for measurement error in Q is even more significant at the firm-level. To account for this, we study the implications of alternate definitions of firm-level Q on investment behavior – particularly of high-intangible firms. For reference, recall our three measures of firm-level Q: Q^{used}, which is a proxy for firm-level market-to-book ratio; Q^{alt}, which is the ratio of market value of productive assets to gross PP&E; and Q^{tot}, which is the ratio of market value of productive assets to gross PP&E plus Intangibles.

Peters and Taylor [2016] compare the performance of Q^{alt} and Q^{tot}; while the implications of intangibles on investment have been studied in two papers: first, Alexander and Eberly [2016] link within-firm increases in intangible assets to decreases in tangible investment. Namely, they regress:

$$log\left(\frac{CAPX_i}{AT_i}\right) = \beta_o + \beta_1 log\left(\frac{CF_i}{AT_i}\right) + \beta_2 log\left(Q_i\right) + \beta_3 log\left(\frac{Intan_i}{AT_i}\right) + \mu_i + \eta_t + \varepsilon_{it}$$

where μ_i and η_t denote industry and time fixed effects, respectively. They use a measure of Q similar to Q^{alt}. By including firm-level fixed effects, the implication is that firms decrease tangible investment as they increase their share of intangibles. Second, Döttling and Perotti [2017] consider the change in net PP&E normalized by operating cashflows as their measure of tangible investment and include only industry fixed effects. They find that high intangible firms invest less in tangible assets, relative to other firms in the same industry. Dottling et al. [2017] confirm the results of

Table 10: Industry regressions: Intangible Measurement Error

Table shows the results of industry errors-in-variables panel regressions of Net I/K over the periods specified. All variables are de-meaned at industry-level. NI/K from BEA; remaining variables primarily from Compustat. Q^{tot} from Peters and Taylor [2016], aims to correct for measurement error in intangibles. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)
		Net I/K	
	≥1990	≥1990	≥1990
Median Log-Q (t-1)	0.163**	0.138**	
	[16.812]	[23.700]	
Median Log-Q^{tot} (t-1)			**0.138****
			[20.330]
Mean % QIX own (t-1)	-0.118**	-0.110**	-0.183**
	[-3.068]	[-3.015]	[-3.231]
Mod-Herfindahl (t-1)	-0.056*	-0.043*	-0.075**
	[-2.394]	[-2.111]	[-2.703]
Share of Intan Inv(t-1)		**-0.064***	**-0.015**
		[-2.298]	**[-0.295]**
Observations	1,110	1,110	1,109
Age Controls	YES	YES	YES
Year FE	YES	YES	YES
Industry de-meaned	YES	YES	YES
ρ^2	0.39	0.387	0.545

Döttling and Perotti [2017] with a sample of European firms.

Table 11 starts by comparing the empirical distribution (before winsorizing) of our three measures of Q over two periods: 1975-1980 and 2010-2015.[39] As shown, all three distributions have become increasingly skewed since 1980, but Q^{alt} is by far the most affected: the 75th percentile of the distribution as of 2010-2015 is 7.6, and the 90th percentile is 30. This is likely due to high intangible firms carrying low PP&E balances. Q^{tot} resolves some of these issues by adding an estimate of intangible assets to the denominator, reaching a distribution similar to our proxy Q^{used}. Interestingly, the median Q also increased across all measures – especially Q^{alt} and Q^{tot}, which increased by a factor of 8 and 4, respectively. Our measure, Q^{used}, appears to be the most stable of the three.

Such drastic differences in the distribution and skewness of Q have material implications for regression results – particularly as they relate to the role of intangibles on investment; as well as the effect of correcting for measurement error using the cumulant-estimator. Let us study these implications.

Table 12 shows the results of regressing firm-level net investment on Q^{used}, Q^{alt} and Q^{tot}. Columns 1-3 show OLS results with firm fixed effects. Q^{used} and Q^{tot} exhibit strong statistical significance, especially compared to Q^{alt}. Log-transforming all measures of Q substantially improves the fit of Q^{alt}, but has a limited effect on Q^{used} and Q^{tot} (in fact it decreases the fit for Q^{tot}). Columns

[39] We consider firms after applying our data cleaning and exclusion criteria. In other words, our population includes only US-incorporated firms and excludes Utilities, Financials and Real Estate. See Section 3.3 for details.

Table 11: Percentiles of three measures of Q

	1975-1980			2010-2015		
Percentile	Q^{used}	Q^{alt}	Q^{tot}	Q^{used}	Q^{alt}	Q^{tot}
1%	0.5	-4.8	-1.0	0.5	-5.1	-0.9
5%	0.7	-1.5	-0.5	0.7	-0.6	-0.2
10%	0.7	-0.8	-0.3	0.9	0.0	0.0
25%	0.8	-0.2	-0.1	1.1	0.7	0.3
50%	1.0	0.3	0.2	1.6	2.1	0.8
75%	1.3	0.9	0.6	2.5	7.6	1.6
90%	1.9	**2.5**	1.4	4.4	**30.0**	3.4
95%	2.7	**4.6**	2.4	6.5	**73.1**	5.9
99%	6.6	**24.1**	9.6	16.2	**746.2**	22.4

1-3 also suggest that increases in intangible assets are correlated with decreases in net investment within firms. This conclusion, however, is sensitive to measurement error corrections: as shown in columns 4-6, the coefficient on intangible assets remains negative only for Q^{alt} once controlling for measurement error.[40]

This does not contradict our industry-level results, however. Column 7 and 8 shift from firm to industry fixed effects while using Q^{used} and Q^{tot}, respectively. As shown, we find a negative and significant coefficient on intangible intensity – suggesting that high intangible firms do invest less in the cross-section. This is consistent with Dottling et al. [2017] and Döttling and Perotti [2017]. Industry-level investment may therefore decrease as high-intangible firms account for a larger share of the market. In unreported tests, we confirm that out conclusions are robust to using $CAPX/AT$, instead of net investment as the dependent variable; as well as using the CRSP-Compustat Merged sample instead of the full Compustat sample.

Our results lead to several conclusions. First, Q^{alt} does not appear to be a valid proxy of Q in the presence of high intangible firms: either Q^{tot} or Q^{used} should be used going forward. Both of these measures exhibit similar results and broadly similar levels of significance. Second, Q^{used} appears like a reasonable, and stable proxy of Q.

5.2.4 Take-Away on Intangible Investment

The industry-level evidence suggests that high-intangible industries exhibit lower 'measured' investment; and the firm-level evidence suggests that high intangible firms invest less in the cross section. What portion of the under-investment can be explained by the rise of intangibles? We estimate this by adding measures of intangible intensity to regressions similar to those underlying Figure 5. For industry results, we use the same regression as in Figure 5 and add the share of intangible

[40] We note that the positive coefficient on Q^{tot} is sensitive to log-transformations (i.e., it is negative and significant when regressing net investment on $log(Q^{tot})$) but Q^{tot} exhibits a much higher t-stat than $log(Q^{tot})$. The positive coefficient on Q^{used} remains even when using logs.

Table 12: Firm regressions: Intangible Measurement Error

Table shows the results of firm-level panel regressions of Net I/K against alternate measures of Q. Variables de-meaned at firm- or industry-level, as noted. Total Q from Peters and Taylor [2016]; all remaining variables from Compustat.Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Net CAPX/PPE				
	≥1980	≥1980	≥1980	≥1980	≥1980	≥1980	≥1980	≥1980
Q^{used} (t-1)	0.074**			0.218**			0.103**	
	[84.810]			[50.108]			[50.807]	
Q^{alt} (t-1)		**0.000****			**0.000****			
		[6.238]			**[3.154]**			
Q^{tot} (t-1)			0.076**			0.207**		0.098**
			[105.324]			[65.656]		[71.389]
Intan/Assets(t-1)	-0.048**	-0.165**	-0.035**	**0.158****	-0.103**	**0.123****	**-0.028***	**-0.049****
	[-4.145]	[-13.804]	[-3.113]	**[7.574]**	[-6.214]	**[5.724]**	**[-2.338]**	**[-4.103]**
Observations	116,351	113,527	115,473	116,351	113,527	115,473	116,351	115,473
Method		OLS			EW		EW	
Age Controls		YES			YES		YES	
Year FE		YES			YES		YES	
Firm de-meaned		YES			YES		NO	
Industry de-meaned		NO			NO		YES	
ρ^2	0.139	0.082	0.171	0.258	0.0747	0.33	0.205	0.246

investment as a predictor variable. For firm-level results, we move from industry- to firm-level fixed effects (given the results in Table 10) and add the the firm-level ratio of intangibles to assets to the regression.

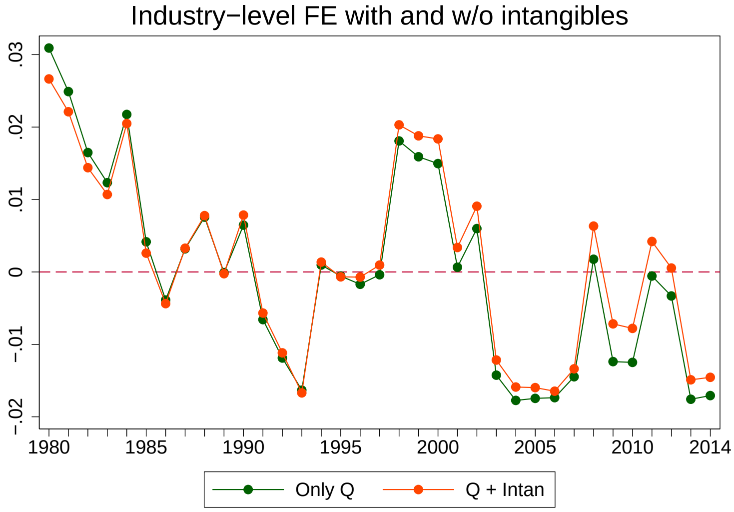
Figure 17 shows the results, where we have re-centered the fixed effects at zero and flipped the plot for readability. The rise of intangibles appears to explain a quarter to a third of the observed investment gap. Importantly, adding intangibles not only increases the time effects after 2000 but also decreases them before 1990 – suggesting that part of the long term drop in investment is in fact driven by the rise of intangibles. Our estimate of the impact of intangibles is broadly consistent with that of Alexander and Eberly [2016].

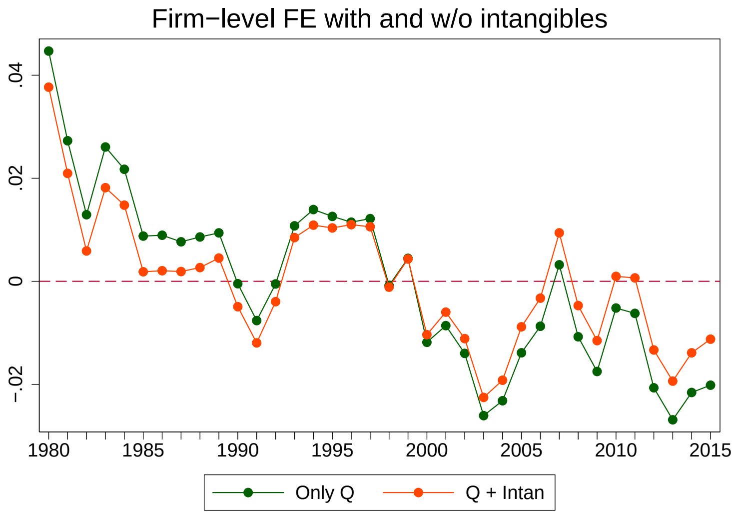
Even after controlling for intangible investment, however, large and persistent negative time effects remain after 2000 – time effects that are correlated with increased concentration and increased quasi-indexer ownership. Corporations have reduced investment in both tangible and intangible assets since 2000, suggesting that other factors are in play. We conclude that the rise of intangibles accounts for some – a quarter to a third – but not all of the observed under-investment.

5.3 Debt issuance and investment by highly-rated firms

According to the safe asset scarcity hypothesis, the value of being able to issue safe assets increased after the Great Recession. This should increase the value of very safe (AA to AAA) firms, but, to the extent that safety cannot be readily scaled up, it would not increase their physical investment to

Figure 17: Time Effects from Intangible Asset Regressions





Note: Time fixed effects from errors-in-variables panel regressions (Erickson et al. [2014]) of industry net investment on median Q (top) and (CAPX+R&D)/AT on firm-level Q (bottom), as well as a control for firm age. Industry regressions follow the same specification as in Figure 5 (i.e., the green line corresponds to the same fixed effects as those of Figure 5, except that they have been de-meaned here). Firm regressions based on de-meaned variables at industry-level instead of firm-level for the reasons discussed in the text. Industry investment data from BEA; Q and firm investment from Compustat.

Table 13: Safe Asset Scarcity: Valuation test

Table shows the results of firm-level OLS regressions of Market Value, PP&E and Assets as of 2014 on 2006 Market value and a AA-to-AAA rating indicator. Annual data, sourced from Compustat. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(1)	(2)	(1)	(2)
	Log MV (2014)		Log PPE (2014)		Log Assets (2014)	
AA to AAA rated (2006)	**-0.079**	**-0.241**	**-0.362**	**-0.224**	**-0.205**	**-0.274**
	[-0.34]	**[-1.03]**	**[-0.94]**	**[-0.65]**	**[-0.98]**	**[-1.31]**
Log MV (2006)	0.036	0.021	0.192*	0.170*	0.032	0.034
	[0.70]	[0.40]	[2.27]	[2.22]	[0.70]	[0.73]
Log Assets (2006)	1.034**	1.001**	0.373**	0.459**	0.546**	0.552**
	[25.75]	[24.17]	[5.60]	[7.55]	[15.27]	[14.98]
Log(age)	-0.008	0.03	0.748**	0.613**	0.455**	0.443**
	[-0.20]	[0.73]	[11.36]	[10.09]	[12.90]	[12.04]
Industry FE	No	Yes	No	Yes	No	Yes
Observations	1795	1795	1781	1781	1795	1795
Overall R^2	0.85	0.858	0.721	0.793	0.873	0.879

the same extent that it increases their value. This might then account for relatively low investment despite high Q. Note that, at some broad abstract level, this is an example of decreasing returns to (physical) scale.

To better understand whether this hypothesis is supported by the data, this section discusses valuation and investment patterns of AA to AAA rated firms and below AA-rated firms. To mitigate endogeneity problems, we assign firms to rating groups based on their 2006 rating, before the Great Recession. The year 2006 is chosen because safe asset scarcity is understood to be a post-Great Recession effect.

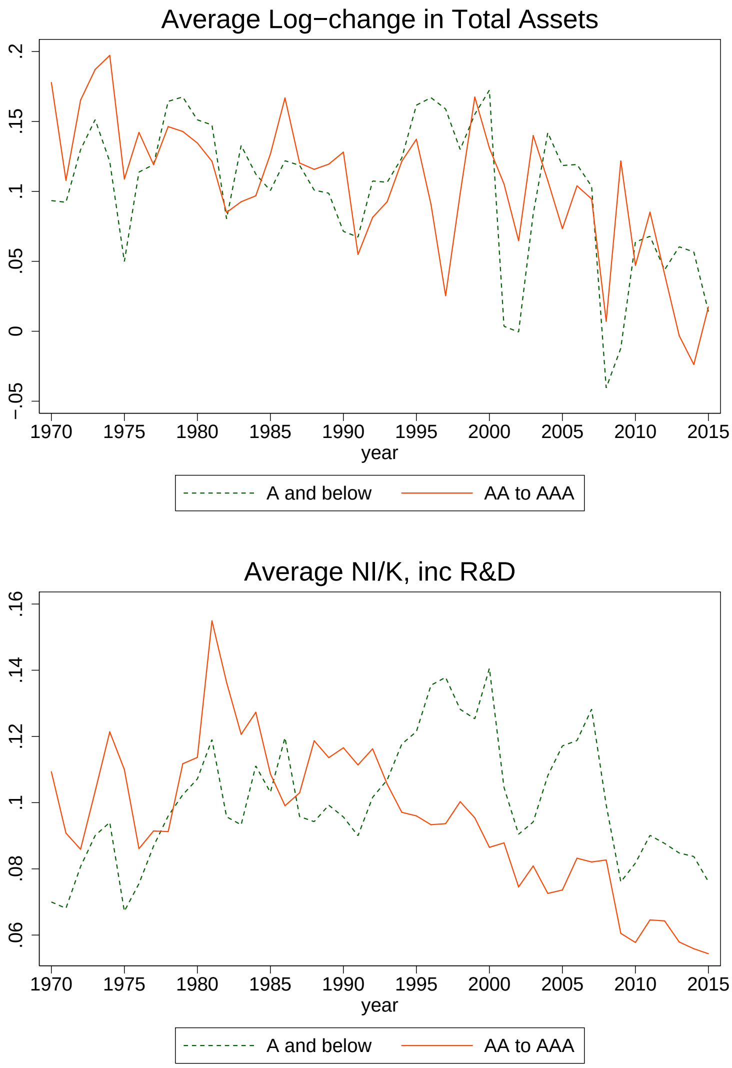
We start with valuations. According to the safe asset scarcity hypothesis, the value of being able to issue safe assets increased after the Great Recession. In that case, valuation (and investment, to a lesser extent) of highly rated firms should increase relative to that of other firms.We regress the 2014 value on the 2006 value and an indicator for AA to AAA rated firms:

$$logMV_{i,2016} = \beta_0 + \beta_1 log\, age_i + \beta_2 log\, assets_{i,2006} + log\ MV_{i,2006} + \mathbb{I}\{AA - AAA_{i,2006}\} + \varepsilon_i \quad (20)$$

We include industry fixed effects in some regressions; and run a similar regression for capital (PP&E) and assets to test for higher (cumulative) capital expenditures or balance sheet growth. Table 13 summarizes the results. As shown, the coefficient on the AA to AAA rated indicator is not significant and, if anything, it is negative. In unreported tests, we find positive results at the height of the Great Recession (2009 and 2010), but not in later years. The AAA premium did exist immediately after the Great Recession, but it was short lived, and cannot account for valuation and investment after 2010.

Let us move on to investment patterns. Figure 18 shows the average log-change in total assets

Figure 18: Assets and investment, by rating



Note: Annual data. Firms mapped to categories based on ratings as of 2006.

and the average net investment rate (including R&D expenses) for both groups of firms.[41] At least until 2012, both groups of firms seem to be increasing assets at roughly the same rate. By contrast, the investment rate of highly rated firms has been well-below that of lower rated firms since 1990. This suggests that highly rated firms have grown their balance sheets at roughly the same rate as lower-rated firms, but have invested less.

Have these firms reduced external financing given the lower investment? To answer this question, we follow Frank and Goyal [2003] and compute the uses and sources of funding based on Compustat data. Specifically, we define the total finance deficit as the sum of dividends, investment and changes

[41] Conclusions are qualitatively similar excluding R&D expenses from the NI/K calculation

in working capital minus internal cash flow:[42]

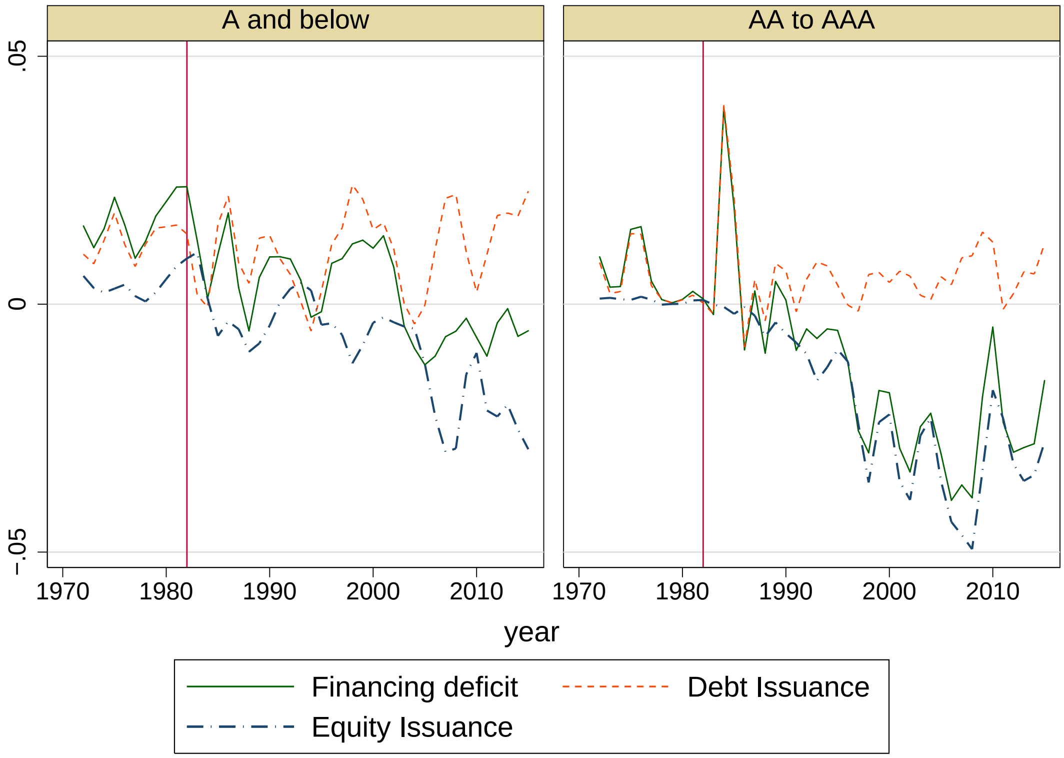
$$DEF = DIV + INV + \Delta WC - IntCF \tag{21}$$

Note that this definition of investment is substantially broader than capital expenditures: it includes all short and long term investment as defined in the statement of cash flows. We also compute net debt and equity issuance, such that $DEF = NetDebtIss + NetEqIss$.

Figure 19 shows the 2-year cumulative financing deficit, debt and equity issuance by rating group, normalized by total assets. We highlight the year 1982, when SEC Rule 10b-18 was instituted, which allows companies to repurchase their shares on the open market without regulatory limits. Two interesting conclusions arise: first, both types of firms have either maintained or increased their debt issuance since the mid-1990s. Highly rated firms issued a substantial amount of debt in 2009, at the height of the Great Recession. Such debt issuance allowed them to maintain large buybacks despite lower internal funds. They decreased issuance in the early 2010s but returned to the market in 2015 as internal funds decreased but buybacks remained high. Low rated firms issued almost no debt during the Great Recession, which led to a substantial decrease in buybacks. But they quickly returned to the market after the crisis, and used the funds raised primarily for buybacks. Second, buybacks at highly-rated firms increased soon after 1982, moving almost one-to-one with the internal finance deficit for the past 20 years. The increase in buybacks is much less pronounced for lower rated firms until the mid-2000s. In fact, lower rated firms maintained a positive finance deficit until about 2000, which was financed primarily with debt.

[42]The following Compustat items are used: $Div = div$, $INV = capx + ivch + aqc - sppe - siv - ivstch - ivaco$, $\Delta WC = -recch - invch - apalch - txach - aoloch + chech - fiao - dlcch$ and $IntCF = ibc + xidoc + dpc + txdc + esubc + sppiv + fopo + exre$. Note that adjusted definitions are used for prior disclosure regimes – see Frank and Goyal [2003] for additional details.

Figure 19: Uses and sources of financing, by rating



Note: 2-year cumulative rates, normalized by total assets. Based on annual data. Firms mapped to categories based on ratings as of 2006. The vertical line on 1982 highlights the passing of SEC rule 10b-18, which allows companies to repurchase their shares on the open market without regulatory limits.

The improving finance deficit and associated buybacks may be driven by increasing profits, or by decreasing investments. Table 14 decomposes the sources and uses of financing for highly rated firms and lower-rated firms. As shown, the improving finance deficit for both types of firms is driven by decreasing investments and, to a lesser extent, working capital. Cash dividends have remained stable while cash flow decreased slightly. The decrease in investment is particularly pronounced for highly rated firms, from ∼11% in the 1970s and 1980s to only 6% in the 2000s.

6 Interpretation of Macro-economic Trends

Recent work in the macro-literature has studied the slow U.S. recovery following the Great Recession. Fernald et al. [2017] (FHSW), in particular, use a quantitative growth-accounting decomposition to study the output shortfall. According to their calculations, the shortfall is almost entirely explained by slower TFP growth and decreased labor force participation. Focusing on the capital stock, they argue that "although capital formation has been below par [since 2009], so has output growth, and by 2016, the capital/output ratio was in line with its long-term trend."

Our goal in this section is to test how the growth accounting decomposition of Fernald et al.

Table 14: Funds flow and financing as a fraction of total assets, by rating (%)

Rating	**Field / Year**	1970-1979	1980-1989	1990-1994	1995-1999	2000-2004	2005-2009	2010-2015
	Cash dividends[a]	3.7	3.9	4.3	4.7	4.5	4.2	4
	Investments[b]	9.7	11.9	8.4	7.9	7.3	6.2	6.2
	ΔWorking capital[c]	1.6	-0.3	0.5	1.4	1.4	0.8	0.1
AA to AAA	Internal cash flow[d]	14.2	15.8	13.8	15.6	16.3	15.7	13
rated firms	**Financing deficit[a+b+c-d]**	**0.7**	**0.1**	**-0.7**	**-1.9**	**-2.7**	**-3**	**-2.3**
	Net debt issues[1]	0.6	0.2	0.4	0.3	0.4	1.1	0.6
	Net equity issues[2]	0.1	-0.1	-1.1	-2.2	-3.1	-4.1	-2.9
	Net external financing[1+2]	**0.7**	**0.1**	**-0.7**	**-1.9**	**-2.7**	**-3**	**-2.3**
	Cash dividends[a]	2.6	2.5	2.1	1.8	1.3	1.7	2
	Investments[b]	10.7	12.2	7.8	9.3	6.8	7.4	7.8
	ΔWorking capital[c]	1.8	0.9	0.8	2	1.9	1.5	1.4
Below AA	Internal cash flow[d]	13.4	14	10.1	11.7	9.8	11.3	11.7
rated firms	**Financing deficit[a+b+c-d]**	**1.5**	**1.1**	**0.4**	**1**	**0.2**	**-0.7**	**-0.6**
	Net debt issues[1]	1.2	1.1	0.2	1.6	0.6	1.3	1.7
	Net equity issues[2]	0.3	0	0.2	-0.7	-0.4	-2.1	-2.4
	Net external financing[1+2]	**1.5**	**1.1**	**0.4**	**0.9**	**0.2**	**-0.8**	**-0.7**

Notes: Annual data, in percentages. Based on the average of yearly cumulative totals across all firms in each category. Firms mapped to categories based on 2006 ratings.

[2017] would deal with an increase in markups. To tease out the effect of increased market power on growth-accounting decompositions, we generate 100 simulations of an economy under increasing mark-ups using the model in Jones and Philippon [2016], which is briefly described in the Appendix. We assume a change in the steady-state markup from 20% to 35% over 100 quarters.[43] We use the simulations to study the contribution of alternate macro-series to aggregate output under the following two decompositions (see FHSW for their derivation):

$$\Delta log(Y_t) = \Delta log(TFP_t) + \alpha_t \Delta log(K_t) + (1 - \alpha_t)\Delta log(N_t) \tag{22}$$

and

$$\Delta log(Y_t) = \frac{\Delta log(TFP_t)}{1-\alpha_t} + \frac{\alpha_t}{1-\alpha_t}\Delta log\left(\frac{K_t}{Y_t}\right) + \Delta log(LQ_t) \tag{23}$$

where α_t denotes the capital share of output and LQ_t denotes labor quality. We model only total labor N_t, so in our simulated data $\Delta log(LQ_t) = 0$. All other definitions are standard.

Each simulation includes estimates for the growth of output, consumption, labor and capital; as well as shocks to economy-wide TFP (among others). Using the simulated series, we estimate each of the components in equations 22 and 23. We report results using the change in measured TFP, defined as

$$\Delta log(TFP_t) = \Delta log(Y_t) - \overline{\alpha_t} log(K_t) - (1 - \overline{\alpha_t})\Delta log(N_t) \left[-\overline{\alpha_t} log(K_{t-1})\right] \tag{24}$$

where $\overline{\alpha_t} = \frac{\alpha_t + \alpha_{t-1}}{2}$.[44] This definition roughly follows Fernald [2014] (which is used in FHSW), but two items are worth highlighting: first, Fernald [2014] carefully controls for changes in utilization when computing TFP. This issue is moot in the simulated data because our model does not include variable utilization. Second, Fernald [2014] maintains the assumption of zero profits. He estimates the factor shares using BLS output data excluding taxes. This approach implies that any profit above and beyond the rental cost of capital is included in the capital share. To mirror this approach, we re-estimate α_t every period as $\frac{W_t N_t}{Y_t}$.[45]

[43] This is comparable in size to the estimate in Jones and Philippon [2016]. The model is calibrated and the shocks estimated using a Kalman-Filter, taking into account the Zero Lower Bound on nominal rates. See Jones and Philippon [2016] for the details of the model.

[44] We use the average capital share across adjacent periods rather than the the time t capital share to (roughly) account for the increase in the capital share with market power. This is the standard approach, but note that it can be substantially biased in periods of rising capital shares as simulated here (and observed in recent years). In fact, the change in measured TFP could be written as:

$$\begin{aligned} \Delta log(TFP_t) =& \Delta log(Y_t) - [\alpha_t log(K_t) - (\alpha_t - \Delta\alpha_t) log(K_{t-1})] - [(1-\alpha) log(N_t) - (1 - (\alpha_t - \Delta\alpha_t)) log(N_{t-1})] \\ =& \Delta log(Y_t) - \alpha_t \Delta log(K_t) - (1-\alpha_t)\Delta log(N_t) - \Delta\alpha_t \left[log\left(\frac{K_{t-1}}{N_t}\right)\right] \end{aligned} \tag{25}$$

where the last term captures changes in capital shares, and can be material for large cumulative changes in capital shares.

[45] Estimating labor shares based on the Cobb-Douglas production structure yields similar results. Namely, for a given elasticity of substitution ε_t, the implied mark-up is $\mu_t = \frac{\varepsilon_t}{1-\varepsilon_t}$ and the corresponding labor share is $s_t^N = \frac{1-\alpha}{\mu_t}$.

Armed with our time series of changes, we then follow FHSW to decompose the simulated series into a cyclical, trend and residual (i.e., irregular) components (c_t, μ_t and z_t, respectively):

$$y_t = c_t + \mu_t + z_t \tag{26}$$

The only difference between our decomposition and that of FHSW is that we use employment as our basis for Okun's law instead of unemployment [Okun, 1962]. The decomposition proceeds as follows. First, c_t is estimated using a Generalized Okun's law

$$c_t = \sum_{j=-p}^{q} \beta_j \Delta n_{t+j} = \boldsymbol{\beta(L)\Delta n_t} \tag{27}$$

where we use total labor n as our basis for calculations. β_j is estimated through a simple OLS regression with two forward and backward lags ($p = q = 2$). Substituting equation 27 into 26, we obtain the Okun's Law residual (which includes the long-run trend μ_t)

$$y_t - \boldsymbol{\beta(L)\Delta n_t} = \mu_t + z_t \tag{28}$$

The second term, $\boldsymbol{\beta(L)\Delta n_t}$, captures the change in a given time series y_t that can be explained by changes in employment. Next, we estimate μ_t as a long-run smoothed value of y after removing the cyclical part. Namely

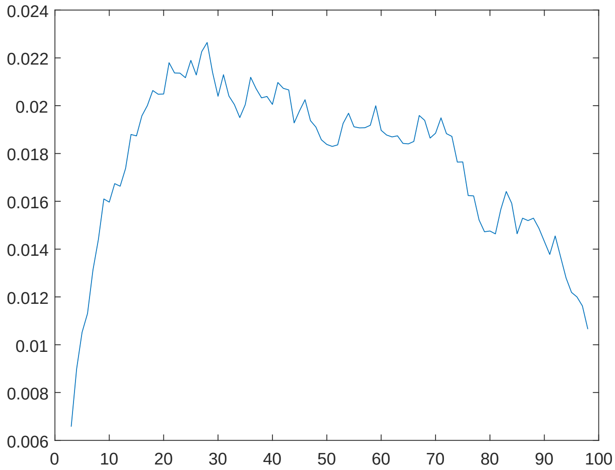
$$\hat{\mu}_t = \kappa(L)\left(y_t - \boldsymbol{\hat{\beta}(L)\Delta n_t}\right) \tag{29}$$

where $\kappa(L)$ is a biweight filter with truncation parameter of 60. Note that this trend-cycle-irregular decomposition preserves additivity.

The basic results are shown in Table 15, along with the results of FHSW for comparison. Columns 1 and 2 show the median and standard deviation across 100 simulations of the Generalized Okun's law coefficient $\beta(1)$. Row 1 shows that an increase in employment of 1 percent leads to an increase in output of 0.68 percent – as expected given the use of $\alpha = 0.33$. The increase is explained by a mixture of TFP and labor N_t (rows a and c). Similarly, row 2 shows that output-per-unit of labor decreases by 0.32 percent when employment increases by 1 percent. This is driven by a drop in K/Y partly compensated by a rise in TFP (rows d and e). The behavior of K/Y is relevant. FHSW note that, in theory, slower TFP growth should raise the steady-state capital/output ratio – but this is not what the data show. The capital/output ratio has been fairly smooth since the 1970s. In the benchmark model, the channel from TFP growth to K/Y is via the interest rate and the cost of capital. Lower trend-growth leads to a lower interest rate, which lowers the cost of capital and increases K/Y. We have indeed observed a decrease in the real interest rate and in the cost of funds, but it did not seem to translate into a clear increase in K/Y. The lack of growth in the capital/output ratio may therefore be driven by other factors, such as an increase in market power or the rise of superstar firms.

The 'measured' capital share of output including profits is then $\hat{\alpha}_t = 1 - \frac{1-\alpha}{\mu_t}$

Figure 20: Standard deviation of Trend-Residual Gap in K/Y, by simulation period



In order to compare coefficients to those of FHSW, first recall that we use employment and they use unemployment as the basis for Okun's law, so we flip the signs of their estimates to make the comparison easier. The volatility of log changes in employment and unemployment are not the same, which might explain the differences in magnitudes as well. Also note that FHSW consider output per capita under the first decomposition, vs. total output (with fixed population) in our case. Nonetheless, we find common patterns in terms of the relative contribution and volatility of the coefficients. Our trend component is much less volatile than that of FHSW, as expected since we simulated de-trended series except for the rise in market power. Of the remaining series, some of our components appear less volatile (e.g., irregular components) but they are almost always in the same order of magnitude.

Columns (6) and (7) show our primary measure of interest: the median and standard deviation of cumulative gaps between cycle-adjusted and long-run trends for each measure. As shown, cycle adjusted quantities are largely captured by the trend decomposition: median gaps are essentially zero, and the corresponding standard deviations are also quite small. Thus, it appears that the cycle-trend-irregular decomposition of Fernald et al. [2017] absorbs the rise in market power. The decomposition does not seem able to separately identify deviations from trend in K/Y driven by (long term) changes in market power.

It is also worth noting that the residual and trend series approach each other towards the end of the sample by construction. Figure 20 shows the standard deviation of the gap between the trend and residual K/Y series by simulation period. As shown, the standard deviation decreases rapidly as you approach the end of the series. This effect appears for virtually all simulated quantities – likely due to the additional weight placed on observations when using a truncated bi-weight filter.

To further study the dynamics, Figure 21 and 22 show the cumulative changes in output, 'measured' TFP, capital, labor, output-labor ratio and capital-output ratio; for a simulation with no shocks (except the rise in market power) and with shocks, respectively. For each series, we include

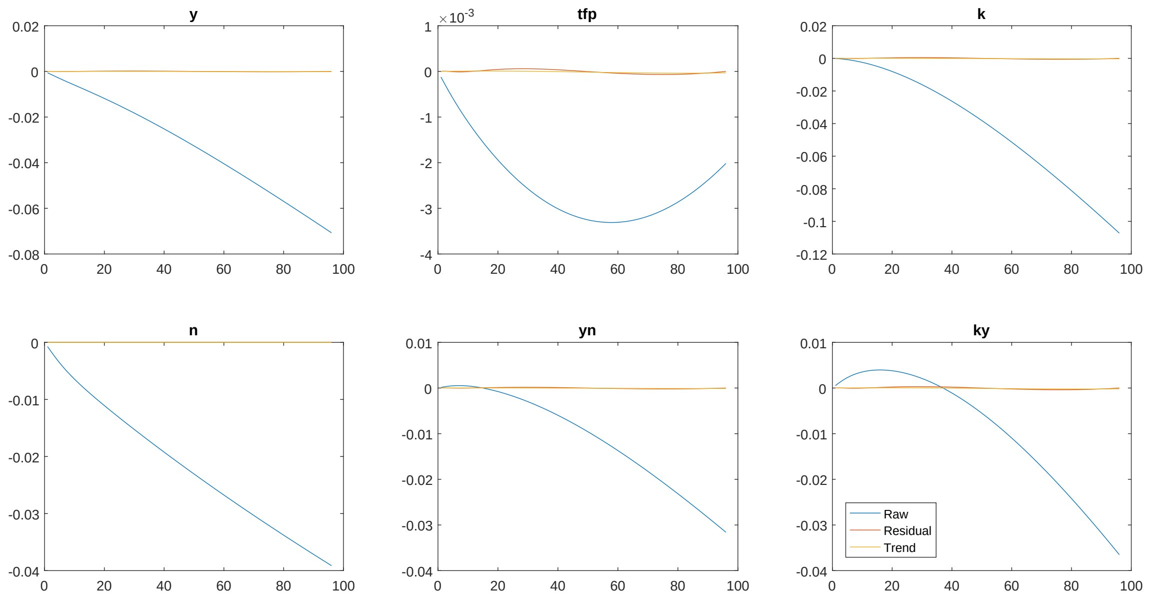
Table 15: Macro-estimates

Table shows the median and standard deviation of the results across all simulated series with stochastic shocks, against the coefficients in FHSW. Recall that FHSW use unemployment as the basis of Okun's law and we use employment, hence coefficients are flipped. We report coefficient $\beta(1)$ ($\beta(1)/4$ in FHSW), which measure per-period increases in output relative to a percentage point change in the employment (unemployment) rate. The standard deviations of the components are for quarterly growth rates reported in percentage points at an annual rate. R^2 reported only for GP's regression of each variable on employment (FHSW report R^2 for regression on factors, which follows a different method). Note that sub-components may not add up perfectly as we report the medians across simulations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Generalized Okun's law coeff.				Std. deviation of components						Median R^2 from Okun's law regression	Gap to trend at $t = 100$	
	GP		FHSW‡		GP: Sim. Median			FHSW: Actual					
	Median	St. Dev.	Coeff	St. Dev.	cycle (c)	trend (μ)	irregular (z)	cycle (c)	trend (μ)	irregular (z)		Median	St. Dev.
1. Y^{a+b+c}	**0.68**	**0.08**	**2.02**	**0.20**	**1.19**	**0.08**	**1.22**	**2.51**	**0.54**	**2.12**	**0.48**	**0.00**	**0.01**
a. TFP	0.09	0.08	0.5	0.19	0.32	0.08	1.20	1.24	0.24	2.27	0.06	0.00	0.01
b. αK_t	0.01	0.01	0.09	0.06	0.03	0.06	0.13	0.2	0.19	0.32	0.04	0.00	0.01
c. $(1-\alpha)N_t$	0.58	0.01	1.43	0.14	0.97	0.00	0.04	1.54	0.26	1.24	1.00	0.00	0.00
2. Y_t/N_t^{d+e+f}	**-0.32**	**0.08**	**-0.28**	**0.22**	**0.61**	**0.08**	**1.22**	**0.77**	**0.37**	**2.23**	**0.20**	**0.00**	**0.01**
d. $TFP/(1-\alpha)$	0.16	0.14	0.75	0.29	0.54	0.13	2.09	1.88	0.35	3.41	0.06	0.00	0.02
e. $K/Y \times \alpha/(1-\alpha)$	-0.48	0.06	-0.90	0.09	0.84	0.09	0.90	1.3	0.07	1.09	0.46	0.00	0.01
f. Labor Quality	NA	NA	-0.13	0.05	NA	NA	NA	0.37	0.05	0.99	NA	NA	NA

‡ FHSW coefficient signs flipped given their use of unemployment for Okun's law (vs. employment used here). Also note that decomposition 1 is based on output per capital in FHSW, vs. total output (with a fixed population) in our case.

Figure 21: Sample simulations: Cumulative changes with only market power



Note: Blue series shows the cumulative raw changes; red series shows the employment-adjusted series; and yellow series shows the long-run trend. We assume a change in the steady-state markup from 20% to 35% over 100 quarters.

the raw, cyclically adjusted and trend series. Several items are worth highlighting.

First, as shown in Figure 21 (i.e., the simulation without shocks), the rise of market-power pushes output, capital and labor productivity down. Measured TFP goes down a little, but the magnitude of the decline is very small.

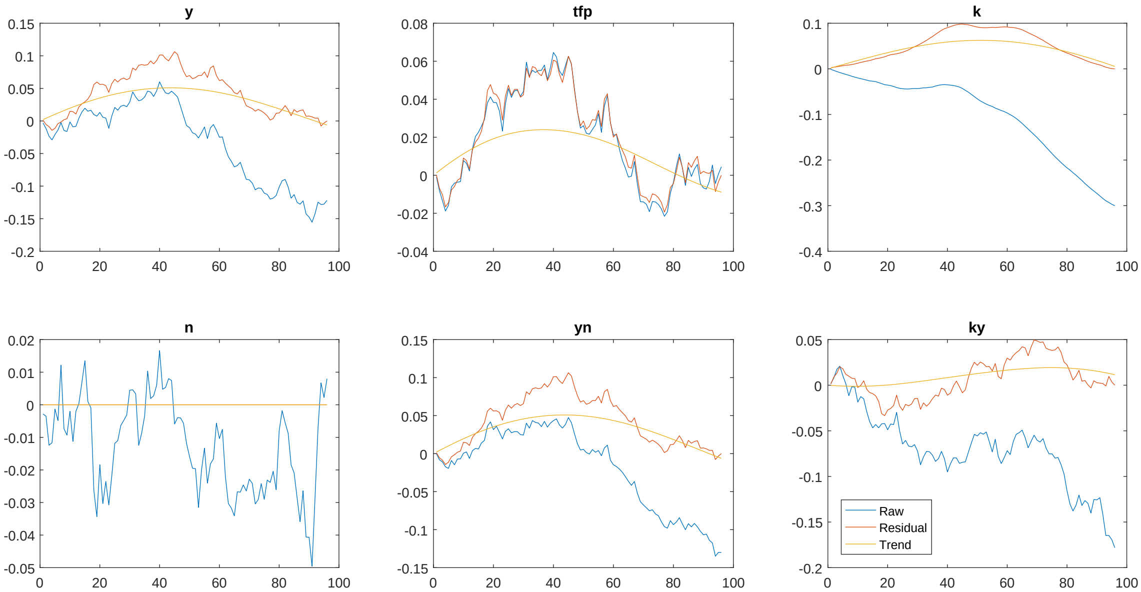
Looking at the cycle- and trend-adjusted series we see that the entire decrease is captured by Okun's law decomposition: both the residual and trend are essentially zero. This is because employment moves with market power, along with all the other series. So employment can 'explain' all of the trends even though the only parameter affecting the simulated economy is the level of the markup.

Moving to Figure 22, which adds stochastic shocks, we find substantial additional variation in the trends. Importantly, the decrease in employment driven by the rise of market power accounts for a large part of the decreases in all series: the cycle- and trend-adjusted series are much closer to zero than the actuals. This is particularly true for the K/Y series, which remains largely around zero over the full period (this is fairly consistent across all simulations). The actual series, however, drops well-below trend as observed in the data (this is true in some, not all simulations obviously).

Focusing on the period with the largest output drop (around the 40-60th simulation period), the reduction in output leads to an increase in capital-output ratio relative to trend, and a decrease in 'measured' TFP relative to trend. This is in-line with the results in Fernald et al. [2017] who allocate the output shortfall to lower TFP while noting that K/Y remains in line with trend.

Importantly, these patterns are consistent across simulations: define the crisis trough as the last period in a given simulation that exhibits a cumulative drop of output greater than 8% over ten or

Figure 22: Sample simulation: Cumulative changes with shocks



Note: Blue series shows the cumulative raw changes. Red series shows the employment-adjusted series. Yellow series shows the long-run trend.

fewer periods; and the post-crisis period as the (at most) 28 quarters following the trough. Then compute the average quarterly gap between the (cumulative) cycle-adjusted and trend series for TFP and K/Y over the post-crisis period in each simulation. This gives an estimate of the gap to trend following a crisis under rising mark-ups. The median average gap to trend in TFP is -0.35%, while the median gap for K/Y is +0.13% (i.e., TFP is below trend while K/Y is above trend). 29% of the average simulation gaps are positive for TFP compared to 71% for K/Y. these results suggest that (even) in the presence of rising mark-ups, the output gap following a crisis can appear to be in TFP rather than K/Y – consistent with the findings of Fernald et al. [2017].

Overall, we conclude that growth-accounting decompositions may confound a rise in market power with a decrease in TFP, and conclude that any output gaps are due to lower TFP rather than market power.

7 Conclusion

Private fixed investment in the United States has been lower than expected since the early 2000's. The trend started before 2008, but the Great Recession made it more striking. Investment is low despite high levels of profitability and Tobin's Q. This simple observation rules out a whole class of theories that would explain low investment *along with* low values of Tobin's Q, and guides us to theories that predict low investment *despite* high Q. We test 8 such theories, and find consistent support for decreased competition, tightened governance/increased short-termism and intangibles in our industry and firm level datasets. The rise of intangibles explains a quarter to a third of the investment gap, yet it leaves large and persistent residuals after 2000. These residuals are explained by decreased competition and tightened governance/increased short-termism. These conclusions are based on simple regressions and therefore cannot establish causality between competition, governance and investment. We address this in follow-up work by relying on a combination of instrumental variables and natural experiments [Gutiérrez and Philippon, 2017a,b]. Last, we show that standard growth-accounting decompositions may be unable to separately identify deviations from trend in K/Y driven by (long term) changes in market power. As a result, such decompositions may confound a rise in market power with a decrease in TFP, and conclude that any declines in output are due to lower TFP rather than higher market power.

If our conclusions are correct, they suggest that U.S. policy makers should focus on increasing competition in the market for goods and services. Related research [Grullon et al., 2016, Dottling et al., 2017] suggests a role for reducing barriers to entry and product market regulations, as well as improving anti-trust enforcement.

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Appendix I: Industry Investment Data

As noted above, investment is available for 63 granular industry groupings from the BEA. These are grouped into 47 categories (3 of which are omitted) to ensure all groupings have material investment and better Compustat coverage. Industries are grouped to ensure measures of investment and concentration are stable over time. In particular, we group industries to ensure each group has at least ∼10 firms, on average, from 1990 - 2015 and it contributes a material share of investment. The groupings are summarized in Table 16, including the BEA industry code, the granular industry name and the mapped industry group. We also include the dollar value and % of total capital as of 2014. Table 17 shows the total investment from 2000 to 2015 by grouping, along with the Compustat coverage ratios defined as described in the text.

Table 16: Mapping of BEA industries to segments

BEA code	**Industry**	**Mapped segment**	**Capital (2014)**	**% of total**
721	Accommodation	Acc_accommodation	358.9	2.2%
722	Food services and drinking places	Acc_food	249.2	1.5%
561	Administrative and support services	Adm_and_waste_mgmt	189.2	1.2%
562	Waste management and remediation services	Adm_and_waste_mgmt	102.3	0.6%
110	Farms	Agriculture	567.7	3.5%
113	Forestry, fishing, and related activities	Agriculture	62.3	0.4%
713	Amusements, gambling, and recreation industries	Arts	163.7	1.0%
711	Performing arts, spectator sports...	Arts	159.9	1.0%
230	Construction	Construction	284.6	1.7%
334	Computer and electronic products	Dur_Computer	506.3	3.1%
335	Electrical equipment, appliances...	Dur_Electrical	73.5	0.5%
333	Machinery	Dur_Machinery	234.4	1.4%
337	Furniture and related products	Dur_Furniture	22.8	0.1%
338	Miscellaneous manufacturing	Dur_Misc	115.1	0.7%
336	Motor vehicles, bodies and trailers, and parts	Dur_Transportation	383.7	2.4%
321	Wood products	Dur_Wood	42.6	0.3%
327	Nonmetallic mineral products	Dur_nonmetal	87.1	0.5%
331	Primary metals	Dur_prim_metal	165.5	1.0%
332	Fabricated metal products	Dur_fab_metal	175.3	1.1%
610	Educational services	Educational	557.7	3.4%
521	Federal Reserve banks	Finance	Omitted	
522	Credit intermediation and related activities	Finance	Omitted	
523	Securities, commodity contracts, and investments	Finance	Omitted	
524	Insurance carriers and related activities	Finance	Omitted	
525	Funds, trusts, and other financial vehicles	Finance	Omitted	
622	Hospitals	Health_hospitals	916.1	5.6%
623	Nursing and residential care facilities	Health_hospitals	94.6	0.6%

Table 16: Investment and coverage, by industry (cont'd)

BEA code	Industry	Mapped segment	Capital (2014)	% of total
621	Ambulatory health care services	Health_other	352	2.2%
624	Social assistance	Health_other	65.4	0.4%
514	Information and data processing services	Inf_data	168.3	1.0%
512	Motion picture and sound recording industries	Inf_motion	287.8	1.8%
511	Publishing industries (includes software)	Inf_publish	196.5	1.2%
513	Broadcasting and telecommunications	Inf_telecom	1352.5	8.3%
550	Management of companies and enterprises	Mgmt	401.4	2.5%
212	Mining, except oil and gas	Min_exOil	186.5	1.1%
211	Oil and gas extraction	Min_Oil_and_gas	1475.2	9.1%
213	Support activities for mining	Min_support	142	0.9%
325	Chemical products	Nondur_chemical	900.1	5.5%
311	Food and beverage and tobacco products	Nondur_food	336.4	2.1%
313	Textile mills and textile product mills	Nondur_textile	40.4	0.2%
315	Apparel and leather and allied products	Nondur_apparel	17.5	0.1%
322	Paper products	Nondur_paper	120.7	0.7%
323	Printing and related support activities	Nondur_printing	49.4	0.3%
326	Plastics and rubber products	Nondur_plastic	104.2	0.6%
324	Petroleum and coal products	Nondur_petroleum	221	1.4%
810	Other services, except government	Other_ex_gov	619.5	3.8%
541	Legal services	Prof_serv	42.6	0.3%
541	Computer systems design and related services	Prof_serv	74.3	0.5%
541	Miscellaneous professional, scientific, and technical services	Prof_serv	477.6	2.9%
531	Real estate	Real Estate	Omitted	
532	Rental and leasing services and lessors of intangible assets	Real Estate	Omitted	
44R	Retail trade	Retail_trade	1236.4	7.6%
481	Air transportation	Transp_air	249.1	1.5%
484	Truck transportation	Transp_ground	143.6	0.9%
485	Transit and ground passenger transportation	Transp_other	44.8	0.3%
487	Other transportation and support activities	Transp_other	132.6	0.8%
493	Warehousing and storage	Transp_other	46	0.3%
486	Pipeline transportation	Transp_pipeline	227.3	1.4%
482	Railroad transportation	Transp_rail	405.7	2.5%
483	Water transportation	Transp_other	45.6	0.3%
220	Utilities	Utilities	Omitted	
420	Wholesale trade	Wholesale_trade	590.1	3.6%

Table 17: Investment and coverage, by industry

Rank	Industry	Total Capital ('2014; BN)	Total investment ('00- '15; BN 09USD)	% of total invest-ment	PPE Coverage ('00-'15)	CAPX Coverage ('00-'15)
1	Inf_telecom	$1,353	$431.8	11%	32%	56%
2	Health_hospitals	$1,011	$427.6	11%	4%	5%
3	Nondur_chemical	$900	$357.7	9%	34%	40%
4	Retail_trade	$1,236	$255.5	7%	15%	34%
5	Prof_serv	$595	$251.7	7%	7%	9%
6	Educational	$558	$191.9	5%	1%	2%
7	Min_Oil_and_gas	$1,475	$186.0	5%	36%	93%
8	Wholesale_trade	$590	$162.4	4%	7%	9%
9	Inf_data	$168	$155.5	4%	23%	23%
10	Agriculture	$630	$142.4	4%	2%	2%
11	Health_other	$417	$120.8	3%	2%	3%
12	Other_ex_gov	$620	$111.3	3%	1%	1%
13	Arts	$324	$100.9	3%	6%	7%
14	Adm_and_waste_mgmt	$292	$98.3	3%	3%	5%
15	Inf_motion	$288	$98.3	3%	6%	7%
16	Transp_pipeline	$227	$96.9	3%	15%	20%
17	Acc_accomodation	$359	$84.2	2%	20%	31%
18	Nondur_Petro	$221	$79.8	2%	100%	100%
19	Dur_Computer	$506	$76.6	2%	30%	40%
20	Construction	$285	$66.4	2%	2%	4%
21	Transp_truck	$144	$63.3	2%	9%	11%
22	Nondur_Food	$336	$62.3	2%	39%	63%
23	Inf_publish	$197	$54.2	1%	12%	18%
24	Dur_Transp	$384	$49.9	1%	51%	57%
25	Min_support	$142	$47.7	1%	37%	65%
26	Min_exOil	$187	$47.3	1%	51%	63%
27	Transp_air	$249	$29.0	1%	28%	48%
28	Acc_food	$249	$28.4	1%	23%	42%
29	Dur_Misc	$115	$22.9	1%	14%	23%
30	Dur_Machinery	$234	$21.7	1%	25%	49%
31	Transp_rail	$406	$19.7	1%	29%	67%
32	Dur_fab_metal	$175	$12.6	0%	12%	19%
33	Nondur_plastic	$104	$6.7	0%	14%	17%
34	Dur_nonmetal	$87	$5.8	0%	14%	20%
35	Dur_Furniture	$23	($0.4)	0%	17%	27%
36	Dur_Wood	$43	($1.7)	0%	39%	29%
37	Nondur_Apparel	$18	($6.4)	0%	52%	100%
38	Transp_other	$269	($6.9)	0%	20%	44%
39	Nondur_Printing	$49	($9.9)	0%	8%	13%
40	Dur_Electrical	$74	($12.9)	0%	23%	43%
41	Dur_prim_metal	$166	($17.0)	0%	18%	39%
42	Nondur_Textile	$40	($23.2)	-1%	8%	21%
43	Nondur_Paper	$121	($26.0)	-1%	53%	63%

Note: Only US-incorporated firms included in Compustat sample.

Appendix II: Detailed Regression Results

This appendix contains detailed regression results. In particular, it includes the following Tables:

1. Detailed regression results
    (a) Table 18: Aggregate Moving Average Regressions
    (b) Table 19: Industry regressions: all explanations except competition
    (c) Table 20: Industry regressions: competition
    (d) Table 21: Industry regressions: ownership
    (e) Table 22: Firm regressions: all explanations except governance and short-termism
    (f) Table 23: Firm regressions: governance and short-termism
2. Post-2000 regression results
    (a) Table 24: Post-2000 Industry regressions: all explanations except competition
    (b) Table 25: Post-2000 Industry regressions: competition
    (c) Table 26: Post-2000 Firm regressions: all explanations except governance and short-termism
    (d) Table 27: Post-2000 Firm regressions: governance and short-termism

Table 18: Aggregate Moving Average Regressions

Table shows the results of aggregate moving average regressions of Net I/K on Q, measures of competition and quasi-indexer institutional ownership over the periods specified. As shown, the coefficients remain stable and often significant even when accounting for serial correlation in the time series. Annual data. T-stats in brackets. + $p<0.10$, * $p<0.05$, ** $p<.01$.

	(1)	(2)	(3)	(4)	(5)	(6)
	Net I/K					
	≥1980	≥1980	≥1980	≥1990	≥1990	≥1990
Agg. Compustat Q (t-1)	0.010*	0.005	0.011*	0.021**	0.016**	0.018**
	[2.17]	[1.41]	[2.24]	[3.34]	[3.15]	[2.98]
Median Sales Herfindahl(t-1)†		-0.378**	-0.284		-0.317**	-0.229+
		[-3.04]	[-1.62]		[-3.80]	[-1.65]
Mean % QIX own (t-1)			-0.035			-0.023
			[-1.18]			[-0.83]
MA (t-1)	1.068	1.019**	0.887**	0.800**	0.762**	0.696*
	[0.01]	[4.39]	[3.28]	[4.52]	[2.93]	[2.39]
MA (t-2)	1	0.343	0.192	0.740**	0.251	0.284
	[0.00]	[1.27]	[0.64]	[4.58]	[0.85]	[0.85]
Observations	36	36	34	26	26	26
Log-likelihood	142.18	149.29	144.607	108.662	112.813	113.642

Notes: Investment from the Financial Accounts; Q, Herfindahl and Ownership across all US incorporated firms in Compustat.
† Alternate measures of competition including changes in number of firms, concentration, firm entry and firm exit are also often significant.

Table 19: Industry regressions: all explanations except competition

Table shows the results of industry errors-in-variables panel regressions of Net I/K over the periods specified. Variables are de-meaned at industry level over the regression period (i.e., we apply a 'within' transformation) where noted. All regressions include our 'core' explanations: Q, modified Herfindahl and quasi-indexer ownership, as well as Age controls (mean log-age), and time fixed effects. We add additional explanatory variables one by one in columns 3-7 and simultaneously (when significant and properly signed) in column 8. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Net I/K							
	≥1980	≥1990	≥2000	≥2000	≥2000	≥1990	≥1990	≥1990
Median Log-Q (t-1)	0.170**	0.163**	0.250**	0.246**	0.245**	0.146**	0.144**	0.140**
	[14.633]	[16.812]	[11.643]	[12.814]	[14.513]	[15.755]	[16.411]	[15.154]
Mean % QIX own (t-1)†	-0.091*	-0.118**	-0.044	0.073	-0.078	-0.110**	-0.127**	-0.120**
	[-2.276]	[-3.068]	[-0.589]	[1.101]	[-1.017]	[-3.003]	[-3.786]	[-3.548]
Mod-Herfindahl (t-1)†	-0.056*	-0.056*	-0.124**	-0.109**	-0.127**	-0.046*	-0.045*	-0.040*
	[-2.556]	[-2.394]	[-2.727]	[-2.950]	[-2.946]	[-2.248]	[-2.087]	[-2.042]
Mean ext fin dep ('96-'00)			-0.007					
			[-0.672]					
Mean % bank dep ('96-'00)				0.104**				
				[3.828]				
% rated AA to AAA ('96-'00)					-0.328			
					[-1.225]			
IP share of investment(t-1)						**-0.063***		-0.058*
						[-2.223]		[-2.107]
Mean % foreign prof (t-1)‡							**-0.065****	-0.057**
							[-3.278]	[-2.931]
Observations	1,445	1,110	687	687	687	1,110	1,110	1,110
Age controls	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry de-meaned	YES	YES	NO	NO	NO	YES	YES	YES
ρ^2	0.38	0.39	0.699	0.683	0.673	0.395	0.38	0.394

† Quasi-indexer ownership and Modified Herfindahl measured as the change from average 1996-1999 level in columns 3, 4 and 5
‡ Foreign profits set to zero if missing

Table 20: Industry regressions: competition

Table shows the results of industry errors-in-variables panel regressions of Net I/K over the periods specified. All variables are de-meaned at industry level over the regression period (i.e., we apply a 'within' transformation). All regressions include Q, quasi-indexer ownership, Age controls, and alternate measures of competition; as well as time effects and a control for age. Herfindahls, Lerner index and (Compustat and Census) concentration appear significant. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					Net I/K				
	≥1990	≥1990	≥1990	≥1990	≥1990	≥1990	'97-'12	≥1990	≥2000
Median Log-Q (t-1)	0.210**	0.163**	0.275**	0.253**	0.146**	0.169**	0.099+	0.137**	0.163**
	[11.231]	[16.812]	[6.610]	[4.508]	[16.178]	[16.063]	[1.806]	[3.053]	[24.778]
Mean % QIX own (t-1)	-0.119*	-0.118**	-0.125*	-0.114*	-0.131**	-0.122**	-0.094**	-0.103*	-0.093**
	[-2.381]	[-3.068]	[-2.454]	[-1.961]	[-3.416]	[-2.986]	[-2.582]	[-2.308]	[-2.636]
3YΔLog#of Firms (t-1)	0.005								
	[0.376]								
Mod-Herfindahl (CP) (t-1)		**-0.056***							
		[-2.394]							
Sales Herfindahl (CP) (t-1)			**-0.093****						
			[-2.614]						
CO Herf adjustment (t-1)			**-0.104***						
			[-2.373]						
Lerner Index (t-1)				**-0.053+**					
				[-1.779]					
% sales Top 8 (CP) (t-1)					**-0.064***				
					[-2.160]				
% MV Top 8 (CP) (t-1)						-0.023			
						[-1.147]			
% sales in Top 50 (Census) (t-1)‡							**-0.054+**		
							[-1.788]		
Log of Reg index (t-1)								-0.001	
								[-0.089]	
% Licensed ('08)									0.003
									[0.579]
Observations	1,110	1,110	1,110	1,110	1,110	1,110	571	771	687
Age controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry de-meaned	YES	YES	YES	YES	YES	YES	YES	YES	YES
ρ^2	0.443	0.39	0.499	0.486	0.385	0.4	0.447	0.365	0.423

‡ When a given BEA category includes more than one NAICS Level 3 code, we use the sales-weighted average of Census-based concentrations across all relevant NAICS Level 3 categories. Only consistent NAICS L3 categories included. We interpolate concentration between census years (e.g., from 1997 to 2002).

Table 21: Industry regressions: ownership

Table shows the results of industry errors-in-variables panel regressions of Net I/K over the periods specified. All variables are de-meaned at industry level over the regression period (i.e., we apply a 'within' transformation). All regressions include Q, modified Herfindahl, Age controls, and alternate measures of ownership; as well as time effects and a control for age. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)
	Net I/K			
	≥1990	≥1990	≥1990	≥1990
Median Log-Q (t-1)	0.163**	0.138**	0.151**	0.202**
	[16.812]	[14.467]	[14.299]	[16.313]
Mod-Herfindahl (CP) (t-1)	-0.056*	-0.053*	-0.054*	-0.070**
	[-2.394]	[-2.458]	[-2.464]	[-2.851]
Mean % QIX own (t-1)	**-0.118****			
	[-3.068]			
Mean % INS own (t-1)		**-0.115****		
		[-4.104]		
Mean % TRA own (t-1)			**-0.225***	
			[-2.470]	
Mean % DED own (t-1)				-0.006
				[-0.065]
Observations	1,110	1,110	1,110	1,110
Age controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry de-meaned	YES	YES	YES	YES
ρ^2	0.39	0.363	0.359	0.414

Table 22: Firm regressions: all explanations except governance and short-termism

Table shows the results of firm-level errors-in-variables panel regressions of Net CAPX/PPE over the periods specified. All variables are de-meaned at firm- or industry-level over the regression period, as noted. All regressions include our 'core' firm-level explanations: Q, measures of competition and quasi-indexer ownership, as well as time effects and firm log-age. We add additional explanatory variables individually in columns 1-7. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Net CAPX/PPE			
	≥1990	≥2000	≥2000	≥2000	≥1990	≥1990	≥1990
Q (t-1)	0.218**	0.188**	0.212**	0.193**	0.216**	0.219**	0.218**
	[39.291]	[12.062]	[32.393]	[25.068]	[34.527]	[39.341]	[33.609]
% QIX own MA2	**-0.120****	**-0.181****	**-0.114****	**-0.108****	**-0.126****	**-0.121****	**-0.138****
	[-6.765]	**[-6.975]**	**[-5.926]**	**[-6.038]**	**[-6.732]**	**[-6.776]**	**[-6.773]**
Mod-Herfindahl (t-1)	**-0.071****	**-0.101***	**-0.138****	**-0.142****	**-0.069***	**-0.072****	**-0.089****
	[-2.639]	**[-2.162]**	**[-3.208]**	**[-3.591]**	**[-2.446]**	**[-2.690]**	**[-2.942]**
Ext fin dep ('96-'00)		0.001					
		[0.249]					
Bank dep ('00)			-0.001				
			[-0.109]				
AA to AAA rating ('00)				-0.130**			
				[-5.179]			
(Intan ex GW)/at (t-1)					0.313**		
					[5.481]		
% foreign prof (t-1)						0.004	
						[1.037]	
Log of Reg index (t-1)							0.005
							[0.547]
Observations	77,772	15,615	36,377	32,801	64,425	77,731	60,804
Age controls	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Firm de-meaned	YES	NO	NO	NO	YES	YES	YES
Industry de-meaned	NO	YES	YES	YES	NO	NO	NO
ρ^2	0.263	0.3	0.397	0.321	0.249	0.264	0.248

Table 23: Firm regressions: governance and short-termism

Table shows the results of firm-level errors-in-variables panel regressions of Net CAPX/PPE over the periods specified. All variables are de-meaned at firm-level over the regression period (i.e., we apply a 'within' transformation). Regressions include alternate measures of ownership as well as firm-level Q, log-age and time effects. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)
	Net CAPX/PPE			
	≥1990	≥1990	≥1990	≥1990
Q (t-1)	0.218**	0.234**	0.222**	0.221**
	[39.291]	[46.101]	[38.123]	[38.846]
Mod-Herfindahl (t-1)	-0.071**	-0.024	-0.077**	-0.090**
	[-2.639]	[-0.851]	[-2.879]	[-3.301]
% QIX own MA2	**-0.120****			
	[-6.765]			
% Inst own MA2		**-0.137****		
		[-9.365]		
% TRA own MA2			**-0.258****	
			[-7.350]	
% DED own MA2				**0.056+**
				[1.762]
Observations	77,772	86,001	77,775	76,479
Age controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Firm de-meaned	YES	YES	YES	YES
ρ^2	0.263	0.304	0.261	0.264

Table 24: Post-2000 Industry regressions: all explanations except competition

Table shows the results of industry errors-in-variables panel regressions of Net I/K over the periods specified. Variables are de-meaned at industry level over the regression period (i.e., we apply a 'within' transformation) where noted. All regressions include our 'core' explanations: Q, modified Herfindahl and quasi-indexer ownership, as well as Age controls (mean log-age), and time effects. We add additional explanatory variables one by one in columns 2-6 and simultaneously (when significant and properly signed) in column 7. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Net I/K			
	≥2000	≥2000	≥2000	≥2000	≥2000	≥2000	≥2000
Median Log- Q (t-1)	0.163**	0.250**	0.246**	0.245**	0.165**	0.160**	0.162**
	[13.130]	[11.643]	[12.814]	[14.513]	[14.762]	[12.691]	[14.355]
Mean % QIX own (t-1)†	-0.105**	-0.044	0.073	-0.078	-0.096*	-0.109**	-0.100**
	[-2.657]	[-0.589]	[1.101]	[-1.017]	[-2.402]	[-2.865]	[-2.581]
Mod-Herfindahl (t-1)†	-0.067+	-0.124**	-0.109**	-0.127**	-0.068+	-0.062+	-0.063+
	[-1.844]	[-2.727]	[-2.950]	[-2.946]	[-1.907]	[-1.725]	[-1.796]
Mean ext fin dep ('96-'00)		-0.007					
		[-0.672]					
Mean % bank dep ('96-'00)			0.104**				
			[3.828]				
% rated AA to AAA ('96-'00)				-0.328			
				[-1.225]			
IP share of investment(t-1)					**-0.040***		-0.039*
					[-2.193]		[-2.131]
Mean % foreign prof (t-1)‡						-0.028	-0.026
						[-1.620]	[-1.465]
Observations	687	687	687	687	687	687	687
Mean Age controls	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Industry de-meaned	YES	NO	NO	NO	YES	YES	YES
ρ^2	0.431	0.699	0.683	0.673	0.446	0.428	0.443

† Quasi-indexer ownership and Modified Herfindahl measured as the change from average 1996-1999 level in columns 2, 3 and 4
‡ Foreign profits set to zero if missing

Table 25: Post-2000 Industry regressions: competition

Table shows the results of industry errors-in-variables panel regressions of Net I/K over the periods specified. All variables are de-meaned at industry level over the regression period (i.e., we apply a 'within' transformation). All regressions include Q, quasi-indexer ownership, age controls, time effects, and alternate measures of competition. Herfindahls, Lerner index and (Compustat and Census) concentration appear significant. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)
	Net I/K								
	≥2000	≥2000	≥2000	≥2000	≥2000	≥2000	≥2000	≥2000	≥2000
Median Log-Q (t-1)	0.148**	0.163**	0.169**	0.158**	0.160**	0.132**	0.099+	0.095**	0.134**
	[11.718]	[13.130]	[14.206]	[9.584]	[11.955]	[11.337]	[1.806]	[5.264]	[10.378]
Mean % QIX own (t-1)	-0.111**	-0.105**	-0.107**	-0.105*	-0.114**	-0.112**	-0.094**	-0.101*	-0.110**
	[-2.807]	[-2.657]	[-2.708]	[-2.473]	[-2.871]	[-3.002]	[-2.582]	[-2.134]	[-2.912]
3YΔLog#of Firms (t-1)	0.004								
	[0.287]								
Mod-Herfindahl (CP) (t-1)		**-0.067**+							
		[-1.844]							
Sales Herfindahl (CP) (t-1)			**-0.089**+						
			[-1.780]						
CO Herf adjustment (t-1)			**-0.057**+						
			[-1.677]						
Lerner Index (t-1)				**-0.054**+					
				[-1.668]					
% sales Top 8 (CP) (t-1)					**-0.092***				
					[-2.001]				
% MV Top 8 (CP) (t-1)						-0.018			
						[-0.859]			
% sales in Top 50 (Census) (t-1)‡							**-0.054**+		
							[-1.788]		
Log of Reg index (t-1)								-0.01	
								[-1.010]	
% Licensed ('08)									0
									[-0.935]
Observations	687	687	687	687	687	687	571	478	687
Age controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry de-meaned	YES	YES	YES	YES	YES	YES	YES	YES	YES
ρ^2	0.429	0.431	0.44	0.455	0.449	0.404	0.447	0.343	0.408

‡ When a given BEA category includes more than one NAICS Level 3 code, we use the sales-weighted average of Census-based concentrations across all relevant NAICS Level 3 categories. Only consistent NAICS L3 categories included. We interpolate concentration between census years (e.g., from 1997 to 2002).

Table 26: Post-2000 Firm regressions: all explanations except governance and short-termism

Table shows the results of firm-level errors-in-variables panel regressions of Net CAPX/PPE over the periods specified. All variables are de-meaned at firm- or industry-level over the regression period, as noted. All regressions include our 'core' firm-level explanations: Q, measures of competition and QIX ownership, as well as firm log-age and time effects. We add additional explanatory variables individually in columns 2-7. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Net CAPX/PPE						
	$\geq$2000	$\geq$2000	$\geq$2000	$\geq$2000	$\geq$2000	$\geq$2000	$\geq$2000
Q (t-1)	0.212**	0.188**	0.212**	0.193**	0.206**	0.212**	0.198**
	[29.422]	[12.062]	[32.393]	[25.068]	[26.802]	[29.421]	[25.968]
% QIX own MA2	-0.071**	-0.181**	-0.114**	-0.108**	-0.082**	-0.071**	-0.102**
	[-3.238]	[-6.975]	[-5.926]	[-6.038]	[-3.735]	[-3.234]	[-4.199]
Mod-Herfindahl (t-1)	-0.074*	-0.101*	-0.138**	-0.142**	-0.078*	-0.074*	-0.081*
	[-2.275]	[-2.162]	[-3.208]	[-3.591]	[-2.419]	[-2.273]	[-2.277]
Ext fin dep ('96-'00)		0.001					
		[0.249]					
Bank dep ('00)			-0.001				
			[-0.109]				
AA to AAA rating ('00)				-0.130**			
				[-5.179]			
(Intan ex GW)/at (t-1)					0.330**		
					[5.235]		
% foreign prof (t-1)						0.001	
						[0.138]	
Log of Reg index (t-1)							-0.013
							[-1.101]
Observations	45,264	15,615	36,377	32,801	41,163	45,253	34,538
Age controls	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Firm de-meaned	YES	NO	NO	NO	YES	YES	YES
Industry de-meaned	NO	YES	YES	YES	NO	NO	NO
ρ^2	0.276	0.3	0.397	0.321	0.244	0.276	0.245

Table 27: Post-2000 Firm regressions: governance and short-termism

Table shows the results of firm-level errors-in-variables panel regressions of Net CAPX/PPE over the periods specified. All variables are de-meaned at firm-level over the regression period (i.e., we apply a 'within' transformation). Regressions include alternate measures of governance and short-termism as well as firm-level Q, log-age and time effects. Annual data. T-stats in brackets. + p<0.10, * p<0.05, ** p<.01.

	(1)	(2)	(3)	(4)
	Net CAPX/PPE			
	≥2000	≥2000	≥2000	≥2000
Q (t-1)	0.212**	0.234**	0.218**	0.215**
	[29.422]	[35.168]	[28.756]	[28.949]
Mod-Herfindahl (t-1)	-0.074*	-0.088*	-0.079*	-0.076*
	[-2.275]	[-2.462]	[-2.372]	[-2.254]
% QIX own MA2	**-0.071****			
	[-3.238]			
% Inst own MA2		**-0.134****		
		[-6.958]		
% TRA own MA2			**-0.226****	
			[-5.411]	
% DED own MA2				**0.072**+
				[1.766]
Observations	45,264	48,849	45,267	43,971
Age controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Firm de-meaned	YES	YES	YES	YES
ρ^2	0.276	0.332	0.278	0.28

Appendix III: Model

We use the model of Jones and Philippon [2016] to simulate data from an economy with changes in market power. This is a standard DSGE model with capital accumulation, nominal rigidities, and time varying competition in the goods markets. For simplicity, we separate firms into capital producers – who lend their capital stock at price R_t^k – and good producers – who hire capital and labor to produce goods and services. The variables of interests are: Y_t, N_t, W_t, C_t, K_t, x_t, $\mathtt{MC}_t$, $\mathtt{MRS}_t$, R_t^k, Λ_t, D_t, V_t^n, Q_t, Q_t^k, Q_t^{obs}, R_t, π_t, π_t^w. The equations are as follows. Net investment:

$$x_t = \frac{I_t}{K_t} - \delta \tag{30}$$

Production function, with fixed costs:

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha} - \Phi Y \tag{31}$$

where Y is steady state output. Resource constraint:

$$Y_t = C_t + P_{k,t} I_t + \frac{\varphi_k}{2} P_{k,t} K_t x_t^2 \tag{32}$$

where φ_k is the capital adjustment cost. Evolution of capital:

$$K_{t+1} = (1-\delta) K_t + I_t \tag{33}$$

Capital-labor ratio:

$$\frac{N_t}{K_t} = \frac{1-\alpha}{\alpha} \frac{R_t^k}{W_t/P_t} \tag{34}$$

Marginal cost:

$$\mathtt{MC}_t = \frac{1}{A_t} \left(\frac{R_t^k}{\alpha} \right)^{\alpha} \left(\frac{W_t/P_t}{1-\alpha} \right)^{1-\alpha} \tag{35}$$

Marginal rate of substitution:

$$\mathtt{MRS}_t = N_t^{\varphi} C_t^{\gamma} \tag{36}$$

where γ is the CRRA and φ is the curvature of labor disutility. Pricing kernel:

$$\Lambda_{t+1} = \beta \left(\frac{C_t}{C_{t+1}} \right)^{\gamma} \tag{37}$$

Euler equation:

$$1 = \mathbb{E}_t \left[\Lambda_{t+1} \frac{P_t}{P_{t+1}} R_t \right] \tag{38}$$

Investment equation:

$$x_t = \frac{1}{\varphi_k} \left(Q_t^k - 1 \right) \tag{39}$$

Capital producing firms:

$$Q^k_t = \mathbb{E}_t \left[\frac{\beta^k}{\beta} \frac{\Lambda_{t+1}}{P^k_t} \left(R^k_{t+1} + P^k_{t+1} \left(Q^k_{t+1} - \delta + \frac{1}{2\varphi_k} \left(Q^k_{t+1} - 1 \right)^2 \right) \right) \right] \tag{40}$$

where β^k is the discount rate for (risky) corporate capital. Goods-producing (monopolists) firms:

$$V^n_t = D_t + \mathbb{E}_t \left[\frac{\beta^k}{\beta} \Lambda_{t+1} V^n_{t+1} \right] \tag{41}$$

with real dividends

$$D_t = (1 - \mathtt{MC}_t)\, A_t K^\alpha_t N^{1-\alpha}_t - \Phi Y \tag{42}$$

Goods-producing Q:

$$Q_t = \frac{\mathbb{E}_t \left[\frac{\beta^k}{\beta} \Lambda_{t+1} V^n_{t+1} \right]}{P^k_t K_{t+1}} \tag{43}$$

Total Q (mapped into observed Q in the data):

$$Q^{\text{obs}}_t = Q^k_t + Q_t \tag{44}$$

Policy rule, taking into account the ZLB:

$$R_t = \max \left[1, R^{\phi_r}_{t-1} \left(\frac{\pi^p_t}{\pi} \right)^{(1-\phi_r)\phi_\pi} \left(\frac{\pi^w_t}{\pi} \right)^{(1-\phi_r)\phi_w} \left(\frac{N_t}{N} \right)^{(1-\phi_r)\phi_y} \right] \tag{45}$$

Log-linear equations We take log-linear approximations of the above equations, together with standard New Keynesian equations with Calvo stickiness in prices and wages.

$$\pi^p_t = \beta \mathbb{E}_t \left[\pi^p_{t+1} \right] + \lambda_p \mathtt{mc}_t \tag{46}$$

$$\pi^w_t = \beta \mathbb{E}_t \left[\pi^w_{t+1} \right] + \lambda_w \left(\mathtt{mrs}_t - \omega_t \right) \tag{47}$$

$$\omega_t = \omega_{t-1} + \pi^w_t - \pi^p_t \tag{48}$$

with $\lambda_p \equiv \frac{(1-\vartheta_p)(1-\beta\vartheta_p)}{\vartheta_p}$ and $\lambda_w \equiv \frac{(1-\beta\vartheta_w)(1-\vartheta_w)}{\vartheta_w} \frac{1}{1+\varphi\epsilon_w}$ as in Gali [2008] and Woodford [2003].

Shocks Shocks in the log-linear equations.

1. Productivity:

$$a_t = \rho_a a_{t-1} + \epsilon_{a,t}$$

2. Demand/ZLB shock:

$$\mathbb{E}_t \left[\lambda_{t+1} + r_t - \pi^p_{t+1} \right] = -\zeta^d_t$$

$$\zeta^d_t = \rho_d \zeta^d_{t-1} + \epsilon^d_t$$

3. Shock to the valuation of corporate assets:

$$q_t^k = \mathbb{E}_t\left[\lambda_{t+1} + \zeta_t^q + \frac{R_k}{R_k + Q^k - \delta} r_{k,t} + \frac{Q^k}{R_k + Q^k - \delta} q_t^k\right]$$

$$v_t = (1-\beta)d_t + \lambda_{t+1} + \zeta_t^q + \beta v_{t+1}$$

$$q_t = \lambda_{t+1} + \zeta_t^q + v_{t+1} - k_{t_1}$$

$$\zeta_t^q = \rho_d \zeta_{t-1}^q + \epsilon_t^q$$

4. Shock to the policy rule:

$$r_t = \max\left[0, \phi_r r_{t-1} + (1-\phi_r)\left(\phi_\pi \pi_t + \phi_w w_t + \phi_y y_t\right) + \epsilon_{r,t}\right]$$

5. Transitory shock to markups:

$$\pi_t^p = \beta \mathbb{E}_t\left[\pi_{t+1}^p\right] + \lambda_p \mathtt{mc}_t + \zeta_t^e$$

$$\zeta_t^e = \rho_e \zeta_{t-1}^e + \epsilon_t^e$$

In addition, there is a permanent shock to competition in the form of a unanticipated and permanent change to the elasticity of substitution between intermediate goods.

Steady state $P_k = 1$, $x = 0$, $Q^k = 1$, $A = 1$, $\mathtt{mc} = \frac{\varepsilon_p - 1}{\varepsilon_p}$

$$R^k = \frac{1}{\beta^k} - 1 + \delta$$

$$(W/P)^{1-\alpha} = \mathtt{MC}(1-\alpha)^{1-\alpha}\left(\frac{R^k}{\alpha}\right)^{-\alpha}$$

$$N/K = \frac{1-\alpha}{\alpha}\frac{R^k}{W/P}$$

$$\frac{Y}{K} = \frac{1}{1+\Phi}\left(\frac{N}{K}\right)^{1-\alpha}$$

$$\frac{C}{K} = \frac{Y}{K} - \delta$$

Since wages are sticky, we have $\mathtt{mrs} = \frac{W}{P}\left(\frac{\varepsilon_w - 1}{\varepsilon_w}\right)$, then:

$$K^{\varphi+\gamma} = \mathtt{mrs}\left(\frac{C}{K}\right)^{-\gamma}\left(\frac{N}{K}\right)^{-\varphi}$$

With K, we get the other steady-state aggregates.

$$V^n = \frac{D}{1-\beta^k}$$

$$Q = \frac{\beta^k V^n}{K}$$

Calibrated parameters Calibrate the following parameters. The discount factor used in the valuation of corporate assets is $\beta^k < \beta$. Risk aversion and Frisch elasticity taken from Smets and Wouters [2007].

```
bet     = 0.97^0.25 ;
betq    = bet*0.96^0.25 ;
alph    = 1/3 ;    % technology capital share
varphi  = 1.92 ;   % disutility of labor
gamm    = 1.4 ;    % risk aversion
elasp   = 6 ; % Subsitution across goods (initial value)
elasw   = 6 ; % Subsitution labor types.
phifc   = 0.1 ; % Fixed cost as fraction of output
delt    = 0.025 ;
phik    = 40 ; % Capital adjustment costs
```

Estimation Shocks and monetary policy parameters are estimated over 1984Q1 to 2015Q3. We also estimate the ZLB duration, with the prior on each ZLB duration being derived from the NY Federal Reserve survey of primary dealers.