# Rents and Intangible Capital: A Q+ Framework<sup>\*</sup>

Nicolas Crouzet and Janice Eberly

This version: March 15, 2020

#### Abstract

In recent years, US investment has been lackluster, despite rising valuations. Key explanations include growing rents and growing intangibles. We propose and estimate a framework to quantify their roles. The gap between valuations — reflected in average Q — and investment — reflected in marginal q — can be decomposed into three terms: the value of installed intangibles; rents generated by physical capital; and an interaction term, measuring rents generated by intangibles. The intangible-related terms contribute significantly to the gap, particularly in fast-growing sectors. Our findings suggest care in a pure-rents interpretation, given the rising role of intangibles.

<sup>\*</sup>Crouzet: Northwestern University and Chicago Fed; Eberly: Northwestern University and NBER. We thank François Gourio and Thomas Philippon for comments on earlier work that led to this paper, and Tom Winberry for helpful discussions. We also thank Andrea Eisfeldt and Ernest Liu, our formal discussants, and seminar participants at the IMF, the Q group, the University of Michigan, the Women in Macro conference, the Yale Junior Finance conference, the Danish Central Bank, the Chicago Fed, Northwestern, the London Business School, the Shanghai University of Finance and Economics, the Jackson Hole Finance Conference, and the Booth Finance Workshop.

# 1 Introduction

Recent research highlights two apparently contradictory, medium-run facts about the US economy: returns to business capital, and corporate profits more generally, have been either stable or growing (Gomme et al., 2011); yet investment has been lackluster, in particular relative to corporate valuations (Gutiérrez and Philippon, 2017; Alexander and Eberly, 2018). These facts are particularly puzzling because over the same period of time, measures of the risk-free interest rate have been decreasing (Caballero et al., 2008). In the face of a decline in risk-free rates, standard models would predict an increase in investment and a decline in rates of return — both at odds with the data.

In neoclassical models, the divergence between returns and investment can be cast as a rising gap between the average value of business capital, or Tobin's average Q, and its marginal value, or Tobin's marginal q. We directly observe the rise of the former in the data, via market values, while the latter is a shadow value measured implicitly by lackluster investment. In turn, a gap between the average value of capital and its marginal value can arise and grow for a number of reasons. Two leading explanations have recently emerged: intangibles and rents.

Over the last several decades, intangible capital has been growing as a share of investment and as a share of assets (Corrado et al., 2005, 2009). A shift toward intangibles in production could make physical investment appear low relative to valuations, because typical measures of corporate valuations, such as Tobin's average Q, will increasingly underestimate the true stock of assets, and thus increasingly overstate the incentive to invest in physical capital (Gutiérrez and Philippon, 2017; Alexander and Eberly, 2018; Crouzet and Eberly, 2019).

Alternatively, the gap between average Q and marginal q may be explained by market power. Rising market power and its corresponding rents can account for a stable or rising rate of return on assets despite a falling user cost of capital. Rising rents also reduce the marginal return to additional capital, consistent with a weaker incentive to invest. Several recent papers indeed document a rise in the measured capital share over the last three decades, which, along with declining required returns to capital, is consistent with higher rents (Barkai, 2019; Gutiérrez and Philippon, 2018).

While, from a positive perspective, both intangibles and rents have the potential to explain the divergence between returns and investment, the normative implications of the two hypotheses differ sharply. Rising intangibles reflect supply-side changes in the organization of production (Haskel and Westlake, 2018), with no clear implications for welfare. By contrast, rising rents and declining competition generate deadweight losses, via, for instance, price markups (De Loecker and Eeckhout, 2017) or wage markdowns (Benmelech et al., 2018).

Hence, any normative implications depend crucially on which mechanism is most empirically relevant. However, most of the literature has considered these mechanisms in isolation, thus maximizing their respective explanatory power. The goal of this paper is to assess them jointly, and in doing so, to provide a quantitative estimate of the role of each in the divergence between returns and investment. To do this, we extend the Q-theory model (Hayashi, 1982; Abel and Eberly, 1994) to simultaneously allow for the presence of economic rents, and the accumulation of a stock of intangible assets. We call this model the "Q+" framework.

Using this framework, we make two main contributions. First, from a theoretical perspective, we show that the gap between average Q and marginal q for physical capital, which we call the "investment gap", can be decomposed into a term capturing rents to physical capital, a term capturing the value of installed intangible capital, and a term capturing rents to intangible capital. The last element of this decomposition, an interaction term that is new to our analysis, is particularly important: it clarifies the fact that rising rents and rising intangibles cannot be meaningfully analyzed in separation, as their interaction contributes to the gap between investment and returns. Moreover, this decomposition is very general, as our framework nests a number of existing investment models.

Second, from an empirical perspective, we show that this interaction term is an important contributor in the recent rise of the investment gap. Each term in our decomposition can be quantified using data on profits, investment, valuations, and estimates of the intangible capital stock. In aggregate data, the interaction term accounts for between one third and one half of the investment gap, depending on how broad the definition of intangibles is. In addition, our approach leads to lower estimates of the increase in total rents than existing work. In large part, this is because our estimates of user costs of intangibles are elevated, and have remained so, in contrast with the post-1980 decline in the user costs of physical capital. Finally, we move beyond the aggregate data, recognizing that economy-wide increases in rents and intangibles may be driven by composition effects across sectors. We indeed find that the aggregate investment gap is driven by fast-growing industries, such as Healthcare and Tech, but that these industries' investment gaps are mostly explained by intangibles, even when intangibles are narrowly measured. Taken together, these empirical results thus cast doubt on the extent to which the investment gap should be viewed as unequivocal evidence of rising market power, and form the basis for broad macroeconomic policy recommendations.

In Section 2, we analyze the "Q+" framework. The gap between average Q and marginal q, which we call the "investment gap", is our main focus. As mentioned above, this gap can be decomposed into three terms: a term capturing rents to physical capital, a term capturing the value of installed intangibles, and a term capturing rents to intangible capital. The first two terms would obtain, respectively, in a model without rents (but with intangibles), and in

a model without intangibles (but with rents). When both are present in the model, a third term appears, which captures the economic rents earned by intangible capital. These can be identified separately from rents earned by physical capital. The result is independent of the specifics of exogenous processes and of capital adjustment cost and revenue functions, so long as they satisfy simple homogeneity assumptions. We also provide versions of the framework in which each of these terms can be solved in closed form. These analytical expressions clarify the key forces driving the effects of rents, intangibles, and their interaction. In particular, rents on intangible capital are the present value of markups multiplied by an appropriately defined user cost, which takes into account adjustment costs. This user cost is large for intangible capital because intangibles depreciate quickly, foreshadowing some our findings on the quantitative importance of rents generated by intangibles.

In Section 3, we apply this decomposition to aggregate data, after showing how to estimate the components of the investment gap using moments of corporate profits, investment, valuations, and estimates of the intangible stock. We begin with data from US national accounts, which are broader in coverage, but provide a narrower definition of intangibles, as they focus on R&D capital. Two periods stand out with large investment gaps: the 1965-1975 decade, and the post-1990 period. Most interestingly, the composition of the gap is different between these two periods: whereas the 1965-1975 gap is mostly driven by rents generated by physical capital, approximately 40% of the post-1990's gap is due to the intangibles-related terms. The term capturing rents to intangibles becomes sizable, accounting for 25% of the gap, with the direct intangibles effect making up the other 15%. The post-1990's change is driven by three underlying trends. First, the share of intangibles in the production function approximately doubles. Second, user costs of intangibles are not only much higher, but more stable than those of physical capital. Third, overall rents increase, though they do so more moderately than suggested by other recent work, a result which we explore in detail in Section 3. These three effects combine to boost the contribution of rents generated by intangibles to the investment gap.

Section 4 provides a different perspective on these results, using data on publicly traded firms. These data allow us to both adopt a broader definition of intangible capital, and to disaggregate results by sector. When we expand intangibles to include the organization capital stock of firms, following Eisfeldt and Papanikolaou (2013), we find that by 2015, the two intangibles-related terms account for two thirds of the total investment gap. Including organization capital has relatively little impact on estimated user costs of intangibles they remain elevated —, but it substantially increases their stock, boosting both their direct effect on the investment gap, and the interaction term. Our estimates of rents as a share of value added are also roughly cut in half. Thus, empirically plausible amounts of intangible capital can explain the investment gap without requiring high rents.

Finally, in Section 4, we also estimate our decomposition at a more disaggregated level, in order to assess the extent to which the aggregate investment gap reflects composition effects. We divide our sample into four broad sectors: Consumer, High-tech, Healthcare, and Manufacturing. In the Manufacturing sector, the investment gap is small, and both rents and intangibles are declining. By contrast, in the High-tech and Healthcare sectors, the investment gap has been growing rapidly since the 2000's. In both sectors, the primary driver is rents to intangible capital. Finally, in the Consumer sector, results depend on the measurement of the intangible capital stock. Reported R&D is small, so there is little role for intangibles when they are measured with this proxy. However, innovation in the consumer sector is not well-measured in R&D (see Foster et al. 2006 and Crouzet and Eberly 2018). When including organization capital, most of the gap is estimated to reflect the direct effect of large investment in intangibles in that sector — rents on either physical or intangible capital appear to have only modestly increased.

Our results caution against interpreting the gap as a broad rise in market power. Our evidence shows that intangibles play a key role, and no single mechanism provides a unified account of the gap, even across broadly defined sectors. Normative implications should hence be drawn with care.

Related research and contribution Our work first relates to the literature on the implications of rising intangible capital for macroeconomics and finance, which itself builds on work measuring intangibles and documenting their rise (Corrado et al., 2005, 2009; Eisfeldt and Papanikolaou, 2013). Closest to our approach are Hall (2001), who links the rise in intangibles to stock market valuations, and McGrattan and Prescott (2010), who examine the potential role of intangibles for macro trends in a business cycle model.<sup>1</sup> Relative to these papers, we study medium-run trends, emphasize sectoral heterogeneity, and, most importantly, allow for market power in our model.

Second, our work is related to a recent literature on the size and implications of rising rents. A number of researchers have interpreted the findings of Autor et al. (2017), who show that industry concentration rose in U.S. industries after 2000, as potential evidence of market power, and examined profitability and markup data for further evidence.<sup>2</sup> Most closely related to our work are Gutiérrez and Philippon (2018) and Barkai (2019), who document a significant increase in pure profit shares and markups, especially after 2000. Barkai (2019), in particular, does not directly examine investment, but shows that the decline in the labor

<sup>&</sup>lt;sup>1</sup>See also Hansen et al. (2005) and Ai et al. (2013).

 $<sup>^{2}</sup>$ De Loecker and Eeckhout (2017) and Hall (2018) use firm-level accounting data and industry data, respectively, and find both high and rising markups.

share is not offset by a rising capital share; he attributes the resulting gap to pure profits. Our approach, based on valuations, uncovers a more modest increase in rents than these papers, a point we expand on in Section 3. Similarly, Basu (2019) reviews the evidence from the rents literature, and argues that macro trends related to profitability are largely consistent with historical variation. He points instead to weak investment as the outlier and asks how to reconcile it with the apparently modest changes in rents. Our paper explains this apparent divergence as the combined effect of moderate rents with rising intangibles.

In recent and related research, Karabarbounis and Neiman (2019) find that the gap between measured capital income and estimates of the required compensation of capital is most likely explained by mismeasurement in the cost of capital. Consistent with this, our results indicate that the cost of capital has not fallen as much as relying on fixed risk premia from historical data would suggest. Most closely related to our work is Farhi and Gourio (2018), who estimate the contribution of market power, risk premia, and intangibles to recent macro trends.<sup>3</sup> Relative to their work, our analysis focuses more specifically on investment and on the role that intangible capital plays in explaining its low level relative to valuations.

Finally, a rich literature in corporate finance has discussed potential sources of wedges bewteen average Q and marginal q, and the performance of investment-Q regressions. We discuss how our framework relates to that literature in Section 2. Most recently, Peters and Taylor (2017) revisit the relationship between investment and Q when intangibles are present.<sup>4</sup> Belo et al. (2018) also provide decompositions of firm value across types of capital, including intangibles. We leverage the empirical results of both papers in our analysis, but also provide a more general framework than either, by allowing for rents, a key element in the relationship between investment and Q.

# 2 Rents, intangibles, and the investment gap: theory

In this section, we derive a general decomposition of the gap between average Q and marginal q, which we refer to as the "investment gap". For each type of capital employed by the firm, the gap depends not only on economic rents, but also on other forms of capital employed by the firm, and on the rents they generate. We also relate this decomposition to existing results in the literature, and provide analytical results that allow for clearer economic interpretations.

<sup>&</sup>lt;sup>3</sup>Corhay et al. (2018) highlight the more specific role of declining entry as a source of increasing market power.

<sup>&</sup>lt;sup>4</sup>Related, Andrei et al. (2019) study the correlation between Q and investment at higher frequencies, and find it has recently icreased; by contrast, we focus on the medium-run divergence in the level of valuations and investment.

### 2.1 Model

Time t is discrete. A firm uses n = 1, ..., N different capital inputs in production.<sup>5</sup> The firm's operating profits as a function of capital are  $\Pi_t(K_t)$ , where  $K_t$  is an aggregate of the different types of capital given by:

$$K_t = F_t \left( \mathbf{K}_t \right), \quad \mathbf{K}_t = \left\{ K_{n,t} \right\}_{n=1}^N.$$
(1)

Investment is subject to adjustment costs given by:

$$\hat{\Phi}_t \left( \mathbf{K}_t, \mathbf{K}_{t+1} \right). \tag{2}$$

We index the operating profit, production, and adjustment cost functions to indicate these functions can arbitrarily depend on exogenous variables, which we do not specify explicitly. The discount factor of the firm is  $M_{t,t+1}$ . Firm value satisfies:

$$V_t^c(\mathbf{K}_t) = \max_{\mathbf{K}_{t+1}} \Pi_t(K_t) - \tilde{\Phi}_t(\mathbf{K}_t, \mathbf{K}_{t+1}) + \mathbb{E}_t \left[ M_{t,t+1} V_{t+1}^c(\mathbf{K}_{t+1}) \right]$$
s.t.  $K_t = F_t(\mathbf{K}_t),$ 
(3)

where  $V_t^c(.)$  is the value of the firm including distributions. We make the following assumptions about the primitives of the problem.

Assumption 1. The function  $F_t(\mathbf{K}_t)$  is homogeneous of degree 1.

Assumption 2. The function  $\Pi_t(K_t)$  is increasing, concave, and homogeneous of degree  $\frac{1}{\mu} \leq 1$ .

Assumption 3. Adjustment costs satisfy  $\tilde{\Phi}_t(\mathbf{K}_t, \mathbf{K}_{t+1}) = \sum_{n=1}^N \Phi_{n,t}\left(\frac{K_{n,t+1}}{K_{n,t}}\right) K_{n,t}$ . where each function  $\Phi_{n,t}$  is strictly increasing and convex.

The parameter  $\mu$  plays a central role in our discussion: it captures the economic rents accruing to the firm, with  $\mu = 1$  corresponding to no rents. In Section 2.4, we list examples of models in the literature which are particular cases of the general model just described. We also highlight frictions from which this model abstracts.

<sup>&</sup>lt;sup>5</sup>The firm may also use any other fully flexible inputs, such as labor. Appendix A.1.5 provides an example with variable labor. The operating profit function used here assumes that these flexible inputs have been optimized out.

## 2.2 A decomposition of the investment gap

Our main result on the investment gap uses the following expression for firm value, which is proved in Appendix A.1.

Lemma 1. Let

$$V_t^e = \mathbb{E}_t \left[ M_{t,t+1} V_{t+1}^c \right], \quad q_{n,t} \equiv \frac{\partial V_t^e}{\partial K_{n,t+1}}, \quad \Pi_{n,t} \equiv \frac{\partial \Pi_t}{\partial K_t} \frac{\partial K_t}{\partial K_{n,t}}.$$
 (4)

Then, firm value can be written as:

$$V_t^e = \sum_{n=1}^N q_{n,t} K_{n,t+1} + (\mu - 1) \sum_{n=1}^N \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} \Pi_{n,t+k} K_{n,t+k} \right].$$
(5)

This Lemma decomposes firm value into two parts. The first part is the sum of the value of the installed stocks of capital. The value of each type of installed capital is equal to its replacement cost,  $K_{n,t+1}$ , multiplied its the marginal q,  $q_{n,t}$ . The marginal q of each capital type will be different from 1 so long as its adjustment costs are strictly convex. This part of firm value is non-zero even when  $\mu = 1$ , that is, when profits exhibit constant returns to scale with respect to capital. It generalizes the Hayashi (1982) result to multiple capital inputs; this generalization was first noted by Hayashi and Inoue (1991), in a framework where  $\mu = 1$ .

In order to interpret the second part of this firm value decomposition, note that when there is only one type of capital, the expression boils down to the discounted sum of the terms  $(\mu - 1)\Pi_{n,t+k}K_{n,t+k}$ . These terms capture the gap between average and marginal products. Note that:

$$(\mu - 1)\Pi_{K,t+k} = \frac{\Pi_{t+k}}{K_{t+k}} - \Pi_{K,t+k}.$$
(6)

In the one-capital case, the second term in decomposition (5) is simply the present value of the gap between average and marginal products, which we interpret as the present value of economic rents. This gap is positive only when  $\mu > 1$ , as first noted by Lindenberg and Ross (1981) in the case of a firm employing a single type capital.

When there are multiple types of capital, the second term in Equation (5) is the sum of terms of the form:

$$(\mu - 1)\Pi_{n,t+k} = \left(\frac{\Pi_{t+k}}{K_{n,t+k}} - \Pi_{K,t+k}\right) \frac{\partial F_{t+k}}{\partial K_{n,t+k}}.$$
(7)

These terms capture the marginal contribution of capital of type n to overall rents earned by the firm. Rents themselves depend on the gap between the average and marginal product of capital of type n, as in the one-capital case. The intuition from the one-capital case thus carries through with multiple types of capital. The added insight is that total rents are additively separable across capital types; more specifically, they are the sum of rents attributable to each capital type weighted by its marginal contribution to total capital,  $\frac{\partial F_{t+k}}{\partial K_{n,t+k}}$ .

**Result 1.** Define average Q for capital of type n,  $Q_{n,j,t}$ , as:

$$Q_{n,t} = \frac{V_t^e}{K_{n,t+1}}.$$
(8)

Then, the investment gap for capital of type n can be written as:

$$Q_{n,t} - q_{n,t} = (\mu - 1) \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} \Pi_{n,t+k} (1 + g_{m,t+1,t+k}) \right]$$
(9)

+ 
$$\sum_{\substack{m=1\\m\neq n}}^{N} S_{m,n,t+1} q_{m,t}$$
 (10)

+ 
$$(\mu - 1) \sum_{\substack{m=1 \ m \neq n}}^{N} S_{m,n,t+1} \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} \Pi_{m,t+k} (1 + g_{m,t+1,t+k}) \right],$$
 (11)

where  $1 + g_{n,t+1,t+k} \equiv \frac{K_{n,t+k}}{K_{n,t+1}}$ , and  $S_{m,n,t+1} \equiv \frac{K_{n,t+1}}{K_{m,t+1}}$ .

This result decomposes the investment gap into three terms, (9), (10) and (11). These three terms can be interpreted as follows.

When there are no rents and a single type of capital ( $\mu = 1$  and N = 1), average Q and marginal q are equal, as in the standard model of Hayashi (1982). In this this case, the terms (9), (10) and (11) are zero, and the investment gap is zero.

If there are rents but only one type of capital ( $\mu > 1$  and N = 1), average Q will overstate marginal q. The positive investment gap is then equal to the present value of the difference between average and marginal products of capital, that is, the term (9). This case includes the Lindenberg and Ross (1981) effect.

If there are no rents but several types of capital ( $\mu = 1$  and N > 1), then for each type of capital, average Q will *still* overstate marginal q. Average Q for a specific type of capital reflects, in part, the value of other types of capital used by the firm, because these other types of capital contribute to firm value overall. It therefore overstates the true incentive to invest — the marginal q — of that type of capital.<sup>6</sup> This omitted capital effect is captured by the term (10) in the expression of the investment gap.

<sup>&</sup>lt;sup>6</sup>This point in made in a model with two types of capital and no rents in Crouzet and Eberly (2019).

If there are both economic rents and several types of capital ( $\mu > 1$  and N > 1), the rents term (9) and the omitted capital term (10) are still non-zero. But additionally, the term (11) is non-zero. This term represents the interaction between the rents and the omitted capital effects: it captures how the present value of the rents accruing to other types of capital affects total firm, value and, through the omitted capital effect described above, add to the gap between average Q and marginal q. This interaction term is larger, the higher the relative importance of other types of capital, and the higher the rents generated by other types of capital.

## 2.3 Analytical example

We now provide an analytical example of the investment gap decomposition. The expressions we obtain help build intuition for each of its components, and also anticipate the empirical applications. Without loss of generality, we focus on the case of two types of capital;  $K_{1,t}$  is "physical capital," and  $K_{2,t}$  is "intangible capital." Additionally, we assume the profit function is given by  $\Pi_t = A_t^{1-\frac{1}{\mu}} K_t^{\frac{1}{\mu}}$ , where  $\mu \geq 1$  and  $A_t$  is an exogenous process capturing firm fundamentals.<sup>7</sup> Firm fundamentals grow at a constant rate:  $A_{t+1}/A_t = 1 + g.^8$  We also assume  $M_{t,t+1} = (1+r)^{-1}$ , with g < r. Finally, let adjustment costs be given by:

$$\Phi_{n,t}(x) = \Phi_n(x) = x - 1 + \delta_n + \gamma_n r \left( x - 1 + (r - (x - 1)) \log \left( \frac{r - (x - 1)}{r} \right) \right).$$
(12)

This adjustment cost is increasing and strictly convex; moreover, it satisfies  $\Phi_n(1) = \delta_n$ ,  $\Phi'_n(1) = 1$  and  $\Phi''_n(1) = \gamma_n$ . We choose the functional form so as to obtain simple analytical expressions. Appendix A.1 shows that:

$$Q_1 - q_1 = \frac{\mu - 1}{r - g} (r + \delta_1 + \gamma_1 rg) + Sq_2 + \frac{\mu - 1}{r - g} (r + \delta_2 + \gamma_2 rg)S, \quad (13)$$

where marginal q, average Q, and the ratio of intangible to physical capital, S, are constant.

Following Result 1, the investment gap for physical capital has three components: the rents attributable to physical capital; the omitted capital term; and the rents attributable to intangibles. In order to build intuition, consider first the special case of linear adjustment

<sup>&</sup>lt;sup>7</sup>Appendix A.1.5 describes a general equilibrium model in which monopolistically competitive firms also use labor in production, and shows that they effectively face this operating profit function.

<sup>&</sup>lt;sup>8</sup>Appendix A.1.4 provides analytical expressions for a version of the model with stochastic growth rates; these expressions are very similar to Equation (14), and key insights from that decomposition are preserved.

costs,  $\gamma_1 = \gamma_2 = 0$ . Marginal q for both types of capital is then equal to 1, and so:

$$Q_1 - q_1 = Q_1 - 1 = \frac{\mu - 1}{r - g}(r + \delta_1) + S + \frac{\mu - 1}{r - g}(r + \delta_2)S.$$
(14)

When adjustment costs are linear, the firm behaves as though it was renting capital in perfectly competitive markets, equating the marginal revenue product of each type of capital to its Jorgensonian user cost:  $\Pi_{n,t} = \Pi_n = r + \delta_n$ . The two rents terms in decomposition (14) can then be thought of as a markup on the marginal (user) cost of each of these two inputs, discounted by the Gordon growth term r - g. The relative magnitude of the two terms capturing rents will then depend on how intangible-intensive the firm is (that is, on S), and on how high intangible user costs are, relative to physical user costs.

When adjustment costs are positive  $(\gamma_1 > 0, \gamma_2 > 0)$ , the main difference is in the expression for user costs. The typical Jorgensonian user cost  $r + \delta_n$  which appeared in decomposition (14) is replaced with  $r + \delta_n + \gamma_n rg$ . The additional term reflects the cost of continuously adjusting capital along the firm's growth path.

### 2.4 Discussion

Why is  $Q_{n,t} - q_{n,t}$  an "investment gap"? We extend the terminology "investment gap" used in Gutiérrez and Philippon (2017) and Alexander and Eberly (2018). The first-order condition for investment can be written as:  $g_{n,t} = \Psi_{n,t} (q_{n,t} - 1)$ , where  $g_{n,t}$  is the net investment rate in capital  $K_{n,t}$ , and  $\Psi_{n,t}(y) \equiv (\Phi'_{n,t})^{-1} (1 + y) - 1$  is a strictly increasing function capturing investment adjustment costs. When the investment gap is positive  $(Q_{n,t} > q_{n,t})$ , we have  $\Psi_{n,t} (q_{n,t} - 1) = g_{n,t} < \Psi_{n,t} (Q_{n,t} - 1)$ . Investment predicted using average Qinstead of using marginal q will always exceed actual investment. That is, there will appear to be a "gap" between actual investment and observed Q values.

Why not use Total Q? Total Q is defined as  $Q_{tot,t} = V_t^e / \sum_{n=1}^N K_{n,t+1}$  (Peters and Taylor, 2017). It is the ratio of the value of the firm to its total (physical plus intangible) capital stock. Total Q in our model is given by:

$$Q_{tot,t} = \sum_{n=1}^{N} s_{n,t+1} q_{n,t} + (\mu - 1) \sum_{n=1}^{N} s_{n,t+1} \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} \Pi_{n,t+k} (1 + g_{n,t+1,t+k}) \right]$$

where  $s_{n,t+1} = K_{n,t+1} / \sum_{n=1}^{N} K_{n,t+1}$ . Define the "total investment gap" as the difference between  $Q_{tot,t}$  and  $q_{tot,t} = \sum_{n=1}^{N} s_{n,t+1}q_{n,t}$ . This gap will be positive, if and only if, the firm earns rents; moreover, rents can be decomposed across types of capital, as described above. However, we do not focus on this "total investment gap" for one main reason:  $q_{tot,t}$  is not a sufficient statistic for total investment, except in specific cases.<sup>9</sup> This implies that there is no one-to-one mapping between the gap  $Q_{tot,t} - q_{tot,t}$  and the relationship between total investment and  $Q_{tot,t}$ . By contrast,  $q_{n,t}$  is always a sufficient statistic for investment in  $K_{n,t}$ , and so the capital-specific investment gap  $Q_{n,t} - q_{n,t}$  entirely accounts for the relationship between  $Q_{n,t}$  and investment in  $K_{n,t}$ .

How general is this model? Other than Assumptions 1-3, the model puts no restrictions on the functional forms for  $F_t$ ,  $\Pi_t$  and  $\Phi_{n,t}$ , and therefore nests a number of existing models.<sup>10</sup> However, it has three limitations. First, it does not allow for non-convex adjustment costs. Second, it abstracts from financial constraints.<sup>11</sup> Finally, it assumes that rents,  $\mu$ , are exogenous. In particular, they do not depend on past investment, in contrast, for instance, with models of customer capital.<sup>12</sup> In this sense, our results are restricted to "neoclassical" models of the firm, and provide a benchmark against which the effects of other frictions on the investment gap can be compared.

# 3 The investment gap in aggregate data

We now show that the investment gap for non-financial corporate businesses has tripled since 1985, driven by the combined effects of rising rents and rising intangibles. This section uses aggregate data, which has the most coverage, but the narrowest measure of intangible capital. We broaden this measure in the next section, drawing on firm-level data.

## 3.1 Methodology

We use the constant growth version of the model, described in Section 2.3, in order to construct the investment gap and its components in the data. We have:

$$Q_1 - q_1 = \frac{\mu - 1}{r - g} R_1 + q_2 S + \frac{\mu - 1}{r - g} R_2 S, \qquad (15)$$

 $<sup>^{9}</sup>$ Appendix A.1.3 discusses this issue in more detail. An example is the case of case of perfectly substitutable capital types and identical adjustment cost functions.

<sup>&</sup>lt;sup>10</sup>For instance, our model nests Lindenberg and Ross (1981), Hayashi (1982), Abel (1983), Abel and Blanchard (1986), Hayashi and Inoue (1991), case I of Abel and Eberly (1994), and Abel and Eberly (2011). It also nests the investment blocks of macroeconomic models that study the importance of intangibles, for instance, McGrattan and Prescott (2010), Karabarbounis and Neiman (2019) or Barkai (2019).

<sup>&</sup>lt;sup>11</sup>A large literature has shown financial constraints can drive a wedge between average Q and marginal q (Whited, 1992; Gomes, 2001; Hennessy et al., 2007; Bolton et al., 2011; DeMarzo et al., 2012). The size this wedge is a matter of debate, particularly if the firm has market power (Cooper and Ejarque, 2003).

<sup>&</sup>lt;sup>12</sup>See, for instance, Gourio and Rudanko (2014) and Belo et al. (2014).

where recall that  $R_n = r + \delta_n + \gamma_n rg$ , and  $q_n = 1 + \gamma_n g$ , n = 1, 2. We assume  $Q_1$  and S are measured. Thus, we need values for  $\{\mu, r - g, R_1, R_2, q_1, q_2\}$ . We derive these values from the following observable moments:  $\{ROA_1, i_1, i_2, g\}$ , where  $ROA_1 = \prod_t / K_{1,t}$  is average returns to physical capital,  $i_1$  and  $i_2$  are gross investment rates, and g is the net growth rate of the total capital stock  $K_{1,t} + K_{2,t}$ . First, we use the fact that:<sup>13</sup>

$$\mu = \frac{ROA_1}{R_1 + SR_2}.\tag{16}$$

Intuitively, rents imply a wedge between average returns to physical capital and the weighted average user cost of capital. Second, we have that:

$$R_n = r - g + i_n + \gamma_n r g, \quad n = 1, 2,$$
 (17)

where we used the fact that  $i_n = g + \delta_n$  along the balanced growth path. Finally, substituting Equations (16) and (17) in the investment gap decomposition (15), we obtain:

$$r - g = \frac{ROA_1 - (i_1 + Si_2)}{Q_1} - \frac{\gamma_1 + S\gamma_2}{Q_1}g^2.$$
 (18)

This expression for the Gordon growth term r - g only depends on observable moments and values of the adjustment cost parameters. Given the value for r - g and other data moments, values of  $R_1$  and  $R_2$  follow from Equation (17); and the value of  $\mu$  follows from Equation (16). Finally,  $q_1$  and  $q_2$  are obtained from the values of g and of the adjustment cost parameters.

This approach matches, by construction, the empirical value of  $Q_1$ . That is, it infers the Gordon growth term r - g which, given other moments, ensures that the model produces a value of  $Q_1$  consistent with the data. Our use of valuations is a natural implication of the model, but also an important point of departure from the recent literature. We come back to this point in Section 3.3.

### 3.2 Data

Our sample period is 1947-2017. We construct time series for five of the moments used in the decomposition,  $\{i_{1,t}, i_{2,t}, S_t, ROA_{1,t}, Q_{1,t}\}$ , using six times series in levels,  $\{K_{1,t}, I_{1,t}, K_{2,t}, I_{2,t}, \Pi_t, V_t\}$ . These are the operating surplus of the NFCB sector, the stock of physical capital at replacement cost, investment in physical capital, the stock of intangibles at replacement

 $<sup>^{13}\</sup>mathrm{See}$  Appendix A.1 for a formal derivation of this relationship.

cost, investment in intangibles, and the market value of claims on the NFCB sector.<sup>14</sup>

We obtain measures of  $K_{1,t}$ ,  $I_{1,t}$ ,  $K_{2,t}$  and  $I_{2,t}$  from BEA fixed asset tables 4.1 and 4.7. The BEA fixed asset tables use perpetual inventory methods to construct the stock of three specific forms of intangible capital: R&D; own-account software; and artistic originals. To the extent that firms invest in other types of intangibles, results in this section should thought of as a lower bound on the overall role of intangibles. Section 4 expands the analysis to organization capital for the subset of publicly traded firms in the NFCB sector.

Operating surplus  $\Pi_t$  is obtained from NIPA Table 1.14. Consistent with the model, this series represents the difference between value added and payments to labor; expenditures categorized as intangible investment are not treated as intermediates in value added.

We construct a measure of  $V_t$  using Flow of Funds tables L.103 and F.103. In the model,  $V_t$  represents the market value of all net claims on the NFCB sector, both debt and equity. The Flow of Funds data provide an estimate for the market value of equity of the NFCB sector, but not for debt. We follow an approach analogous to Hall (2001) to estimate the latter. Importantly, and different from Hall (2001), we do not subtract all financial assets owned by the sector from the gross market value of claims, but only financial assets identified as liquid in the Flow of Funds.<sup>15</sup> Section 3.3 shows that this choice affects the level of the investment gap, but not its composition.

We then construct  $ROA_{1,t} = \prod_t / K_{1,t}$ ,  $i_{1,t} = I_{1,t} / K_{1,t}$ ,  $i_{2,t} = I_{2,t} / K_{2,t}$ ,  $S_t = K_{2,t} / K_{1,t}$ , and  $Q_{1,t} = V_t / K_{1,t}$ . Finally, we compute  $g_t$  as the annual growth rate of the chain-type quantity index for private non-residential fixed assets of the NFCB sector, provided in BEA fixed asset table 4.2. The time series for the resulting six moments,  $\{i_{1,t}, i_{2,t}, S_t, ROA_{1,t}, Q_{1,t}, g_t\}$  are reported in Appendix Figure A1. The key trends discussed in the introduction are visible in that figure. The average return to physical capital increases after 1985, while the physical investment rate declines. The ratio of intangible to physical capital increases, particularly after 1985.  $Q_1$  rises sharply after 1985, and after a peak in 2000, remains approximately double its value in the pre-1985 period.

Finally, we compute the decomposition using moving averages of moments over 7-year centered rolling windows. This treats each successive window as if it were generated by a different quantitative implementation of the model, allowing us to capture gradual changes in the investment gap.<sup>16</sup>

<sup>&</sup>lt;sup>14</sup>We use current-dollar values for all time series in levels, with the exception of our proxy for  $g_t$ , the computation of which is described below. Details on data construction are reported in Appendix A.2.1.

<sup>&</sup>lt;sup>15</sup>Financial assets are generally subtracted from the gross market value of claims in order to include net debt, instead of gross debt, in firm value calculations. On the other hand, financial assets can only meaningfully be counted as negative debt to the extent that they are liquid. Additionally, a large part of non-liquid financial assets in table L103 are obtained as a residual, further complicating their interpretation.

<sup>&</sup>lt;sup>16</sup>Using alternative window sizes from 3 to 9 years gives quantitatively similar results.

### 3.3 Results

**Baseline results** Figure 1 reports the investment gap decomposition, Equation (15), for the NFCB sector and R&D intangible capital. We consider two cases: zero adjustment costs,  $\gamma_1 = \gamma_2 = 0$ ; and positive adjustment costs. We choose values of  $\gamma_1 = 3$  and  $\gamma_2 = 12$  for the latter case following (Belo et al., 2018), but also show, below, that our results are generally robust to the choice of adjustment costs.<sup>17</sup>

We highlight three main findings. First, the investment gap is large during two distinct periods: 1960-1970, and after 1985. The wedge between average Q and marginal q is therefore not strictly a hallmark of the post-1980s period. Second, rents attributable to physical capital — the first term in Equation (15) — play a sizeable (though somewhat declining) role in explaining the investment gap: they account 61% of it in 2015, compared to 67% in 1965.<sup>18</sup> Third, rents attributable to intangibles — the third term in Equation (15) — have become markedly more important in recent years. In 2015, 25% of the investment gap reflects the combined effects of high rents and a large stock of intangibles, compared to 10% in 1965, using the BEA measure of R&D capital only.

From the standpoint of the model, these changes are driven by three underlying forces, reported in Figure 2: a greater importance of intangibles in the production function; higher rents; and a decline in user costs, more pronounced for physical than for intangible capital.

The top left panel of Figure 2 shows that even using the relatively narrow definition of intangibles in the NFCB data, the share of intangible capital in production increased substantially after 1985, from 0.17 to 0.29 in 2015.<sup>19</sup> The behavior of the intangible share approximately mimics the behavior of the measured ratio of intangible to physical capital at replacement cost, which increases rapidly after 1985.

The effects of the intangible share on the overall investment gap are magnified by the rise in rents after 1985. The top right panel of Figure 2 reports estimates of the rents implicit in Equation (15). In order to facilitate comparison with existing estimates of the profit share, we express them as the flow value of rents relative to value added, which is related to the parameter controlling rents in the model,  $\mu$ , through  $s = (1 - s_L)(1 - 1/\mu)$ , where  $s_L$  is the labor share of value added.<sup>20</sup> Total rents, as a fraction of value added, increase from 0.015

<sup>&</sup>lt;sup>17</sup>For physical adjustment costs, this value is in the lower end of existing estimates in the literature, which range from 1 to 32 (Hall, 2001). For intangible capital, we use a value close to the recent estimate of 12.5 obtained by Belo et al. (2018) for R&D capital in a panel of publicly traded firms.

<sup>&</sup>lt;sup>18</sup>These numbers, and those that follow in this discussion, refer to the model with adjustment costs.

<sup>&</sup>lt;sup>19</sup>This number is derived assuming that the capital aggregator is Cobb-Douglas. The level of intangible share is sensitive to this assumption, but not the magnitude of the change after 1985.

<sup>&</sup>lt;sup>20</sup>We measure the labor share for the NFCB sector using NIPA data on labor payments for that sector, as described in Appendix A.2.1. Internet Appendix IA.1 discusses the implications of our analysis the labor share in more detail, using a model with variable labor.

in 1985, to 0.077 in 2015 — a cumulative 6.2 percentage point change over three decades. Expressed in markup terms, this is an increase from 1.015 in 1985, to 1.083 in 2015.

These findings are qualitatively consistent with the recent literature arguing that pure profits as fraction of value added have been growing over the last three decades (Gutiérrez and Philippon, 2017; Barkai, 2019; Karabarbounis and Neiman, 2019). However, they differ quantitatively. For instance, Barkai (2019) finds that the pure profit share rose from -5.6% in 1984 to 7.9% in 2014, an increase of 13.5% over the period. Karabarbounis and Neiman (2019), in their "case  $\Pi$ ," find that the pure profit share must have risen by about 13% over the same period. We find an increase in rents of half that magnitude.<sup>21</sup>

User costs are at the heart of this difference. Specifically, our approach leads to user costs that are initially lower, but that decline more slowly. Figure 3 reports these implied user costs. User costs for physical capital decline from 15.4% to 12.6% between 1985 and 2015, while user costs for intangibles decline from 36.8% to 30.4%; their weighted average only declines from 17.1% to 15.2%. (By contrast, Barkai (2019), for instance, finds a required rate of return on capital that falls from approximately 20% in 1985 to approximately 14% in 2014.) The smaller decline in user costs translates to higher payments to capital (particularly to intangibles), and therefore a smaller increase in rents.

The way we infer the discount factor perceived by firms from the data is central to this result. As discussed before, we rely on valuations; by contrast, the papers mentioned above generally combine risk-free rates with imputed estimates of risk premia to obtain discount rates. Appendix Figure A3 reports the implied discount rate implied by our approach. It declines from 7.9% to 5.6% between 1985 and 2015. This is a smaller decline than the risk-free rate over the same period of time, and is therefore consistent with a mild rise in risk premia over this period of time, as argued by Caballero et al. (2017), Farhi and Gourio (2018), and Karabarbounis and Neiman (2019) in their case R.

Finally, it is worth noting that our analysis implies that user costs for intangible capital have fallen by *less* than those of physical capital. Our approach infers this from the higher gross investment rates in intangibles, but this finding is also supported by the data, which shows that economic depreciation rates for intangibles have risen over the past three decades, as reported in Appendix Figure A3. This change in relative user costs explains why rents attributable to intangibles, which are the present value of net markups over their user costs, as indicated by Equation (15), account for an increasing fraction of the investment gap after 1985.

<sup>&</sup>lt;sup>21</sup>Related to this are the markup estimates of De Loecker and Eeckhout (2017) and Hall (2018). These markups, when expressed in value added terms, are much higher than ours — approximately 1.9 and 4 in 2015, respectively —, and also far outside the range typically considered reasonable in the macroeconomics literature, as discussed in detail by Basu (2019).

**Counterfactuals** In order to further illustrate the respective roles played by intangibles and rents in our estimation, Figure 3 reports results from two counterfactual exercises.

The top panel constructs the change in the share of intangibles in production that would be necessary in order to fully account for the increase in the investment gap, assuming that rents remain fixed at their 1985 level. This change is 34 percentage points, compared to 12 percentage points in our baseline results. This, in turn, implies that the ratio of intangible to total capital, at replacement cost, would need to be 30% in 2015, or approximately twice it observed value of 14% for R&D capital in the NFCB.<sup>22</sup> In Section 4, we show that this magnitude is comparable to the ratio of intangible to total capital *including* organization capital among publicly traded firms, measured as in Eisfeldt and Papanikolaou (2013).<sup>23</sup>

The bottom panel of Figure 3 shows the increase in rents, as a fraction of value added, which would be required in order to match the observed investment gap, assuming that both the share of intangible capital,  $R_2$ , and the intangible investment rate  $\iota_2$ , had remained fixed at their 1985 values. Instead of the 6.2 percentage point increase in rents as a fraction of value added which we estimate as our baseline, rents would have needed to increase by 8.4 percentage points, or approximately 35% more, reaching 10.0% of value added by 2015. The total contribution of intangibles to the investment gap would nevertheless remain elevated (approximately 31%, instead of 39% in our baseline), due to the rising rents generated by the (moderate) fixed stock of intangibles.

**Robustness** We conclude with three robustness exercises regarding these results.

Appendix Figure A5 reports four implied moments under alternative combinations of adjustment costs for physical and intangible assets. The values considered are  $\gamma_2 \in [0, 20]$  and  $\gamma_1 \in [0, 10]$ . The four moments are the change in the overall investment gap,  $Q_1 - q_1$ ; the contribution of intangibles to the investment gap in 2015; the implied intangible share in 2015; and the implied share of rents in total value added in 2015. Of these moments, none display significant sensitivity to changes in user costs except the share of rents in value added. That share is highest when adjustment costs are lowest, consistent with the intuition, from

<sup>&</sup>lt;sup>22</sup>Simple algebra, using the results of Section 3.1, shows that the counterfactual ratio of intangible to physical capital  $\hat{S}$  under fixed rents is the smallest positive root of  $Ax^2 + Bx + C = 0$ , where  $A = \iota_2 + \gamma_2 g(\iota_2 + g + \gamma_2 g)$ ,  $B = \iota_1 + \iota_2 - ROA_1 - Q_1\iota_2 + \gamma_1 g(\iota_2 + g) + \gamma_2 g(\iota_2 + g - Q_1g - ROA_1) + 2\gamma_1\gamma_2 g^3$ ,  $C = ROA_1Q_1/\mu^{(1985)} + \iota_1 - ROA_1 - Q_1\iota_1 + \gamma_1 g(\iota_1 + g + \gamma_1 g^2 - ROA_1 - Q_1g)$ , and  $\mu^{(1985)}$  is the estimated value of the rents parameter  $\mu$  in 1985 using our baseline approach. The ratio of intangible to total capital is then given by  $\hat{S}/(1 + \hat{S})$ .

<sup>&</sup>lt;sup>23</sup>This magnitude is also comparable to Karabarbounis and Neiman (2019), "case K". These authors show that, if the profit share is assumed to be zero, then unmeasured capital would need to account for approximately 40% of all business capital after 1970 in order to explain the measured capital share. Expressed in terms of value added, our estimates imply that intangibles would need to be approximately 63% of value added in the NFCB sector; this in line with similar estimates obtained by McGrattan and Prescott (2005) under perfect competition.

Section 2.3, that taking into account adjustment costs tends to raise user costs of capital and lower implied rents. Nevertheless, estimates of the profit share in 2015 with zero adjustment costs are 8.5%, still moderate, compared to some of the recent results discussed above.

Next, we consider an alternative measure of the net value of claims on the NFCB sector, that of Hall (2001).<sup>24</sup> As mentioned above, this measure subtracts all financial assets of the NFCB sector from gross claims, instead of subtracting only liquid financial assets, as we do in our baseline. Appendix Figure A4, panel (a), reports the time series for  $Q_1$  obtained this way. It is lower than in our baseline, though it displays approximately the same medium and long-run trends. Appendix Figure A6 then reports the investment gap obtained using this measure of  $Q_1$ . The main difference with our baseline is in the overall level of the gap; it is about half as large. As a result, implied rents are lower than in our baseline. However, the direct effect of intangibles becomes larger; and overall, intangibles account for more of the gap with this measure of  $Q_1$  than in our baseline.

Finally, we consider an alternative to  $Q_1$  for inferring the value of r - g: measures of the price-dividend (PD) ratio. Indeed, in the version of the model we use in this section, the PD ratio is simply given by  $PD = (r-g)^{-1}$ . Appendix Figure A4 reports two empirical measures of the PD ratio for the NFCB sector, and Appendix Figure A7 reports the investment gap decomposition obtained when inferring r - g directly from the PD ratio.<sup>25</sup> Generally, this approach implies a larger estimated investment gap, particularly so in the first half of the sample, prior to 1980. This reflects the fact that empirical measures of the PD ratio are generally larger than implied by our baseline, particularly in pre-1980 period. (The flipside is that, when using PD ratios as a proxy for r - g, implied measures of  $Q_1$  exceed their empirical counterparts).<sup>26</sup> However, targeting the PD ratio still leads to the same basic insights as the baseline approach. In particular, by 2015, the rents attributable to intangibles account for 28% of the total investment gap in the PD ratio approach (compared to 25% in our baseline approach).

Summarizing, we documented a large investment gap in the NFCB sector after 1985. This gap reflects a combination of rising rents and a growing importance intangibles in production,

<sup>&</sup>lt;sup>24</sup>This measure is also used in the recent work of Andrei et al. (2019).

<sup>&</sup>lt;sup>25</sup>We estimate a price-dividend ratio for equity, using cum- and ex-dividend returns on the S&P500, and adjust these estimates for leverage (at market values) and interest payments, estimated from Flow of Funds data.

<sup>&</sup>lt;sup>26</sup>These discrepancies may be driven by differences the sample underlying our measure of  $Q_1$  (the NFCB sector) and the sample underlying our measure of the PD ratio (the S&P 500). Indeed, our estimates of the physical investment gap using the Compustat non-financial sample, presented in Section 4, lead to somewhat higher estimates of  $Q_1$ , and as a result of the physical investment gap, than for the NFCB sector as a whole. An additional reason may be mis-measurement of distributions to equityholders. Our measure is based on cash distributions, and excludes share repurchases, which became more common after the early 2000's.

with the latter accounting for about one-third of the gap. Additionally, though our valuationbased approach finds rising rents, the magnitude of the increase is approximately half that of existing estimates. These results were obtained using aggregate data. This data obscures potential differences across sectors, and also focuses on R&D intangible capital, which is a subset of intangible capital emphasized in the measurement literature. We turn now to another data source in order to address these issues.

# 4 A different empirical view of the investment gap

In this section, we construct investment gaps at the sectoral level, and highlight how they change when measures of intangibles are expanded beyond R&D capital. We find substantial differences across sectors in both the level of the gap and the relative contributions of rents and intangibles. Expanding measures of intangibles beyond R&D reduces the quantitative estimates of rents, and suggests that intangibles are the dominant force behind the growth in the investment gap.

### 4.1 Data

We use the non-financial segment of Compustat, instead of data drawn from the National Accounts. This restricts the scope of our analysis to publicly traded firms. We choose Compustat both because, to our knowledge, there is no comprehensive sectoral data on operating surplus ( $\Pi_t$ , in our notation) spanning a sufficiently long time period, and because it allows for measures intangible capital that can be expanded beyond R&D.<sup>27</sup>

**Sector definitions** We focus on domestically incorporated, publicly traded US firms not in the financial sector, so that the scope of the analysis is similar to Section 3 (but now excludes private corporations). We split the sample into four broad sectors: the Consumer sector (primarily retail and wholesale trade); the High-tech sector (primarily software and IT); the Healthcare sector (producers of medical devices, drug companies, and healthcare service companies); and the Manufacturing sector. These groups are similar to the first four groups of the Fama-French 5 classification. We omit a fifth group from our analysis, which primarily contains service industries, including professional and business services, and hospitality services.<sup>28</sup>

<sup>&</sup>lt;sup>27</sup>Details on data construction are reported in Appendix Appendix A.2.2. Internet Appendix IA.2 contains a more complete discussion of the differences between Compustat and the National Accounts data.

 $<sup>^{28}</sup>$ Internet Appendix Tables IA1 and IA2 report the list of SIC and NAICS codes that make up each sector. Using the KLEMS data, the four sectors we study account for 54.4% of total value added by private

**Data moments** In order to construct the key moments needed for our analysis, we proceed similarly to Section 3; Appendix A.2 reports the details. The two main differences are as follows. First, we consider two types of intangibles: R&D, similar to analysis of Section 3; and organization capital, which we did not measure in Section 3. R&D investment is measured using reported R&D expenditures. For investment in organization capital, we follow Eisfeldt and Papanikolaou (2013) and impute investment as 30% of SG&A expenditures net of R&D investment. Second, for operating surplus,  $\Pi_t$ , we use operating income before depreciation, but we adjust it for the expensing of intangible investment in accounting data, consistent with our model.

## 4.2 The aggregate investment gap in Compustat

We start by applying our baseline analysis to pooled data from all Compustat sectors. The results are summarized in Table 1.<sup>29</sup> Here, we highlight the two main findings of this exercise.

First, when using only R&D capital, the same trends highlighted in the introduction are apparent in both the Compustat and the NFCB data: rising returns to physical capital, rising  $Q_1$ , and declining physical investment rates. Compustat moments are very close to those of the NFCB, consistent with the fact that the fixed asset tables primarily measure intangibles as capitalized R&D. The exception are returns to physical capital, which are higher among publicly traded firms. As a result, total rents as a fraction of value added are estimated to be higher among Compustat firms than in the NFCB sector as a whole. The rent share of value added is about 2 percentage points higher in the post-2001 period in the Compustat sample, as indicated in Table 1. Other than this difference, when using only R&D, the implications of our analysis look similar for Compustat and the NFCB as a whole.

Second, once organization capital is included, results for Compustat suggest that intangibles are the dominant force behind the investment gap. When including organization capital, the ratio of intangible to physical capital more than doubles. Returns to physical capital also further increase, since operating surplus must now be adjusted for the expensing of intangible investment in organization capital. However, the effect of the higher stock of intangibles dominates. After 2001, for instance, the two intangible-related terms account for 69% of the total investment gap, on average, as opposed to 39% when only including R&D.

businesses in 2001.

<sup>&</sup>lt;sup>29</sup>Additionally, Appendix Figure A8 reports the raw time series for the moments used in our baseline analysis, Appendix Figure A9 reports the time series for the investment gap and its decomposition, and Appendix Figure A10 reports the time series for the share of intangible in production, the share of rents in value added, and the user costs of the two types of capital, all based on the aggregated data from the Compustat sample.

The intangible share in production approximately doubles compared to when only R&D capital is included, reaching  $\eta = 48\%$  on average after 2001. Additionally, the importance of rents overall declines. The share of rents in value added falls to 4.9% of value added after 2001, compared to 8.7% when only R&D capital is included. This result is consistent with the intuition developed using counterfactuals in Section 3: unmeasured intangible capital of an empirically plausible magnitude can account for the majority of the investment gap, and reduce the role of rents substantially.

## 4.3 Sectoral results

**Trends across sectors** The top panel of Table 2 reports averages of the six data moments used in the construction of the investment gap over two periods, 1985-2000 and 2001-2017.<sup>30</sup> There are notable differences across sectors, even with the coarse industry classification. High-tech and Healthcare are characterized by a combination of high asset returns and high valuations, declining physical investment, and a high (and rising) intangible share, consistent with the aggregate data for the NFCB sector as a whole. The Consumer sector also features high returns and low physical investment. In that sector, when measured as R&D, intangibles appear to be a negligible fraction of total capital, while they are about half of total capital when organization capital is included, which we discuss further below. Finally, Manufacturing is characterized by declining returns, declining valuations, declining physical investment, and a declining intangible share, in contrast to the other sectors.

**Results using only** R&D Figure 4 reports investment gaps and their decomposition for the four sectors of our analysis, when intangibles are measured only with R&D capital. The model used to construct this decomposition has positive adjustment costs of  $\gamma_1 = 3$  and  $\gamma_2 = 12$ , as in the previous section. This figure shows that the level and the composition of investment gaps differs substantially across sectors.

One extreme is the Manufacturing sector. In that sector, the investment gap is small. Moreover, little of it is explained by intangibles. This is consistent with the fact that the stock of R&D capital (relative to the stock of physical capital) has been declining in manufacturing since the early 2000's. Accordingly, the bottom panel of Table 2 indicates that intangibles' share in the production function has decreased. Though rents have been rising in that sector — they increased by 3.8 percentage points of value added from before to after 2000, as indicated by Table 2) —, they remain small.

The other extreme is the Consumer sector. There, the investment gap is large, in partic-

<sup>&</sup>lt;sup>30</sup>Internet Appendix Figures IA4 to IA7 report the full time series for these moments.

ular after 1990. However, it is almost entirely explained by rents to physical capital when using R&D capital alone — our measure of intangibles for this exercise — since measured R&D is very small.<sup>31</sup> The combination of high returns, high valuations, and low intangibles lead to a high (and rising) share of rents in value added, reaching 12.7% after 2000, as reported in Table 2.

The Healthcare and High-tech sectors are intermediate cases. Both experienced a large increase in the physical investment gap starting in the mid-1980's. In both cases, rents attributable to physical capital have also increased. However, they only account for about one-half — in the High-tech sector — and one-third — in the Healthcare sector — of the investment gap overall. In both sectors, the key change in the composition of the investment gap after 2000 is a substantial increase in rents to intangible capital. For the Healthcare sector, for instance, they account, alone, for 41% half of the total investment gap. Table 2 indicates that this is the effect of two changes: a rising intangible share; and a rise overall rents. Rents as a fraction of value added rise by 6.6 percentage points in the High-tech sector, and 4.3 percentage points in the Healthcare sector, between the pre- and post-2000 periods. The intangible share in production also increases, particularly in the Healthcare sector, where it roughly doubles.

**Results including organization capital** The previous sectoral results were constructed using only R&D as a measure of the intangible capital stock. Expanding the definition of intangibles to include organization capital has two main effects, both of which are most clearly apparent in the Consumer sector. First, unsurprisingly, the implied share of intangibles in the production function increases substantially.<sup>32</sup> The increase is particularly striking in the Consumer sector, where the stock of organization capital becomes comparable to the stock of physical capital. Second, the *level* of implied rents declines substantially. In the Consumer sector, rents fall from 12.4% to 2.7% of value added after 2001. The combined effect of these two changes is to magnify the direct contribution of intangibles to the investment gap. The Consumer and the Healthcare sector are both particularly impacted; in both, intangibles measured in this way account for more than half of the investment gap.

It is worth noting, though, that while including organization capital leads to a substantial decrease in the *level* of rents, it has a more moderate impact on their *trend*. Figure 5 reports the cumulative change in the estimated share of rents in total value added from 1985 onward for each of the four sectors, measuring intangibles using either R&D (blue circled line) or the sum of R&D and organization capital (green crossed line). The Consumer sector is

 $<sup>^{31}\</sup>mathrm{It}$  rises slightly after the mid-2000's, driven primarily by Amazon's reported R&D expenditures, but remains too low to account for the physical investment gap.

 $<sup>^{32}</sup>$ Sectoral moments obtained using this definition of intangibles are reported in Appendix Table A1.

where including organization capital makes the sharpest difference: the cumulative change in rents falls by approximately one-third.<sup>33</sup> In other sectors, there is little trend increase in organization capital relative to R&D capital after 1985, and so cumulative *changes* in rents are similar under the two measures.

**Counterfactuals** Figure 5 also reports a counterfactual that highlights the differential effects of the rise in intangibles across sectors. Similarly to Section 3, we compute the cumulative change in the share of rents that would have had to occur in order to explain the investment gap, had the ratio of intangible to physical capital stayed constant over the sample. In the manufacturing sector, where intangible intensity is *declining*, the cumulative increase in rents would have been smaller. In the three other sectors, it would have been larger, and in some substantially so. The Healthcare sector is the most striking example; there, the increase in rents needed to account for the investment gap without a rise in intangibles would have been about 50% (or 5 p.p.) larger. In the consumer sector, the difference is approximately 30%, relative to the case where intangibles are measured including organization capital. Thus, in both of these sectors, a substantial part of the investment gap is due not purely to rising rents, but to the interaction of rising rents with high and growing intangibles.

Summarizing, the two main findings of this section are the following. First, any aggregate statement about the investment gap is likely to be misleading, as there is substantial heterogeneity, even across broadly defined sectors. The Manufacturing sector has a small investment gap, declining intangibles, and moderate rents, at odds with aggregate trends. By contrast, the Healthcare and High-tech sector are characterized by a larger investment gap than in aggregate, and one where intangibles play a bigger role, particularly in the Healthcare sector. Second, a broader empirical definition of intangibles — one that includes organization capital — generally reduces the contribution of rents to the investment gap, and particularly so in the Consumer sector, where the investment gap becomes primarily driven by intangibles.

<sup>&</sup>lt;sup>33</sup>Prior work (Foster et al., 2006; Crouzet and Eberly, 2018) has indeed argued that the Consumer sector relies extensively on intangible capital, particularly brand capital and, in more recent years, innovations to supply chain and logistics. Investment in these intangibles are not recorded as R&D expenditures, but instead expensed as SG&A, and so they are picked up by our measure of organization capital.

# 5 Conclusion

This research provides a general decomposition of the gap between average Q — which is observable — and marginal q — the shadow value that drives movements in investment — into components reflecting the effects of rents and the effects of omitted capital. Our decomposition shows that the investment gap provides a lens into the sources of firm value and their changes over time.

We use this approach to shed light on the growing divergence between physical investment and valuations, which our approach interprets as being driven by the combined effects of growing rents and growing intangibles. With a relatively narrow measure of intangibles (R&D capital), one-third of the investment gap reflects a combination of growth in the intangible capital stock and rents generated by intangible capital. Expanding the definition of intangibles beyond R&D increases this contribution to about two thirds. We also argue that, because of the substantial heterogeneity across sectors, statements about the aggregate investment gap may be misleading.

Our analysis opens several important questions for future research. First, though our decomposition allows for risk premia, we remained deliberately agnostic about them in our empirical applications. A more thorough treatment of their interaction with the investment gap might be useful, particularly in understanding short-run movements in the gap. Second, though we did not explore heterogeneity within sectors, our decomposition holds at the firm level. Exploring the distribution of the investment gap across firms of particular sectors would both help validate our findings on the sources of the investment gap, and shed further light on the reasons for its growth over the last two decades. Finally, and in a different vein, we have maintained a neoclassical approach to the interaction between intangibles and rents. A broader approach, however, could allow for an economic interaction; for example, investment in intangibles such as product innovation or a software platform may generate rents to the firm. These interactions would augment the neoclassical approach we take here, and could generate additional links between intangible captial and the decisions and valuation of the firm. We pursue this in future work.

# References

- Abel, A. B. (1983). Optimal investment under uncertainty. The American Economic Review 73(1), 228–233.
- Abel, A. B. and O. J. Blanchard (1986). The present value of profits and cyclical movements in investment. *Econometrica* 54(2), 249.
- Abel, A. B. and J. C. Eberly (1994). A unified model of investment under uncertainty. *American Economic Review* 84(5), 1369.
- Abel, A. B. and J. C. Eberly (2011). How q and cash flow affect investment without frictions: An analytic explanation. *The Review of Economic Studies* 78(4), 1179–1200.
- Ai, H., M. M. Croce, and K. Li (2013). Toward a quantitative general equilibrium asset pricing model with intangible capital. *The Review of Financial Studies* 26(2), 491–530.
- Alexander, L. and J. Eberly (2018). Investment hollowing out. *IMF Economic Review* 66(1), 5–30.
- Andrei, D., W. Mann, and N. Moyen (2019). Why did the q theory of investment start working? *Journal of Financial Economics* 133(2), 251–272.
- Autor, D., D. Dorn, L. F. Katz, C. Patterson, and J. Van Reenen (2017). The fall of the labor share and the rise of superstar firms. *National Bureau of Economic Research working paper*.
- Barkai, S. (2019). Declining labor and capital shares. Journal of Finance, Forthcoming.
- Basu, S. (2019). Are price-cost markups rising in the united states? a discussion of the evidence. *Journal of Economic Perspectives* 33(3), 3–22.
- Belo, F., V. Gala, J. Salomao, and M. A. Vitorino (2018). Decomposing firm value. Available at SSRN 3104993.
- Belo, F., X. Lin, and M. A. Vitorino (2014). Brand capital and firm value. Review of Economic Dynamics 17(1), 150–169.
- Benmelech, E., N. Bergman, and H. Kim (2018). Strong employers and weak employees: How does employer concentration affect wages? Technical report, National Bureau of Economic Research.

- Bolton, P., H. Chen, and N. Wang (2011). A unified theory of tobin's q, corporate investment, financing, and risk management. *The journal of Finance 66*(5), 1545–1578.
- Caballero, R. J., E. Farhi, and P.-O. Gourinchas (2008, March). An equilibrium model of "global imbalances" and low interest rates. *American Economic Review 98*(1), 358–93.
- Caballero, R. J., E. Farhi, and P.-O. Gourinchas (2017). Rents, technical change, and risk premia accounting for secular trends in interest rates, returns on capital, earning yields, and factor shares. *American Economic Review* 107(5), 614–20.
- Cooper, R. and J. Ejarque (2003). Financial frictions and investment: requiem in q. *Review* of *Economic Dynamics* 6(4), 710–728.
- Corhay, A., H. Kung, and L. Schmid (2018). Q: Risk, rents, or growth? Technical report, mimeo.
- Corrado, C., C. Hulten, and D. Sichel (2005). Measuring capital and technology: an expanded framework. In *Measuring capital in the new economy*, pp. 11–46. University of Chicago Press.
- Corrado, C., C. Hulten, and D. Sichel (2009). Intangible capital and us economic growth. *Review of income and wealth* 55(3), 661–685.
- Crouzet, N. and J. Eberly (2018). Intangibles, investment, and efficiency. *American Economic Review*, *Papers and Proceedings* 108, 426–31.
- Crouzet, N. and J. C. Eberly (2019). Understanding weak capital investment: the role of market power and intangibles. 2018 Jackson Hole Symposium, Federal Reserve Bank of Kansas City.
- De Loecker, J. and J. Eeckhout (2017). The rise of market power and the macroeconomic implications. *National Bureau of Economic Research working paper*.
- DeMarzo, P. M., M. J. Fishman, Z. He, and N. Wang (2012). Dynamic agency and the q theory of investment. *The Journal of Finance* 67(6), 2295–2340.
- Eisfeldt, A. L. and D. Papanikolaou (2013). Organization capital and the cross-section of expected returns. *The Journal of Finance* 68(4), 1365–1406.
- Farhi, E. and F. Gourio (2018). Accounting for macro-finance trends: Market power, intangibles, and risk premia.

- Foster, L., J. Haltiwanger, and C. J. Krizan (2006). Market selection, reallocation, and restructuring in the us retail trade sector in the 1990s. The Review of Economics and Statistics 88(4), 748–758.
- Gomes, J. F. (2001). Financing investment. American Economic Review 91(5), 1263–1285.
- Gomme, P., B. Ravikumar, and P. Rupert (2011). The return to capital and the business cycle. *Review of Economic Dynamics* 14(2), 262–278.
- Gourio, F. and L. Rudanko (2014). Customer capital. *Review of Economic Studies* 81(3), 1102–1136.
- Gutiérrez, G. and T. Philippon (2017). Investmentless growth: An empirical investigation. Brookings Papers on Economic Activity 2017(2), 89–190.
- Gutiérrez, G. and T. Philippon (2018). Declining competition and investment in the us. National Bureau of Economic Research working paper.
- Hall, R. E. (2001). The stock market and capital accumulation. *American Economic Review 91*(5), 1185–1202.
- Hall, R. E. (2018). New evidence on the markup of prices over marginal costs and the role of mega-firms in the us economy. *National Bureau of Economic Research working paper*.
- Hansen, L. P., J. C. Heaton, and N. Li (2005). Intangible risk. In *Measuring Capital in the New Economy*, pp. 111–152. University of Chicago Press.
- Haskel, J. and S. Westlake (2018). *Capitalism without capital: The rise of the intangible economy*. Princeton University Press.
- Hayashi, F. (1982). Tobin's marginal q and average q: A neoclassical interpretation. *Econo*metrica: Journal of the Econometric Society, 213–224.
- Hayashi, F. and T. Inoue (1991). The relation between firm growth and q with multiple capital goods: Theory and evidence from panel data on japanese firms. *Econometrica* 59(3), 731–53.
- Hennessy, C. A., A. Levy, and T. M. Whited (2007). Testing q theory with financing frictions. Journal of financial economics 83(3), 691–717.
- Karabarbounis, L. and B. Neiman (2019). Accounting for factorless income. NBER Macroeconomics Annual 33(1), 167–228.

- Lindenberg, E. B. and S. A. Ross (1981). Tobin's q ratio and industrial organization. *Journal* of business, 1–32.
- McGrattan, E. R. and E. C. Prescott (2005). Taxes, regulations, and the value of us and uk corporations. *The Review of Economic Studies* 72(3), 767–796.
- McGrattan, E. R. and E. C. Prescott (2010). Unmeasured investment and the puzzling us boom in the 1990s. *American Economic Journal: Macroeconomics* 2(4), 88–123.
- Peters, R. H. and L. A. Taylor (2017). Intangible capital and the investment-q relation. Journal of Financial Economics 123(2), 251–272.
- Whited, T. M. (1992). Debt, liquidity constraints, and corporate investment: Evidence from panel data. *The Journal of Finance* 47(4), 1425–1460.

		Non-Financial Corporate Businesses			Compustat non-financials (R&D)		Compustat non-financials (R&D+ org. cap.)		
	Targeted moments	1947 $1965$	1966 1984	1985 2000	2001 2017	1985 2000	2001 2017	1985 2000	2001 2017
$i_1$	Physical investment rate	0.089	0.108	0.099	0.087	0.109	0.094	0.109	0.094
$i_2$	Intangible investment rate	0.252	0.276	0.281	0.261	0.260	0.248	0.251	0.245
S	Intangible/physical capital	0.053	0.078	0.124	0.164	0.131	0.165	0.398	0.459
$ROA_1$	Return on physical capital	0.208	0.211	0.211	0.221	0.257	0.289	0.323	0.361
$Q_1$	Av. Q for physical capital	1.184	1.413	2.032	2.479	2.014	2.440	2.014	2.440
g	Growth rate of total capital stock	0.034	0.038	0.029	0.019	0.032	0.023	0.032	0.032
	Implied moments	1947 1965	1966 1984	1985 2000	2001 2017	1985 2000	2001 2017	1985 2000	2001 2017
$Q_1 - q_1$	Investment gap	0.072	0.308	0.908	1.439	0.859	1.446	0.859	1.446
	% rents from physical capital	69	41	61	61	47	64	9	31
	% intangibles	25	52	21	14	40	14	81	40
	% rents from intangibles	7	7	18	24	13	22	9	29
$\eta$	Intangible share in production	0.099	0.145	0.227	0.286	0.208	0.252	0.437	0.481
s	Rents as a fraction of value added	-0.008	0.014	0.035	0.067	0.037	0.087	0.009	0.049
$R_1$	User cost of physical capital	0.193	0.171	0.143	0.128	0.175	0.162	0.174	0.161
$R_2$	User cost of intangible capital	0.392	0.369	0.341	0.312	0.349	0.330	0.338	0.326
$\mu$	Curvature of operating profit function	0.984	1.051	1.136	1.244	1.152	1.346	1.038	1.168
$ ilde{\mu}$	Markup over value added	0.993	1.014	1.037	1.072	1.039	1.096	1.010	1.051

**Table 1:** Summary of targeted and implied moments, for the non-financial corporate business sector (columns 3 to 5) and for the Compustat Non-Financial sample. For Compustat non-financials, columns 6 and 7 use R&D as the measure of intangibles, and columns 8 and 9 use the sum of R&D and SG&A as the measure of intangibles. The moments are averages over the sub-period indicated in each column. The intangible share in production is estimated under the assumption that physical and intangible capital are Cobb-Douglas substitutes:  $K_t = K_{1,t}^{1-\eta} K_{2,t}^{\eta}$ . Rents as a fraction of value added are computed as  $s = (1 - s_L)(1 - 1/\mu)$ , where  $s_L$  is the labor share of value added for the NFCB sector. Markups over value added are computed as  $\tilde{\mu} = 1/(1 - s)$ . The implied moments reported are for the model with adjustment costs; the adjustment cost values are  $\gamma_1 = 3$  and  $\gamma_2 = 12$ . In the decomposition of the investment gap, percentages may not add up due to rounding. Data sources and construction are described in Sections 3, 4, and Appendix A.2.

		Compustat non-financials (Intangibles = $R\&D$ )							
		Consumer		High-tech		Healthcare		Manufacturing	
	Targeted moments	1985	2001	1985	2001	1985	2001	1985	2001
	Targetea moments	2000	2017	2000	2017	2000	2017	2000	2017
$i_1$	Physical investment rate	0.128	0.098	0.139	0.101	0.105	0.082	0.094	0.093
$i_2$	Intangible investment rate	0.245	0.317	0.346	0.331	0.225	0.190	0.226	0.226
S	Intangible/physical capital	0.008	0.023	0.227	0.238	0.346	0.722	0.113	0.087
$ROA_1$	Return on physical capital	0.269	0.281	0.359	0.397	0.355	0.495	0.226	0.222
$Q_1$	Av. Q for physical capital	2.672	2.651	2.937	3.261	3.064	4.306	1.467	1.743
g	Growth rate of total capital stock	0.054	0.037	0.065	0.014	0.046	0.028	0.016	0.028
	Implied moments	1985	2001	1985	2001	1985	2001	1985	2001
	Implied moments	2000	2017	2000	2017	2000	2017	2000	2017
$Q_1 - q_1$	Investment gap	1.523	1.645	1.634	2.424	1.908	3.329	0.367	0.687
	% rents from physical capital	98	93	46	55	42	32	43	72
	% intangibles	1	2	31	13	30	27	47	16
	% rents from intangibles	1	6	23	32	28	41	9	12
$\eta$	Intangible share in production	0.013	0.058	0.324	0.367	0.387	0.562	0.176	0.143
s	Rents as a fraction of value added	0.087	0.124	0.044	0.110	0.060	0.103	0.016	0.052
$R_1$	User cost of physical capital	0.188	0.169	0.198	0.174	0.173	0.151	0.175	0.159
$R_2$	User cost of intangible capital	0.319	0.418	0.429	0.420	0.316	0.271	0.332	0.305
$\mu$	Curvature of operating profit function	1.412	1.575	1.184	1.474	1.260	1.433	1.064	1.186
$ ilde{\mu}$	Markup over value added	1.095	1.142	1.047	1.124	1.064	1.115	1.017	1.055

**Table 2:** Summary of targeted and implied moments for the different sectors of the Compustat non-financial sample. All columns measure intangibles as the R&D capital stock. The moments are averages over the sub-period indicated in each column. The intangible share in production is estimated under the assumption that physical and intangible capital are Cobb-Douglas substitutes:  $K_t = K_{1,t}^{1-\eta} K_{2,t}^{\eta}$ . Rents as a fraction of value added are computed as  $s = (1 - s_L)(1 - 1/\mu)$ , where  $s_L$  is the labor share of value added for the NFCB sector. Markups over value added are computed as  $\tilde{\mu} = 1/(1 - s)$ . The implied moments reported are for the model with adjustment costs; the adjustment cost values are  $\gamma_1 = 3$  and  $\gamma_2 = 12$ . In the decomposition of the investment gap, percentages may not add up due to rounding. Data sources and construction are described in Section 4 and Appendix A.2.

#### (a) Zero adjustment costs



#### (b) Positive adjustment costs



Figure 1: The investment gap  $Q_1 - q_1$  for physical capital in the non-financial corporate (NFCB) sector. The crossed blue line is an estimate of  $Q_1 - q_1$  constructed using data from the Flow of Funds and from the BEA fixed asset tables. The shaded areas present the decomposition of the physical investment gap into three terms, corresponding to the effects of rents generated by physical capital, the ommitted capital effect due to intangibles, and rents generated by intangibles. The decomposition is described in Equation (15). The top panel reports results when we assume zero adjustment costs in intangible and physical capital ( $\gamma_1 = \gamma_2 = 0$ ); the bottom panel reports results when we assume  $\gamma_1 = 3$  and  $\gamma_2 = 12$ . Methodology and data sources are described in Section 3.



Figure 2: Other model moments for the NFCB sector. Panel (a) reports the share of intangibles in production,  $\eta$ , when the capital aggregator is assumed to be Cobb-Douglas:  $K_t = K_{1,t}^{1-\eta} K_{2,t}^{\eta}$ . Panel (b) reports rents as a fraction of value added,  $s_{VA}$ , which is given by  $s_{VA} = (1 - s_L)(1 - 1/\mu)$ , where  $\mu$  is the model parameter governing the size of rents, and  $s_L$  is labor's share of value added. Panels (c) and (d) report user costs for each type of capital,  $R_1$  and  $R_2$ . Methodology and data sources are described in Section 3.



(b) Change in rents as a fraction of value added



Figure 3: Counterfactual exercises for the NFCB sector. The top panel reports the change in the change in the intangible share in production,  $\eta$ , from 1985 to 2017, when the capital aggregator is assumed to be Cobb-Douglas:  $K_t = K_{1,t}^{1-\eta} K_{2,t}^{\eta}$ . The blue lines report the change in the baseline decomposition; see panel (a) of Figure 2. The orange lines report the change when the parameter controlling rents,  $\mu$ , is set to its estimated value in 1985. The bottom panel reports the change in rents as a fraction of value added from 1985 to 2017; rents as a fraction of value added are given by  $s = (1 - s_L)(1 - 1/\mu)$ , where  $\mu$  is the model parameter governing the size of rents, and  $s_L$  is labor's share of value added. The blue lines report the change in the baseline decomposition; see panel (b) of Figure 2. The orange lines report the change when the ratio of intangible to physical capital, S, and the intangible investment rate,  $\iota_2$ , are fixed to their 1985 values. Methodology and data sources are described in Section 3.



Figure 4: The investment gap  $Q_1 - q_1$  for physical capital across sectors, using R&D as a measure of intangibles. Data is from the Compustat Non-Financial (NF) sample. We use the version of model with adjustment costs  $\gamma_1 = 3$  and  $\gamma_2 = 12$ , in order to construct the components of the investment gap. Methodology and data sources are described in Section 4.

(a) Consumer sector

(b) High-tech sector



Figure 5: Rents as a fraction value added in the Compustat non-financial sample. Each panel reports the change in the change in the intangible share in production,  $\eta$ , from 1985 to 2017, when the capital aggregator is assumed to be Cobb-Douglas:  $K_t = K_{1,t}^{1-\eta} K_{2,t}^{\eta}$ . The blue circled lines report the change obtained in the baseline exercise, using R&D as the measure of intangible capital. The green crossed line reports the change obtained when also including organization capital. Finally, the orange line with triangles reports the counterfactual change necessary to match the investment gap when the parameter controlling rents,  $\mu$ , is kept equal to its estimated value in 1985, in the case where R&D only is used to measure intangible capital. Methodology and data sources are described in Section 4 and Appendix A.2.

# Appendix

# A.1 Proofs and additional theoretical results

# A.1.1 Derivation of Lemma 1

The first-order necessary condition and the envelope theorem, for each capital type, are:

$$\Phi'_{n,t} = q_{n,t} 
\frac{\partial V_{t+1}^c}{\partial K_{n,t+1}} = \Pi_{n,t+1} - \Phi_{n,t+1} + \Phi'_{n,t+1} \frac{K_{n,t+2}}{K_{n,t+1}}$$
(19)

Multiplying the latter condition by  $M_{t,t+1}K_{n,t+1}$ , combining with the former condition, and taking expectations at time t, we obtain:

$$q_{n,t}K_{n,t+1} = \mathbb{E}_t \left[ M_{t,t+1} \left( \Pi_{n,t+1}K_{n,t+1} - \Phi_{n,t+1}K_{n,t+1} \right) \right] + \mathbb{E}_t \left[ M_{t,t+2}q_{n,t+1}K_{n,t+2} \right]$$
(20)

Assuming the transversality condition  $\lim_{k\to+\infty} \mathbb{E}_t M_{t,t+k} q_{n,t+k-1} K_{n,t+k+1} = 0$  holds for each type of capital, we can iterate forward and sum across capital types to obtain:

$$\sum_{n=1}^{N} q_{n,t} K_{n,t+1} = \sum_{n=1}^{N} \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} \left\{ \Pi_{n,t+k} K_{n,t+k} - \Phi_{n,t+k} K_{n,t+k} \right\} \right].$$
(21)

On the other hand, firm value excluding current distributions is given by:

$$V_t^e = \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} \left\{ \Pi_{t+k} K_{t+k} - \sum_{n=1}^N \Phi_{n,t+k} K_{n,t+k} \right\} \right].$$

Note that, given Assumption 1, we have that:

$$\Pi_{t+k} = \mu \Pi_{K,t+k} K_t$$
$$= \mu \sum_{n=1}^N \Pi_{K,t+k} \frac{\partial F_{t+k}}{\partial K_{n,t+k}} K_{n,t+k} = \mu \sum_{n=1}^N \Pi_{n,t+k} K_{n,t+k},$$

so that firm value can be rewritten as:

$$V_t^e = \sum_{n=1}^N \sum_{k \ge 0} \mathbb{E}_t \left[ M_{t,t+k} \left\{ \mu \Pi_{K_n,t+k} K_{n,t+k} - \Phi_{n,t+k} K_{n,t+k} \right\} \right].$$
(22)

Taking the difference between Equations (22) and (21) gives the result.

### A.1.2 Analytical expressions

We assume that the adjustment cost function, for each type of capital, is given by::

$$\Phi_n(x) = x - 1 + \delta_n + \gamma_n r\left(x - 1 + (r - (x - 1))\log\left(\frac{r - (x - 1)}{r}\right)\right), \quad n = 1, 2.$$

It can be checked that this cost function is strictly convex and satisfies the standard conditions  $\Phi_n(1) = \delta_n$ ,  $\Phi'_n(1) = 1$  and  $\Phi''_n(1) = \gamma_n$ , n = 1, 2. Additionally, these functions satisfy the relationship:

$$(r-y)\Phi'(1+y) + \Phi(1+y) = r + \delta_n + \gamma_n ry.$$

The case  $\gamma_n = 0$ , n = 1, 2, is the case of linear adjustment costs. The necessary first-order conditions, for each type of capital, are given by:

$$\Phi'_{n,t} = q_{n,t},$$

$$q_{n,t} = \frac{1}{1+r} \left( \Pi_{n,t+1} - \Phi_{n,t+1} + \Phi'_{n,t+1} \frac{K_{n,t+2}}{K_{n,t+1}} \right).$$
(23)

Moreover, recall that  $A_t$  is growing at the exogenous rate g. We can use this to rewrite the necessary two first-order conditions as:

$$(1+r)\Phi'_{n}(1+g_{n,t}) = \Pi_{n,t+1} - \Phi_{n}(1+g_{n,t+1}) + \Phi'_{n}(1+g_{n,t+1})(1+g_{n,t+1}),$$

where  $g_{n,t} \equiv \frac{K_{n,t+1}}{K_{n,t}} - 1$ . We next guess and verify that  $g_{n,t} = g$  for n = 1, 2 is a solution. Substituting into the condition above, and re-arranging, we obtain:

$$(r-g)\Phi'_n(1+g) + \Phi_n(1+g) = \prod_{n,t+1}.$$

Using the functional form for  $\Phi_n$ , we can rewrite this as:

$$r + \delta_n + \gamma_n rg = \prod_{n,t+1}.$$
(24)

Moreover:

$$\Pi_{n,t+1} = \frac{1}{\mu} A_{t+1}^{1-\frac{1}{\mu_j}} K_{t+1}^{\frac{1}{\mu}-1} \frac{\partial K_{t+1}}{\partial K_{n,t+1}}.$$

Given our guess and the linear homogeneity of the capital aggregator,  $K_{t+1}$  also grows at rate g. Moreover, each partial derivative  $\frac{\partial K_{t+1}}{\partial K_{n,t+1}}$  is homogeneous of degree 0 in each of its

arguments, implying that they only depend on the ratio  $S_{t+1} = \frac{K_{2,t+1}}{K_{1,t+1}}$  of the two capital stocks. This ratio, given our guess, is constant. Hence, the right-hand side of (24), is constant. The ratio of the two capital stocks, as well as the ratio  $K_t/A_t$ , adjust so that the two first-order conditions (24) hold. In particular, taking the ratio of these two first-order conditions, we obtain:

$$\frac{r+\delta_2+\gamma_2 rg}{r+\delta_1+\gamma_1 rg} = \frac{\partial K_{2,t}}{\partial K_{1,t}}$$

so that the ratio of the two capital stocks (which is determines entirely  $\frac{\partial K_{2,t}}{\partial K_{1,t}}$ , because of the homogeneity of degree 0 of the aggregator), is constant:  $S_t = S$ . Finally, note that in this model, the investment-q relationship  $\Phi'_n(1 + g_{n,t}) = q_n$ , can be approximated, up to first order, by:

$$1 + \gamma_n g = 1 + \gamma_n (i_n - \delta_n) = q_n,$$

given the fact that  $\Phi'_n(x) = 1 + \gamma_n(x-1) + o((x-1)^2)$ . Additionally, note that using Equation (24), we obtain:

$$\sum_{n=1}^{N} R_n K_{n,t} = \sum_{n=1}^{N} \Pi_{n,t} K_{n,t} = \frac{1}{\mu} \Pi_t,$$

where  $R_n \equiv +\delta_n + \gamma_n rg$ . Therefore, for any n,

$$\frac{\Pi_t/K_{n,t}}{R_n + \sum_{m \neq n} S_{m,n}R_m} = \frac{ROA_n}{R_n + \sum_{m \neq n} S_{m,n}R_m} = \mu,$$
(25)

where  $S_{m,n} = K_{m,t}/K_{n,t}$ .

### A.1.3 Total Q

One might wonder whether, in a model with homogeneity like the one studied in this paper, average Q for some measure of the total stock of capital properly captures the overall incentive to invest. Define total Q (Peters and Taylor, 2017) and total net investment as:

$$Q_{tot,t} \equiv V_t^e / \sum_{n=1}^N K_{n,t+1}, \qquad g_{j,t,t+1} = \sum_{n=1}^N s_{n,t+1} g_{n,t+1,t+k}, \qquad s_{n,t+1} = K_{n,t+1} / \sum_{m=1}^N K_{m,t+1}$$
(26)

In general, we have:

$$Q_{tot,t} = \sum_{n=1}^{N} s_{n,t+1} q_{n,t} + (\mu - 1) \sum_{n=1}^{N} s_{n,t+1} \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} \Pi_{n,t+k} (1 + g_{n,t+1,t+k}) \right].$$
(27)

Thus,  $Q_{tot,t}$  is the sum of two terms: a "total marginal q,"  $q_{tot,t} = \sum_{n=1}^{N} s_{n,t+1}q_{n,t}$ , and a term reflecting the rents generated by each type of capital. Unsurprisingly, in the presence of rents ( $\mu > 1$ ),  $Q_{tot,t}$  overstates  $q_{tot,t}$ , and does not provide a good measure of the incentive to invest.

However, even in the absence of rents ( $\mu = 1$ ), Total Q may not be a sufficient statistic for total net investment. The total net investment rate is given by:

$$g_{t,t+1} = \sum_{n=1}^{N} s_{n,t+1} \Psi_{n,t} \left( q_{n,t} - 1 \right),$$

In general,  $g_{t,t+1}$  depends on each marginal q separately; it is not a monotone function of their weighted average  $q_{tot,t}$ . Thus, even when  $\mu = 1$ , and  $Q_{tot,t} = q_{tot,t}$ , the latter need not be a good proxy for total net investment.

When is  $q_{tot,t}$  a sufficient statistic for total net investment? A first case is when adjustment costs are identical across types of capital goods,  $\Psi_{n,t} = \Psi_t$  and when the function  $\Psi_t$  is linear. In that the expression above simplifies to  $g_{n,t,t+1} = \Psi_t (q_{tot,t} - 1)$ , and total Q is indeed a sufficient statistic for total investment. Another case is if marginal q is equal across different types of capital. In this case,  $q_{tot,t} = q_{n,t}$ , and so  $g_{t,t+1} = \sum_{n=1}^{N} s_{n,t+1} \Psi_{n,t} (q_{tot,t} - 1)$ , so that  $q_{tot,t}$  is a sufficient statistic for investment.

When are is marginal q equalized across types of capital? The framework studied by Peters and Taylor (2017) is an example where this is the case. That framework considers cost functions belonging to a slightly more general class,  $C_1(K_{1,t}, K_{2,t})$  and  $C_2(K_{1,t}, K_{2,t})$ . They are not additively separable, as in this paper, but they nevertheless satisfy  $\frac{\partial (C_{1,t}+C_{2,t})}{\partial K_{1,t}} = \frac{\partial (C_{1,t}+C_{2,t})}{\partial K_{2,t}}$ . As discussed in Appendix I.C of Crouzet and Eberly (2019), for this class of cost functions, a necessary condition for  $q_{1,t} = q_{2,t}$  is intangible and physical capital are perfect substitutes, and also that they depreciate at the same rates and enter the capital aggregator with the same weights. In this sense, the conditions under which marginal q is equalized across types of capital, and thus under which  $Q_{tot,t}$  and  $q_{tot,t}$  are relevant to understanding the behavior of total net investment, are fairly specific.

In our model, the difference between marginal q for two types of capital is given by:

$$q_{n,t} - q_{m,t} = \sum_{k \ge 1} \mathbb{E}_t \left[ M_{t,t+k} (1 + g_{n,t,t+k}) \left\{ \Pi_{n,t+k} - \Pi_{m,t+k} - (\Phi_{n,t+k} - \Phi_{m,t+k}) \right\} \right].$$

Thus, a sufficient condition for equalized marginal qs is that (a)  $\Pi_{n,t} = \Pi_{m,t}$ , which, using Equation (7), implies that  $\partial K_{n,t}/\partial K_{m,t} = 1$ , or equivalently that capital types are perfect substitutes; and (b) adjustment costs are identical across capital types.

## A.1.4 An example with stochastic growth

**Result** Assume that the fundamentals process follows:

$$\frac{A_{t+1}}{A_t} = 1 + g_t = \begin{cases} 1 + g_{t-1} & \text{w.p. } 1 - \lambda \\ 1 + \tilde{g} & \text{w.p. } \lambda \end{cases}$$

Here,  $\tilde{g}$  is drawn, at time t, from a distribution F(.), which is time-invariant, and the draw is independent of past realizations of  $g_t$ . The investment gap for physical capital is then given by

$$G_{1,t} = \frac{\mu - 1}{r - \nu(g_t)} (r + \delta_1) + S + \frac{\mu - 1}{r - \nu(g_t)} (r + \delta_2) S.$$
(28)

The function  $\nu(g_t)$ , the expression of which is reported below, depends on the parameters  $\lambda$  and F(.). When  $\lambda = 0$ , the firm's growth rate is constant, and  $\nu(x) = x$ . When  $\lambda = 1$ , the growth rate of the firm is *i.i.d.* In this case, letting  $\bar{g} = \mathbb{E}[\tilde{g}], \nu(x)$  satisfies  $\frac{1}{r-\nu(x)} = \frac{1}{r-\bar{g}} \left(1 + \frac{x-\bar{g}}{1+r}\right)$ . The term  $\frac{1}{r-\nu(g_t)}$  is analogous to the standard Gordon growth formula, but the function  $\nu(.)$  adjusts for the possibility of future "regime changes" in firm-level growth. Moreover, when growth is i.i.d., these expressions extend to the case of convex adjustment costs, with similar change to those in equation (13). Thus, the key insights from the discussion in the main text survive. In particular, even with stochastic growth, the two rents terms can be thought of as the present value of markups over the user costs of physical and intangible capital, respectively.

**Derivations of the result** We use the following lemma, adapted from Abel and Eberly (2011).

Lemma 2. We have:

$$\mathbb{E}_t\left[\sum_{k\geq 0} (1+r)^{-k} \frac{A_{t+k}}{A_t}\right] = \frac{1+r+\lambda(1+g_t)\zeta^*}{r-g_t+\lambda(1+g_t)},$$

where:

$$\zeta^* = \mathbb{E}\left[\frac{1+r}{r-\tilde{g}+\lambda(1+\tilde{g})}\right] \mathbb{E}\left[\frac{r-\tilde{g}}{r-\tilde{g}+\lambda(1+\tilde{g})}\right]^{-1}.$$

*Proof.* Let:

$$\zeta(g_t) \equiv \mathbb{E}_t \left[ \sum_{k \ge 0} (1+r)^{-k} \frac{A_{t+k}}{A_t} \right],$$

then  $\zeta(g_t)$  satisfies:

$$\zeta(g_t) = 1 + \frac{1 + g_t}{1 + r} \left[ \lambda \zeta^* + (1 - \lambda) \zeta(g_t) \right],$$

where we used the law of iterated expectations, and the fact that  $\frac{A_{t+1}}{A_t} = 1 + g_t$  is known at time t. Here, we have denoted:

$$\zeta^* = \int_{\tilde{g}} \zeta(\tilde{g}) dF(\tilde{g}).$$

Solving for  $\zeta(g_t)$ , we obtain:

$$\zeta(g_t) = \frac{1 + r + \lambda(1 + g_t)\zeta^*}{r - g_t + \lambda(1 + g_t)}.$$

Taking expectations on both sides,

$$\zeta^* = \mathbb{E}\left[\frac{1+r+\lambda(1+\tilde{g})\zeta^*}{r-\tilde{g}+\lambda(1+\tilde{g})}\right].$$

Re-arranging,

$$\mathbb{E}\left[\frac{r-\tilde{g}}{r-\tilde{g}+\lambda(1+\tilde{g})}\right]\zeta^* = \mathbb{E}\left[\frac{1+r}{r-\tilde{g}+\lambda(1+\tilde{g})}\right],$$

which gives the result.

The necessary first-order conditions to the firm's problem (taking expectations at time t, and using the fact that  $A_{t+1}$  is known at t) are:

$$q_{n,t} = \frac{1}{1+r} \left( \frac{1}{\mu} A_t^{1-\frac{1}{\mu}} K_t^{\frac{1}{\mu}-1} \frac{\partial K_t}{\partial K_{n,t}} + 1 - \delta_n \right),$$
  

$$1 = q_{n,t}.$$

We can rewrite this as:

$$\mu(r+\delta_n) = A_t^{1-\frac{1}{\mu}} K_t^{\frac{1}{\mu}-1} \frac{\partial K_t}{\partial K_{n,t}}.$$
(29)

Tedious computation shows that these first-order conditions, in combination with the aggregator defining  $K_t$ , can be written as:

$$K_{1,t} = \left(\frac{r+\bar{\delta}}{r+\delta_1}\right)^{\frac{1}{1-\rho}} \eta^{\frac{1}{1-\rho}} \left[\mu(r+\bar{\delta})\right]^{-\frac{\mu}{\mu-1}} A_t,$$

$$K_{2,t} = \left(\frac{r+\bar{\delta}}{r+\delta_2}\right)^{\frac{1}{1-\rho}} (1-\eta)^{\frac{1}{1-\rho}} \left[\mu(r+\bar{\delta})\right]^{-\frac{\mu}{\mu-1}} A_t,$$

$$K_t = \left[\mu(r+\bar{\delta})\right]^{-\frac{\mu}{\mu-1}} A_t,$$
(1)

where  $r + \bar{\delta} \equiv \left(\eta^{\frac{1}{1-\rho}} (r+\delta_1)^{-\frac{\rho}{1-\rho}} + (1-\eta)^{\frac{1}{1-\rho}} (r+\delta_2)^{-\frac{\rho}{1-\rho}}\right)^{-\frac{1-\rho}{\rho}}$ . The expression for the value of the firm reported in the main text, (5), can then be written as:

$$\begin{split} V_t^e &= \sum_{n=1}^2 q_{n,t} K_{n,t+1} + (\mu - 1) \sum_{n=1}^2 \mathbb{E}_t \left[ \sum_{k \ge 1} (1+r)^{-k} \frac{1}{\mu} A_{t+k}^{1-\frac{1}{\mu}} K_{t+k}^{\frac{1}{\mu}-1} \frac{\partial K_{t+k}}{\partial K_{n,t+k}} K_{n,t+k} \right] \\ &= \sum_{n=1}^2 q_{n,t} K_{n,t+1} + (\mu - 1) \sum_{n=1}^2 \mathbb{E}_t \left[ \sum_{k \ge 1} (1+r)^{-k} (r+\delta_n) K_{n,t+k} \right] \\ &= \sum_{n=1}^2 q_{n,t} K_{n,t+1} + (\mu - 1) \sum_{n=1}^2 \alpha_n (r+\delta_n) \mathbb{E}_t \left[ \sum_{k \ge 1} (1+r)^{-k} A_{t+k} \right] \\ &= \sum_{n=1}^2 q_{n,t} K_{n,t+1} + (\mu - 1) \sum_{n=1}^2 \alpha_n (r+\delta_n) A_{t+1} \zeta(g_t) \\ &= \sum_{n=1}^2 q_{n,t} K_{n,t+1} + (\mu - 1) \sum_{n=1}^2 \frac{1}{r - \nu(g_t)} (r+\delta_n) \alpha_n A_{t+1} \\ &= \sum_{n=1}^2 q_{n,t} K_{n,t+1} + (\mu - 1) \sum_{n=1}^2 \frac{1}{r - \nu(g_t)} (r+\delta_n) K_{n,t+1}. \end{split}$$

Here, using conditions (29), we defined  $\alpha_1$  and  $\alpha_2$  such that  $K_{1,t} = \alpha_1 A_t$  and  $K_{2,t} = \alpha_2 A_t$ , and we used lemma 2. Additionally, by analogy with the case of constant growth rates, we define:

$$\zeta(g_t) = \frac{1+r}{r-\nu(g_t)},$$

or equivalently:

$$\nu(g_t) = g_t + \lambda(1+g_t) \frac{(r-g_t)\zeta^* - (1+r)}{(1+r) + \lambda(1+g_t)\zeta^*}.$$

# A.1.5 An example with variable labor

Consider the following model. A representative household chooses consumption,  $C_t$ , to solve:

$$U_t = \max \frac{(C_t)^{1-\sigma}}{1-\sigma} + \beta U_{t+1},$$
(30)

which implies the discount rate  $M_{t,t+1} = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}$ . Labor supply by the household is exogenous and fixed. Final goods are produced and sold by a perfectly competitive firm;

total final output is given by:

$$Y_t = \left(\int_0^1 Y_{j,t}^{\frac{1}{\tilde{\mu}}} dj\right)^{\tilde{\mu}},\tag{31}$$

with  $\tilde{\mu} > 1$ . This leads to the demand curve  $Y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\frac{\tilde{\mu}}{\tilde{\mu}-1}} Y_t$ , and a price index is given by  $P_t = \left(\int_0^1 P_{j,t}^{-\frac{1}{\tilde{\mu}-1}} dj\right)^{-(\tilde{\mu}-1)}$ . Each firm j produces an intermediate variety, with a production function taking labor and total capital as inputs:

$$Y_{j,t} = Z_{j,t} K_{j,t}^{\alpha} L_{j,t}^{1-\alpha},$$
(32)

where total capital is an aggregate of physical and intangible capital, as described in the main text. Here,  $Z_{j,t}$  is an exogenous process capturing firm-level or aggregate total factor productivity. Finally, the goods market clears:

$$P_t Y_t = P_t C_t + \sum_{n=1}^2 \int_0^1 \Phi\left(\frac{K_{n,j,t+1}}{K_{n,j,t}}\right) K_{n,j,t} dj.$$
 (33)

In this model, labor is flexible in the short-run, so each firm solves:

$$\Pi_{j,t} = \max \quad P_{j,t} \left(\frac{P_{j,t}}{P_t}\right)^{-\frac{\tilde{\mu}}{\tilde{\mu}-1}} Y_t - W_t L_{j,t}.$$

After some computation, the solution to this problem can be written as:

$$\Pi_{j,t} = A_{j,t}^{\frac{1}{\mu} - 1} K_{j,t}^{\frac{1}{\mu}}$$

where:

$$\mu = 1 + \frac{\tilde{\mu} - 1}{\alpha},$$

and:

$$A_{j,t} = (\alpha + \tilde{\mu} - 1)^{1 + \frac{\alpha}{\tilde{\mu} - 1}} \tilde{\mu}^{-\frac{\tilde{\mu}}{\tilde{\mu} - 1}} (1 - \alpha)^{\frac{1 - \alpha}{\tilde{\mu} - 1}} D_t W_t^{-\frac{1 - \alpha}{\tilde{\mu} - 1}} Z_{j,t}^{\frac{1}{\tilde{\mu} - 1}},$$
$$D_t \equiv P_t^{\frac{\tilde{\mu}}{\tilde{\mu} - 1}} Y_t.$$

This example thus leads to a representation of the profit function that is the same as the one studied in the model of Section (2.3). More generally, firms in this model solve a particular case of the general model of Section 2.1. We use this model to discuss the implications of our findings for the labor share in Internet Appendix (IA.1).

# A.2 Data sources and data construction

## A.2.1 National accounts and fixed asset tables

**Baseline** We use the following time series from NIPA, all for the non-financial corporate business sector (NFCB): NFCB gross value added ( $Y^{(BEA)}$ ) (FRED series A455RC1Q027SBEA), NFCB compensation of employees ( $WN^{(BEA)}$ ) (FRED series A460RC1Q027SBEA), NFCB taxes on production less subsidies ( $T^{(BEA)}$ ) (FRED series W325RC1Q027SBEA), NFCB transfers ( $Tr^{(BEA)}$ ) (FRED series W325RC1Q027SBEA). The data are annual. We use them to compute the surplus of the NFCB sector as:

$$\Pi^{(BEA)} = Y^{(BEA)} - WN^{(BEA)} - T^{(BEA)} - Tr^{(BEA)}$$

and to compute the labor share of the NFCB sector as:

$$LS = WN^{(BEA)} / (Y^{(BEA)} - T^{(BEA)} - Tr^{(BEA)})$$

We use the labor share only to translate our estimates of the model parameter governing rents,  $\mu$ , into the share of rents as a fraction of value added. Additionally, we obtain current cost measures of the capital stock for the NFCB sector from the BEA fixed asset tables. We extract  $K_{struct}^{(BEA)}$ ,  $K_{equip}^{(BEA)}$  and  $K_{intan}^{(BEA)}$ , from BEA table 4.1; in particular, we define  $K_{intan}^{(BEA)}$  as the stock of intellectual property products.<sup>34</sup> We then define:

$$K_1^{(BEA)} = K_{struct}^{(BEA)} + K_{equip}^{(BEA)}, \quad K_2^{(BEA)} = K_{intan}^{(BEA)}.$$

We use table 4.7 to obtain measures of current investment for the NFCB sector, and we define  $I_1^{(BEA)}$  and  $I_2^{(BEA)}$  analogously to  $K_1^{(BEA)}$  and  $K_2^{(BEA)}$ . Note that all time series from tables 4.1 and 4.7 are expressed in current dollar values; we only use them in the computation of ratios. We use table 4.2 to obtain the chain-type quantity index for total non-residential capital for the NFCB sector; we measure  $g_t$  as the annual growth rate in this quantity index. Finally, in Appendix Figure A3, we also report the ratios of historical-cost depreciation rates over current cost measures of the capital stock, for physical and intangible capital separately; depreciation costs obtained from BEA fixed asset table 4.6.

**Residential assets** Our baseline approach only includes non-residential fixed assets. As a robustness check, we obtained residential fixed assets  $K_{resid}^{(BEA)}$  as the difference between the sum of the three capital stocks above, and total fixed assets of NFCB sector report in BEA

<sup>&</sup>lt;sup>34</sup>The tables are available at https://apps.bea.gov/iTable/iTable.cfm?ReqID=10&step=2.

fixed asset table 6.1, and likewise for investment. The top panel of Figure A2 reports time series for the ratio  $\Pi^{(BEA)}/K^{(BEA)}$ . The solid red and solid orange line use  $\Pi^{(BEA)}$  as the numerator, and for the total capital stock, either  $K = K_{struct}^{(BEA)} + K_{equip}^{(BEA)} + K_{intan}^{(BEA)}$  (as in our baseline analysis), or  $K = K_{struct}^{(BEA)} + K_{equip}^{(BEA)} + K_{intan}^{(BEA)} + K_{resid}^{(BEA)}$ . The two lines are almost identical. The stock of residential fixed assets in the NFCB sector thus appears to be low relative to other types of fixed assets owned by the NFCB sector, and so we abstract from it in our analysis.

Economy-wide vs. NFCB measures Finally, Figure A2 also compares our measures of  $\Pi/K$  with those reported by Farhi and Gourio (2018), who study economy-wide trends, instead of the NFCB sector specifically. The rate of return on capital measured by these authors is substantially lower than our measures of rates of return for the NFCB sector (by about 5-7% throughout the sample.) Here, we briefly discuss why this is the case, as it matters for inferences about the importance of rents. These authors compute  $\Pi/K$  as:

$$\Pi/K = \left[ (Y^{(BEA)} - WN^{(BEA)} - T^{(BEA)} - Tr^{(BEA)}) / (Y^{(BEA)} - T^{(BEA)} - Tr^{(BEA)}) \right] \times Y/K,$$

where Y is total nominal GDP (including other sectors than the NFCB) and K is the total private capital stock (at replacement cost). This adjustment is made in order to maintain comparability with other ratios in their analysis, which has a broader scope than the NFCB. By contrast, our measures of  $\Pi/K$  are:

$$\Pi/K = \left[ (Y^{(BEA)} - WN^{(BEA)} - T^{(BEA)} - Tr^{(BEA)}) / (Y^{(BEA)} - T^{(BEA)} - Tr^{(BEA)}) \right] \times (Y^{(BEA)} - T^{(BEA)} - Tr^{(BEA)}) / K^{(BEA)}.$$

Thus the differences between our measures of  $\Pi/K$  and the measures in Farhi and Gourio (2018) must be due to differences in the ratio of value added to capital between the NFCB sector and the economy as a whole. The bottom panel of Figure A2 indeed shows that the NFCB sector has a substantially higher dollar of value added per dollar of capital at current cost. The most accurate comparison is between the crossed blue line of the bottom panel, and the orange solid line, which measures K for the NFCB sector as the sum of all types of capital (residential, non-residential physical, and non-residential intangible): the value added to capital ratio is approximately 10 percentage points higher in the NFCB sector versus the economy as a whole.

## A.2.2 Compustat non-financial

**Sample selection** We use the annual version of the Compustat-CRSP merged files. We apply the standard screens (indfmt=INDL, popsrc=D, consol=C, datafmt=STD). We keep firm-year observations that satisfy the following criteria: fic=USA (domestically incorporated), 2-digit SIC code (first two digits of the variable sic) not equal to 49 (utilities), not between 60 and 69 (finance and real estate), and not between 90 to 99 (public administration); 2-digit SIC code not missing; variable sale (sales) and at (assets) not missing; variables emp, sale, at, act, lct, ppent, ppegt, che, and gdwl not negative. Finally, we drop any observation which we can identify as an American Depository Institution (ADR). We use only data from 1974 onward (included), as the data prior to 1974 has incomplete coverage (a jump in the number of firms in the sample occurs from 1973 to 1974.)

Variable construction For each firm, we start by constructing six time series in levels,  $\{K_{1,t}, I_{1,t}, K_{2,t}, I_{2,t}, \Pi_t, V_t\}$ . For physical capital investment, we use capital expenditures (capx) net of sales of property, plant and equipment (sppe); we measure the stock using gross property, plant and equipment (ppegt), for reasons discussed below. We consider two definitions of intangibles: R&D capital, and organization capital. For R&D, we use reported R&D expenditure (xrd), recoding missing values with 0. For investment in organization capital, we follow Eisfeldt and Papanikolaou (2013) and use 30% of SG&A expenditures (variable xsga) net of R&D investment. For the stock of both R&D and organization capital, we used the capitalized values provided by Peters and Taylor (2017). A limitation of this approach is that it does not allow for either rates of depreciation, or for the imputation of investment in organization capital, to vary across industries. This can be done for R&D capital by using the industry-level depreciation rate produced by the BEA for the fixed asset tables, as in Belo et al. (2018). No similar data source exists for organization capital, however. For  $\Pi_t$ , we use the Compustat variable oibdp. We add estimates of intangible investment expenditures to actual measures of operating income in order to obtain an adjusted operating surplus measure consistent with our model. For  $V_t$ , we use the sum of the market value of common stock and the book value of debt, net of cash and liquid securities. We then take the sum of these time series across firms either by year (when studying all publicly traded firms jointly), or by year and sector (when constructing the sectoral investment gaps.) Finally, we construct the growth rate of total capital at either the aggregate or sectoral level by subtracting from the growth rate of  $K_{1,t} + K_{2,t}$  the deflator implicitly used in Section 3, that is, the difference between nominal and real growth rates of total non-residential fixed assets for the NFCB sector. Internet Appendix IA.2 discusses in more detail the comparison between Compustat non-financial and the Flow of Funds and BEA data used in Section 3.

		<b>Compustat non-financials</b> (Intangibles = $R\&D$ + organization capital)							
		Consumer Hig		High	;h-tech He		chcare	Manufacturing	
	Targeted moments	1985	2001	1985	2001	1985	2001	1985	2001
	Turgetted moments	2000	2017	2000	2017	2000	2017	2000	2017
$i_1$	Physical investment rate	0.128	0.098	0.139	0.101	0.105	0.082	0.093	0.093
$i_2$	Intangible investment rate	0.278	0.261	0.302	0.292	0.235	0.196	0.222	0.226
S	Intangible/physical capital	0.799	0.813	0.541	0.548	0.729	1.171	0.267	0.087
$ROA_1$	Return on physical capital	0.489	0.485	0.443	0.478	0.448	0.588	0.262	0.222
$Q_1$	Av. Q for physical capital	2.672	2.651	2.937	3.261	3.064	4.306	1.743	1.743
g	Growth rate of total capital stock	0.054	0.037	0.065	0.014	0.046	0.028	0.016	0.028
	Implied moments	1985	2001	1985	2001	1985	2001	1985	2001
	implied memorie	2000	2017	2000	2017	2000	2017	2000	2017
$Q_1 - q_1$	Investment gap	1.523	1.645	1.634	2.424	1.908	3.329	0.367	0.687
	% rents from physical capital	9	14	13	32	13	18	-21	35
	% intangibles	77	63	73	29	67	45	132	48
	% rents from intangibles	14	23	14	39	20	38	-11	17
η	Intangible share in production	0.606	0.627	0.507	0.546	0.580	0.683	0.373	0.333
s	Rents as a fraction of value added	0.011	0.027	0.019	0.073	0.026	0.065	-0.009	0.027
$R_1$	User cost of physical capital	0.185	0.167	0.197	0.174	0.171	0.150	0.173	0.158
$R_2$	User cost of intangible capital	0.354	0.346	0.384	0.378	0.323	0.278	0.321	0.300
$\mu$	Curvature of operating profit function	1.040	1.086	1.075	1.273	1.103	1.240	0.977	1.088
$ ilde{\mu}$	Markup over value added	1.011	1.028	1.020	1.079	1.027	1.070	0.992	1.028

Table A1: Summary of targeted and implied moments for the different sectors of the Compustat non-financial sample. All columns measure intangibles as the sum of the R&D capital stock and the organization capital stock. The moments are averages over the subperiod indicated in each column. The intangible share in production is estimated under the assumption that physical and intangible capital are Cobb-Douglas substitutes:  $K_t = K_{1,t}^{1-\eta} K_{2,t}^{\eta}$ . Rents as a fraction of value added are computed as  $s = (1 - s_L)(1 - 1/\mu)$ , where  $s_L$  is the labor share of value added for the NFCB sector. Markups over value added are computed as  $\tilde{\mu} = 1/(1 - s)$ . The implied moments reported are for the model with adjustment costs; the adjustment cost values are  $\gamma_1 = 3$  and  $\gamma_2 = 12$ . In the decomposition of the investment gap, percentages may not add up due to rounding. Data sources and construction are described in Section 4 and Appendix A.2.



Figure A1: Time series for the moments used in the construction of the physical investment gap decomposition, Equation (15). Returns to physical capital are defined as  $\Pi_t/K_{1,t}$ , where  $\Pi_t$  is operating surplus and  $K_{1,t}$  the stock of physical capital at current cost. Investment rates are defined as  $i_{n,t} = I_{n,t}/K_{n,t}$ , n = 1, 2, where n = 1 indexes physical capital and n = 2 indexes intangible capital,  $K_{2,t}$  is the stock of intangible capital at current cost, and  $I_{n,t}$  are investment expenditures for each type of capital. The ratio of intangible to physical capital is  $S_t = K_{2,t}/K_{1,t}$ . Average Tobin's Q of physical capital is defined as  $Q_{1,t} = V_t/K_{1,t}$ , where  $V_t$  is an estimate of the total market value of net claims on the sector. The time series are the raw data; in particular, they are not averaged over seven-year windows. Data sources are described in Section 3 and in Appendix A.2.



Figure A2: Comparison between alternative measures of  $\Pi_t/(K_{1,t} + K_{2,t})$  (surplus per unit of total capital) and  $Y_t/(K_{1,t} + K_{2,t})$  (value added per unit of capital) in BEA data. The construction of each time series is discussed in Appendix A.2.1. The blue line reproduces the measures of  $\Pi/K$  and Y/K used in Farhi and Gourio (2018), which differ from our measures primarily because we focus only on the NFCB sector, as discussed in Appendix A.2.1.



Figure A3: Implied moments for the NFCB sector. Panels (a) and (b) reports implied depreciation rates, computed as  $\delta_i = R_i - r - \gamma_i rg$ , i = 1, 2. Additionally, the panels report depreciation as a fraction of the stock of capital, from the BEA fixed asset tables. Panel (c) reports the discount rate implied by our approach, computed as r = (r - g) + g, where g is the real growth rate of the capital stock. Also reported in panel (c) is a measure of the risk-free real interest rate, equal to the interest rate on ten-year Treasury constant maturity rate minus the growth rate of the GDP deflator prior to 2003, and the interest rate on the ten-year Treasury inflation-index security after 2003. Finally, panel (d) reports the model-implied PD ratio, along with the PD ratio estimated for the S&P500, adjusting or not for leverage. None of the data moments reported in this graph are used in the construction of the investment gap. Methodology and data sources are described in Section 3 and Appendix A.2.

(a) Average Tobin's Q for physical capital,  $Q_1$ 



Figure A4: Additional data sources used in the robustness checks for the non-financial corporate (NFCB) sector. The top panel reports our baseline measure of average Tobin's Q for physical capital,  $Q_1$  (black line), and an alternative measure based on Hall (2001). The difference between the two is that our baseline measure only nets out financial assets identified as liquid in the Flow of Funds in the computation of the net value of claims on the NFCB sector. The bottom panel reports two measures of the PD ratio for the NFCB sector, both using the cum- and ex-dividend returns on the S&P500. The grey squared line does not adjust for leverage, and the black line adjusts for leverage, using data from the Flow of Funds on the NCFB sector. Data sources and methodology for the construction of the empirical price-dividend ratio measures are reported in Appendix A.2.



Figure A5: Robustness: adjustment costs. Each panel reports a moment from the investment gap decomposition, Equation (15), for the NFCB sector, for different combinations of adjustment costs for physical and intangible capital. In each panel, a point corresponds to a particular combination for  $(\gamma_1, \gamma_2)$ , and the color corresponds to the value of the moments, with the correspondence reported on the right axis. Panel (a) reports the change in  $Q_1 - q_1$  from 1985 to 2015; in our baseline results, this moment is equal to 1.30. Panel (b) reports the contribution of intangibles to  $Q_1 - q_1$  in 2015; in our baseline results, this moment is equal to 0.39 (or 39%). Panel (c) reports the implied intangible share in production in 2015; in our baseline results, this moment is equal to 0.29. Panel (d) reports rents as a share of value added in 2015; in our baseline moment is equal to 0.063. Our baseline results use  $\gamma_1 = 3$  and  $\gamma_2 = 12$ . Methodology and data sources are described in Section 3.





Figure A6: Robustness: the investment gap  $Q_1 - q_1$  for physical capital in the non-financial corporate (NFCB) sector when using the Hall (2001) measure of Tobin's average Q for physical assets. The top panel reports results when we assume zero adjustment costs in intangible and physical capital ( $\gamma_1 = \gamma_2 = 0$ ); the bottom panel reports results when we assume  $\gamma_1 = 3$  and  $\gamma_2 = 12$ . The series for  $Q_1$  from Hall (2001) is reported in panel (a) of Figure A4. Methodology and data sources are described in Section 3.

#### (a) Zero adjustment costs



(b) Positive adjustment costs



Figure A7: Robustness: the investment gap  $Q_1 - q_1$  for physical capital in the non-financial corporate (NFCB) sector when targeting the PD ratio, instead of Tobin's average Q for physical assets. The top panel reports results when we assume zero adjustment costs in intangible and physical capital ( $\gamma_1 = \gamma_2 = 0$ ); the bottom panel reports results when we assume  $\gamma_1 = 3$  and  $\gamma_2 = 12$ . The series used for the PD ratio is the based on cum- and ex-dividend returns for the S&P500, and adjusted for leverage; it is reported in panel (b) of Figure A4. Methodology and data sources for constructing the decomposition are described in Section 3, and methodology and data sources for the construction of the empirical price-dividend ratio measure are reported in Appendix A.2.



Figure A8: Time series moments for Compustat Non-Financial (NF), all sectors (aggregated). The corresponding time series moments for the aggregate non-financial corporate business (NFCB) sector are also reported, for comparison. All variables are defined as in Figure A1. Data sources for the NFCB sector are described in Section 3 and Appendix A.2. Data sources for Compustat NF are described in Section 4 and Appendix A.2.

(a) Intangibles = R&D



(b) Intangibles = R&D + organization capital



Figure A9: The investment gap  $Q_1 - q_1$  for physical capital in the Computat Non-Financial (NF) sample. In this figure, data from all sectors is pooled and aggregated. The top panel reports results when only R&D is used to measure intangibles. The bottom panel reports results when both R&D and organization capital are used to measure intangibles, where organization capital is measured as in Eisfeldt and Papanikolaou (2013). We use the version of model with adjustment costs  $\gamma_1 = 3$  and  $\gamma_2 = 12$ , in order to construct the components of the investment gap. Methodology and data sources are described in Section 4.



Figure A10: Other model moments for the Compustat Non-Financial (NF) sample. Panel (a) reports the share of intangibles in production,  $\eta$ , when the capital aggregator is assumed to be Cobb-Douglas:  $K_t = K_{1,t}^{1-\eta} K_{2,t}^{\eta}$ . Panel (b) reports rents as a fraction of value added,  $s_{VA}$ , which is given by  $s_{VA} = (1 - s_L)(1 - 1/\mu)$ , where  $\mu$  is the model parameter governing the size of rents, and  $s_L$  is labor's share of value added. Panels (c) and (d) report user costs for each type of capital,  $R_1$  and  $R_2$ . We use the version of model with adjustment costs  $\gamma_1 = 3$  and  $\gamma_2 = 12$ , in order to construct the components of the investment gap. Methodology and data sources are described in Section 4.



Figure A11: The investment gap  $Q_1 - q_1$  for physical capital across sectors, using the sum of R&D and organization capital to measure intangibles. Data is from the Computat Non-Financial (NF) sample. We use the version of model with adjustment costs  $\gamma_1 = 3$  and  $\gamma_2 = 12$ , in order to construct the components of the investment gap. Methodology and data sources are described in Section 4.

# Internet appendix

# IA.1 Implied markups and the labor share

In the model with labor, described in appendix A.1.5, labor demand is given by:

$$P_{j,t} = \tilde{\mu}MC_{j,t}$$

$$MC_{j,t} = (1-\alpha)^{-\frac{(1-\alpha)(\tilde{\mu}-1)}{\tilde{\mu}-1+\alpha}}\tilde{\mu}^{-\frac{\alpha\tilde{\mu}}{\tilde{\mu}-1+\alpha}}D_{t}^{\frac{\alpha(\tilde{\mu}-1)}{\alpha+\tilde{\mu}-1}}W_{t}^{\frac{(1-\alpha)(\tilde{\mu}-1)}{\tilde{\mu}-1+\alpha}}Z_{j}^{-\frac{\tilde{\mu}-1}{\tilde{\mu}-1+\alpha}}K_{j,t}^{-\frac{(\tilde{\mu}-1)\alpha}{\tilde{\mu}-1+\alpha}}$$

$$L_{j,t} = \left(\frac{(1-\alpha)MC_{j,t}Z_{j}}{W_{t}}\right)^{\frac{1}{\alpha}}K_{j,t}$$

where:

$$MC_{j,t} = (1-\alpha)^{-\frac{(1-\alpha)(\tilde{\mu}-1)}{\tilde{\mu}-1+\alpha}} \tilde{\mu}^{-\frac{\alpha\tilde{\mu}}{\tilde{\mu}-1+\alpha}} D_t^{\frac{\alpha(\tilde{\mu}-1)}{\alpha+\tilde{\mu}-1}} W_t^{\frac{(1-\alpha)(\tilde{\mu}-1)}{\tilde{\mu}-1+\alpha}} Z_j^{-\frac{\tilde{\mu}-1}{\tilde{\mu}-1+\alpha}} K_{j,t}^{-\frac{(\tilde{\mu}-1)\alpha}{\tilde{\mu}-1+\alpha}}$$

Since prices are given by:  $P_{j,t} = \tilde{\mu}MC_{j,t}$ , the labor demand curve implies that:

$$LS \equiv \frac{W_t L_{j,t}}{P_{j,t} Y_t} = \frac{1 - \alpha}{\tilde{\mu}}.$$

In order to map this model to the data on labor shares, a first approach consists in deriving  $\mu$ , our rents parameter (which is, more specifically, the firm's markup over its operating surplus), from data on return on assets and user costs, as in our baseline, and then use LS, the labor share of value added, to recover the corresponding value of  $\tilde{\mu}$ , the markup over value added. Specifically:

$$\tilde{\mu} = \alpha(\mu - 1) + 1 = (1 - \tilde{\mu}LS)(\mu - 1) + 1,$$

and so, solving for the markup for value added:

$$\tilde{\mu} = \frac{\mu}{\mu LS + (1 - LS)}$$

However, this approach implicitly assumes that  $1 - \alpha$ , the Cobb-Douglas exponent for labor in the production function, is varying over time, at least to the extent that the labor share varise. Specifically, our procedure also implies that  $1 - \alpha = \mu LS / (\mu LS + (1 - LS))$ . The top panel of figure IA1 shows the implied value for  $1 - \alpha$  in our baseline exercise. The mean is approximately 0.72. Moreover, the implied value declines from 0.74 to 0.70 during the 2000's, along with the decline in LS.

An alternative approach is to fix the Cobb-Douglas labor exponent. In that case, we do not require data on the labor share to obtain the valued-added markup  $\tilde{\mu}$  implied by our estimate of the rents parameter  $\mu$ ; it can simply be obtained from  $\tilde{\mu} = \alpha(\mu - 1) + 1$ . This value-added markup (not reported) it virtually indistinguishable from the markup implied by the first approach described above. Additionally, approach produces an implied labor share that is given by  $LS = (1 - \alpha)/\tilde{\mu}$ . The bottom panel of figure IA1 reports the path of this implied labor share, and compares it to the data. The magnitude of the decline in the implied labor is similar to its empirical counterpart, but the timing is somewhat different. The reason is that the rents parameter  $\mu$  starts rising in the mid-80's, along with the rise in the investment gap, whereas the labor share only starts declining in the late 2000's.

# IA.2 National accounts data vs. Compustat data

There are two potentially important differences between the data used in Section 3 and the Compustat data. First, Compsutat only includes publicly traded corporations. There may be systematic differences in returns to capital and intangible intensity between privately held and publicly traded corporations. Second, the measurement of the stock of physical capital differs across sources. We next discuss these differences in more detail.

In Compustat, our baseline measure of surplus as the sum of ebitda across all observations in our sample. (Missing observations are thus treated as zeros.) We use ebitda because it is the financial statement measure most closely related to our model definition of II; it measures of operating income before depreciation, and does not deduct costs of capital, or non-operating income, which our model does not capture.<sup>35</sup> The top right panel of figure IA2 report the NFCB sector surplus measured in this manner in Compustat, and the measure from the BEA tables. The two are highly correlated, but their levels differs substantially. This reflects the fact that the BEA NFCB sector data also includes private firms. The surplus of public firms (from Compustat) represents about two thirds of the total surplus of the NFCB sector (from the BEA).

The main difficulty in the Compustat data is in computing estimates of the current-cost total stock of physical capital. A natural definition would seem to be net property, plant and equipment (variable ppent). However, measuring  $K_1$  for the NFCB sector in Compsutat leads to extremely elevated measures of  $\Pi/K_1$ , as reported in the bottom right panel of figure IA2. These measures are almost double the BEA-derived measures. This is primarily because the aggregate value of ppent in Compustat is only about a third of physical capital

<sup>&</sup>lt;sup>35</sup>The inclusion of non-operating income makes little difference to the results.

in the NFCB sector according to BEA data (top left panel of figure IA2). The reason for this gap are unclear. One hypothesis is that the surplus of Compustat firms includes income from foreign subsidiaries, and so could overestimate the true surplus of public NFCB firms. Althernatively, it could be that private firms indeed have much lower rates of return on physical capital than public firms do (though the gap would have to be very large, given the relative importance of public firms in total surplus, as indicated in the top right panel of figure IA2). The more likely reason is that the accounting treatment of depreciation may lead the (balance sheet) net stock to underestimate the true current cost stock of physical assets. The red line in the top left and bottom left panels of figure IA2 instead report measures of asset returns using aggregate gross property, plant and equipment at historical cost (deflated using the implicit deflator from the BEA fixed tables). The bottom left panel shows that this estimate of  $K_1$  leads to values of  $\Pi/K_1$  that align more closely (in levels) with those provided by the BEA data on the NFCB. In what follows, in order to align our BEA and Compustat profitability moments as closely as possible, we therefore use gross property, plant and equipment as our main measure of  $K_1$  in Compustat data.

We measure (gross) investment in physical capital in Compustat using capital expenditures (variable capx) minus sales of property, plant and equipment (variable sppe). Figure IA3, top panel, shows that physical investment, computed in this manner, accounts for about two thirds of total physical investment in the BEA NFCB sector ( $I_1^{(BEA)}$ , with closely related cyclical movements. For investment rates (the bottom panel of figure IA3), the data again suggest a much higher investment rate in Compsutat when  $K_1$  is measured using net book values, but investment rates are closer in levels when the capital stock is measured using gross book values.

# IA.3 More information on sectoral data

Tables IA1 and IA2 report the details of the sectoral classification used in the analysis of Section 4.3. Figures IA4 to IA7 report the raw time series for the moments used to construct the decomposition in each of the four sectors studied in Section 4.3.

Sector	$\mathbf{Subsector}$	BEA	KLEMS/BLS	NAICS
	Betail Trade	44RT	44	44
	Wholesale Trade	4200	42	42
Consumer	Crop & Animal Production (Farms)	110C	111 to 112	111 to 112
	Computer and Electronic Products	3340	334	334
	Publishing industries, except internet (includes software)	5110	511	511
	Computer Systems Design and Related Services	5415	5415	5415
High-tech	Data processing, internet publishing, and other information services	5140	518 to 519	518 to 519
	Broadcasting and telecommunications	5130	515 to 517	515 to 517
	Motion picture and sound recording industries	5120	512	512
	Ambulatory Health Care Services	6210	621	621
	Chemical Products	3250	325	325
Healthcare	Hospitals and Nursing and Residential Care Facilities	622H and 6230	622 to 623	622 to 623
	Miscellaneous Manufacturing	3390	339	339
	Transportation Equipment	336M and 336O	336	336
	Food and Beverage and Tobacco	311A	311 to 312	311 to 312
	Froducts Fabricated Metal Products	3320	339	339
	Machinery	3330	333	332
	Petroleum and Coal Products	3240	324	324
	Plastics and Rubber Products	3260	326	326
	Paper Products	3220	322	322
	Electrical Equipment, Appliances, and Components	3350	335	335
	Nonmetallic Mineral Products	3270	327	327
Manufacturing	Primary Metal Products	3310	331	331
	Printing and Related Support Activities	3230	323	323
	Furniture and Related Products	3370	337	337
	Wood Products	3210	321	321
	Textile Mills and Textile Product Mills	313T	313 to 314	313 to 314
	Apparel and Leather and Applied Products	315A	315 to 316	315 to 316
	Oil and Gas Extraction	2110	211	211
	Mining, except Oil and Gas	2120	212	212
	Support Activities for Mining	2130	213	213
	Utilities	2200	22	221
	Miscellaneous Professional, Scientific, and Technical Services	5412	5412 to 5414, 5416 to 5419	5412 to 5414, 5416 to 5419
	Administrative and Support Services	5610	561	561
	Other services except Government	8100	81	81
	Food Services and Drinking Places	7220	722	722
	Accommodation	7210	721	721
	Amusements, Gambling, and Recreation Industries	7130	713	713
	Waste Management and Remediation Services	5620	562	562
	Educational Services	6100	61	61
Other	Construction	2300	23	23
	Truck Transportation	4840	484	484
	Other Transportation and Support Activities	487S	487 to 488, 492	487 to 488
	Air Transportation	4810	481	481
	Rail Transportation	4820	482	482
	Pipeline Transportation	4860	486	486
	Water Transportation	4830	483	483

 Table IA1:
 Industry classification used in the sectoral analysis of Section 4.

Subsector	BEA	KLEMS/BLS	NAICS	Reason for excluding
Real Estate	5310	531	531	FIRE
Rental and Leasing Services and Lessors of Intangible Assets	5320	532 to 533	532 to 533	FIRE
Federal Reserve Banks, Credit Intermediation, and Related Activities	5210 and $5220$	521 to 522	521 to 522	FIRE
Insurance Carriers and Related Activities	5240	524	524	FIRE
Securities, Commodity Contracts, and Investments	5230	523	523	FIRE
Funds, trusts, and other financial vehicles	5250	525	525	FIRE
Forestry, Fishing, and Related Activities		113 to 115	113 to 115	Not enough Compustat observations
Transit and ground passenger transportation	4850	485	485	Not enough Compustat observations
Warehousing and storage	4930	493	493	Not enough Compustat observations
Legal services	5411	5411	5411	Not enough Compustat observations
Management of companies and enterprises	5500	55	55	Not enough Compustat observations
Social assistance	6240	624	624	Not enough Compustat observations
Performing arts, spectator sports, museums, and related activities	711A	711 to 712	711 to 712	Not enough Compustat observations

**Table IA2:** Industries excluded from the sectoral analysis of Section 4.



Figure IA1: Cobb-Douglas exponent on labor and labor share implied by two alternative approaches. The top panel reports the value of the Cobb-Douglas exponent on labor,  $1 - \alpha$ , obtained when using the model described in appendix A.1.5 and matching the labor share. The bottom panel reports the labor share obtained by fixing the parameter  $\alpha$  to 0.3 and inferring markups from user cost data.



Figure IA2: Measures of the total physical capital stock at current cost  $(K_1)$ , of surplus  $(\Pi)$ , and of the ratio of surplus to capital  $(\Pi/K_1)$  in BEA and Compustat data. All nominal data are deflated using the CPI with base 2009. Differences between the series are discussed in appendix A.2.



**Figure IA3:** Measures of the dollar value of investment in the NFCB sector (top panel), and of the investment rate (bottom panel). Dashed lines are measures obtained using BEA data, while solide lines are measures obtained using Compustat data. Differences between the series are discussed in appendix A.2.



--- Consumer sector, intangibles = R&D

Consumer sector, intangibles = R&D + organization capital

Figure IA4: Time series moments for the Consumer sector, in the Compustat non-financials sample. All variables are defined as in Figure A1. Data sources for Compustat NF are described in Section 4 and Appendix A.2. The sectoral classification is described in Appendix Tables IA1 and IA2.

9



--- High-tech sector, intangibles = R&D

High-tech sector, intangibles = R&D + organization capital

Figure IA5: Time series moments for the High-tech sector, in the Compustat non-financials sample. All variables are defined as in Figure A1. Data sources for Compustat NF are described in Section 4 and Appendix A.2. The sectoral classification is described in Appendix Tables IA1 and IA2.



--- Healthcare sector, intangibles = R&D

Healthcare sector, intangibles = R&D + organization capital

Figure IA6: Time series moments for the Healthcare sector, in the Compustat non-financials sample. All variables are defined as in Figure A1. Data sources for Compustat NF are described in Section 4 and Appendix A.2. The sectoral classification is described in Appendix Tables IA1 and IA2.

11



--- Manufacturing sector, intangibles = R&D

Manufacturing sector, intangibles = R&D + organization capital

Figure IA7: Time series moments for the Manufacturing sector, in the Compustat non-financials sample. All variables are defined as in Figure A1. Data sources for Compustat NF are described in Section 4 and Appendix A.2. The sectoral classification is described in Appendix Tables IA1 and IA2.

12