Investment Hollowing Out

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Abstract

Investment in physical capital collapsed during the Great Recession, and while growth subsequently resumed, the capital stock remains below trend (Hall 2014). We explore firm-level data on investment and document that investment fell relative to fundamentals at the turn of the millenium - well before the Great Recession. This downturn in investment coincides with a shift in employment toward services and cognitive skills - the "polarization" described by Autor, Katz, and Kearney (2006), as a possible consequence of off-shoring and automation. An analogous sorting of firms into industries shows a shift of investment toward spatially "grounded" industries, such as energy and telecommunications, from which capital cannot be relocated. Investment shifts away from production sectors, such as manufacturing, which can be relocated. While high tech firms grow in number and value, this growth is associated with a flat share of capital investment. For these sectors, we document a shift toward intangible, rather than physical, capital. The "hollowing out" of investment, like labor, carves out manufacturing and production sectors, leaving grounded industries that are less susceptible to off-shoring and cognitively-intensive industries that substitute toward intangible, rather than fixed, capital.

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1 Introduction and related literature

Weakness in fixed investment has been a persistent and puzzling feature of the US recovery from the financial crisis. GDP slowly returned to modest growth of 2 to 2.5 percent, but fixed investment was slower to recover and has so far not restored the capital accumulation foregone during the financial crisis (Hall 2014). Typical explanations for this weakness seem not to apply during the recovery period. Interest rates were exceptionally low and corporate profits were at record-high levels. The recovery in equity values suggested a high value of capital-in-place. These facts represent a challenge to both q-theory and cash flow-based approaches to investment. The remaining conventional explanation is weak expected future cash flows, though this explanation needs to be squared with q-theory and high equity values. It does however point in the direction of looking at firm performance and expected performance as an explanation for weak US investment.

We examine this puzzle by looking at firm-level data on investment, and in particular at the cross section distribution of investment across firms, in addition to the time series. Our initial evaluation of the data suggests that investment fell well before the Great Recession, and as is the case for employment, the distribution of investment across firms has changed starting around 2000.

Hall (2014) provides an assessment of the role of investment in the downturn and the recovery by examining the sources of the shortfall in U.S. output relative to trend. Hall finds that output was 13.2 percent below trend in 2013, and the shortfall in business capital accounted for the largest portion - 3.9 percentage points - of the output shortfall. This component has risen from 2.1 percentage points in 2011, since the shortfall in investment continued post crisis with greater intensity than other factors. Hall also examines the shortfall due to productivity, unemployment, and labor force participation. He finds that all four factors played important roles during the crisis, especially the labor force factors, but that during the recovery, improvement in the labor market has reduced the contribution of labor market factors. Instead, the capital shortfall is now the largest component. Hall (2016) emphasizes that the earnings of capital have been remarkably steady and returned to normal values quickly after the financial crisis, Hall also notes that intangibles play a larger role in the aggregate Bureau of Economic Analysis (BEA) capital measures as time goes on. He reports investment in Plant, Equipment, and Intellectual Property (IP) separately, as reported in his 2014 Figure 3. By his calculation, intellectual property is the only component of investment that remains on trend, while equipment particularly declined, and plant more mildly so.

The potential role of intellectual property and investment in R&D is also emphasized by Anzoategui, Comin, Gertler, and Martinez (2015), who show that declining investment in R&D before and during the crisis can explain a significant portion of the productivity slowdown. They argue that costly development and implementation of new technologies can link investment decisions during the crisis to post-crisis firm performance. Such a link between the severity of the crisis and the subsequent recovery has been postulated by a number of authors, including DeLong and Summers (2014), who point to several possible sources for the linkage, including investment.

Jones and Philippon (2016) also argue that U.S. investment has fallen below expectations, where they take into account financial market factors, including equity valuations and bond returns. They find that while investment is low relative to expectations based on cash flow and equity valuations, it is consistent with bond returns. Specifically, they argue that rather than investing, firms have used bond financing to finance dividends and repurchases, returning funds to investors rather than investing in fixed capital. While this accounts for the allocation of funds, it leaves open the question of why firms allocated funds in the way – especially given the high market values and cash flows documented in the paper. The set of questions they raise connects to discussions of how firms utilize cash and the incentives they face in allocating resources between short- and long-term investments.

Figure 1 shows the investment share of GDP for various categories of investment from 1970 to 2015. There is a modest decline over time in total private fixed investment relative to GDP. Removing residential investment, in the second line, makes the pattern somewhat clearer. However, the downward trend is most evident in the bottom line, Nonresidential, Non-IP (intellectual property) investment. Notably, each peak in the investment-GDP ratio is lower than the previous one, and is followed by a subsequent and lower cyclical trough.

The fact that the weakness in investment begins before the Great Recession aligns with the "changing nature of work" highlighted in the labor literature and associated "polarization" of the distribution of employment. Autor, Katz, and Kearney (2006) and many others emphasize the potential role of off-shoring and automation in understanding these employment and wage dynamics as a shift away from middle-wage production jobs toward lower-wage service and higher-wage cognitive employment. In this paper, we explore the extent to which these factors are at work in investment, in addition to employment. If production sectors are undermined by off-shoring, capital would also tend to follow abroad. If instead, labor is replaced by capital, or augmented by new technologies, then for these sectors, we may see a shift toward labor-replacing or labor-augmenting capital and technology.

The dynamics that we observe in employment and in capital are also examined by Jaimovich and Siu (2012), who argue that fixed costs of separations produce cyclicality and waves of layoffs in the midst of an overall declining employment trend. They show that cyclical dynamics in the midst of a declining trend can explain "jobless recoveries". Similar dynamics in investment, as evident in Figure 2, suggest that weak investment recoveries

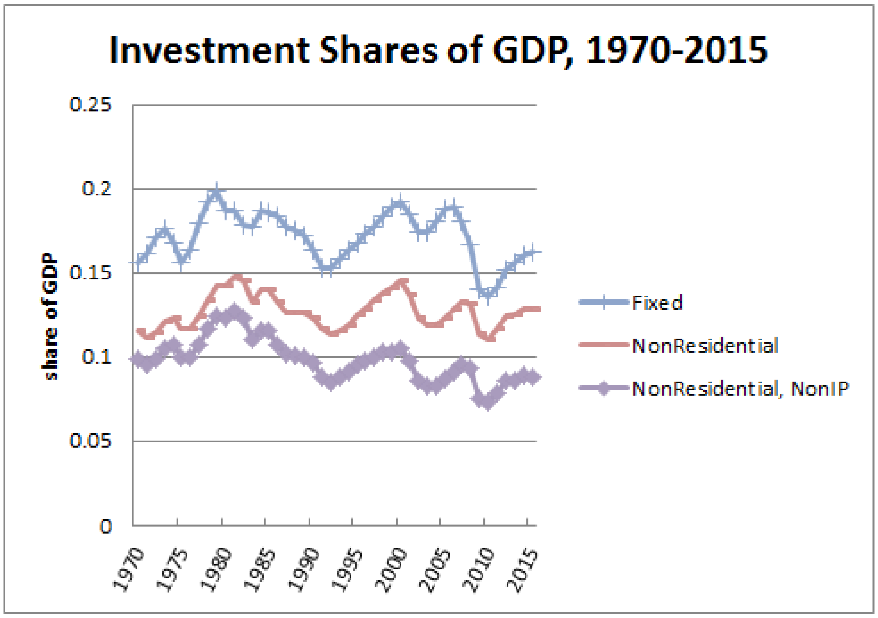

Figure 1: Investment as a share of GDP: Fixed Investment, NonResidential Investment, and NonResidential Non-Intellectual Property Investment, 1970-2015.

may also be due to frictions (such as irreversibility and fixed costs) breaking up, but not reversing, a downward trend in investment.

We use firm-level data from the Compustat/CRSP merged database to examine investment trends over time and across firms. We first confirm that investment has indeed underperformed traditional models, measured by negative time effects in conventional investment models fit to our data. These negative time effects begin in 2000 and extend through the rest of the sample in 2015; they are robust to various measures of fundamentals and are present across a wide range of industries. We then explore this finding through the lens of polarization results in labor economics. Since we explore capital investment by firms, we use industrial categories, rather than skills or job function, as a summary measure of exposure to offshoring and automation. We first document the decline in production sectors measured by either market value or by numbers of firms.

As industries become economically more important, we might expect their share of investment to rise as well. This effect, however, is modulated by the tendency of firms to off-shore or to substitute across factors of production as cost structures and technology change. We show that the investment shares of production sectors decline. However, the corresponding increases in investment shares are not in services (since they are not capital intensive), nor in high tech (which has the fastest growth). Instead, investment shares tip toward energy and telecommunications. Both sectors are growing, but importantly, they are extractive and "local" in that growth in energy comes largely from Oil and Gas Extraction, and to some extent Refining, which are all necessarily done locally, and in telecommunications transmission. In this sense, investment growth, like employment growth, is in the non-tradeables sector.

The most rapid growth, however, is in the high tech and related sectors, where we see little increase in the investment share. This finding may seem puzzling. However, just as labor is vulnerable to automation and substitutability with capital, it appears that physical capital is substitutable with intangible capital. We find that the overall downward trend in physical capital at the aggregate and industry level corresponds to an upward trend in intangible capital. Moreover, we show that at the firm level, capital investment is negatively associated with intangibles investment, especially for newer firms and especially in growing industries. In our data we cannot distinguish the exact type of intangibles, so this effect could represent intellectual property (which trends up in the aggregate data), brand value or other sources of market power, or other forms of intangible capital generated by corporate acquisitions.

In the next section we describe the data set and present preliminary, benchmark results. We then show the industrial composition of the data set, establishing the decline of production sectors and the rise of new technology sectors. In Section 4 we show that the distribution of capital investment has also shifted away from production sectors, but toward "grounded" sectors. In Section 5 we examine the shift away from fixed capital and toward intangibles. Section 6 concludes.

2 Data

We use the merged Compustat/CRSP database of publicly traded, nonfinancial firms from 1975 to 2015. These include the largest firms in the U.S. and the vast majority of business investment. Since investment is the core of our analysis, we filter out firms with missing investment data, as well as negative or missing values of Tobin's q, cash flow, and intangible capital. This sample contains 5434 firms and 50984 firm-year observations. Nominal values are adjusted to 2009 real values using the implicit price deflator for nonresidential investment for investment variables and the GDP deflator for the remainder of variables.

Our empirical approach at this stage is largely descriptive, so we report regression results to be interpreted as partial correlations, not as causal relationships.

We first demonstrate that the unusually "low investment" emphasized in other work is indeed a feature of our data. With firm level data, we control for observable measures, such as Tobin's Q and cash flow, as well as firm fixed effects. Table **??** shows these results for our broad sample of firms, where we report regressions in levels, as in traditional Q theory,

Table 1: Summary Statistics

Variables	N	Mean	STD	Min	p25	p50	p75	Max
A (Asset)	50,984	5,484	20,073	1.691	152.7	629.1	2,792	538,550
I	50,984	352.3	1,612	0	5.909	28.98	142.8	48,955
INTAN	50,984	968.2	5,598	0	0	21.64	249.6	204,805
K	50,984	3,785	16,430	0.0884	64.93	307.2	1,544	456,525
Market Value	50,984	3,811	14,912	0.00906	95.45	441.9	1,925	571,846
CF(CashFlow)	50,984	573.2	2,179	0	12.24	57.33	264.4	58,087
Q	50,984	2.783	3.037	2.40e-06	0.768	1.569	3.597	15.00
I/K	50,984	0.133	0.129	0	0.0638	0.102	0.165	11.60
I/A	50,984	0.0640	0.0677	0	0.0238	0.0437	0.0792	1.749
CF/A	50,984	0.105	0.0707	0	0.0626	0.0962	0.135	4.850
INTAN/A	50,984	0.124	0.166	0	0	0.0487	0.187	0.913

1. Compustat firms with annual data for the period 1975-2015.
2. Investment is adjusted using the implicit price deflator for nonresidential investment, and the other variables are adjusted using theGDP deflator. Both series are obtained from the St.Louis Federal Reserve FRED database.
3. Units: millions of real 2009 dollars.
4. A: Assets; I: Investment; INTAN: Intangible stock; K: Capital Stock

but also in logs.[1] Since investment is so skewed, the log regressions tend to fit better, as emphasized by Eberly, Rebelo, and Vincent (2012), and we use this specification going forward, after making the initial comparison to the level (ratio) regressions here.

While these results confirm the standard results of the positive relationship between investment, Q, and cash flow, the striking finding is the negative time effects starting in 1999, as illustrated in Figure 2, in both levels and logs. Seen in this way, the data suggest three distinct subperiods. There are positive time effects from the late 1970s through 1990, followed by little or no time effect in the 1990s. In 1999 the time effects become systematically negative, with a drop in 2002 and additional sharp declines in 2009-'10, with little recovery thereafter.

These results show that the decline in investment is observed conditional on fundamentals such as Tobin's Q and cash flow (and firm effects). It begins in the early 2000s, well before the Great Recession, as observed elsewhere, and coincident with similar dynamics in employment. Given the changes in industry composition among capital-using industries, we now turn to changes in industrial composition in our data set, as well as the role of intangible

[1] We normalize investment and cash flow by assets rather than physical capital for comparability with our later regressions where we examine broader measures of firms' assets, including intangible capital. Using physical capital in the benchmark regressions does not substantively change the results.

Table 2: Benchmark Regressions

VARIABLES	Full Sample I/A	Top 500 I/A	Full Sample log(I/A)	Top 500 log(I/A)
CF/A	0.0960***	0.117***		
	(0.00415)	(0.00625)		
Q	0.000904***	0.000697***		
	(0.000104)	(0.000157)		
log(CF/A)			0.153***	0.232***
			(0.00535)	(0.00841)
log(Q)			0.0369***	0.0141*
			(0.00512)	(0.00766)
Constant	0.0466***	0.0431***	-2.747***	-2.555***
	(0.00205)	(0.00193)	(0.0359)	(0.0339)
Observations	33,699	14,323	33,699	14,323
R-squared	0.065	0.099	0.101	0.176
Number of gvkey	3,732	1,512	3,732	1,512
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

The table reports panel data regressions of the investment-asset ratio I/A on Q, CF/A and $\log(I/A)$ on $\log(Q)$, $\log(CF/A)$ respectively. Columns (1) and (2) report results for the full sample. Columns (3) and (4), report results for the largest 500 firms by Market value each year. Standard errors are in parentheses. *** indicates the coefficient is different from zero at 1% level, ** at the 5% level, and * at the 10% level.

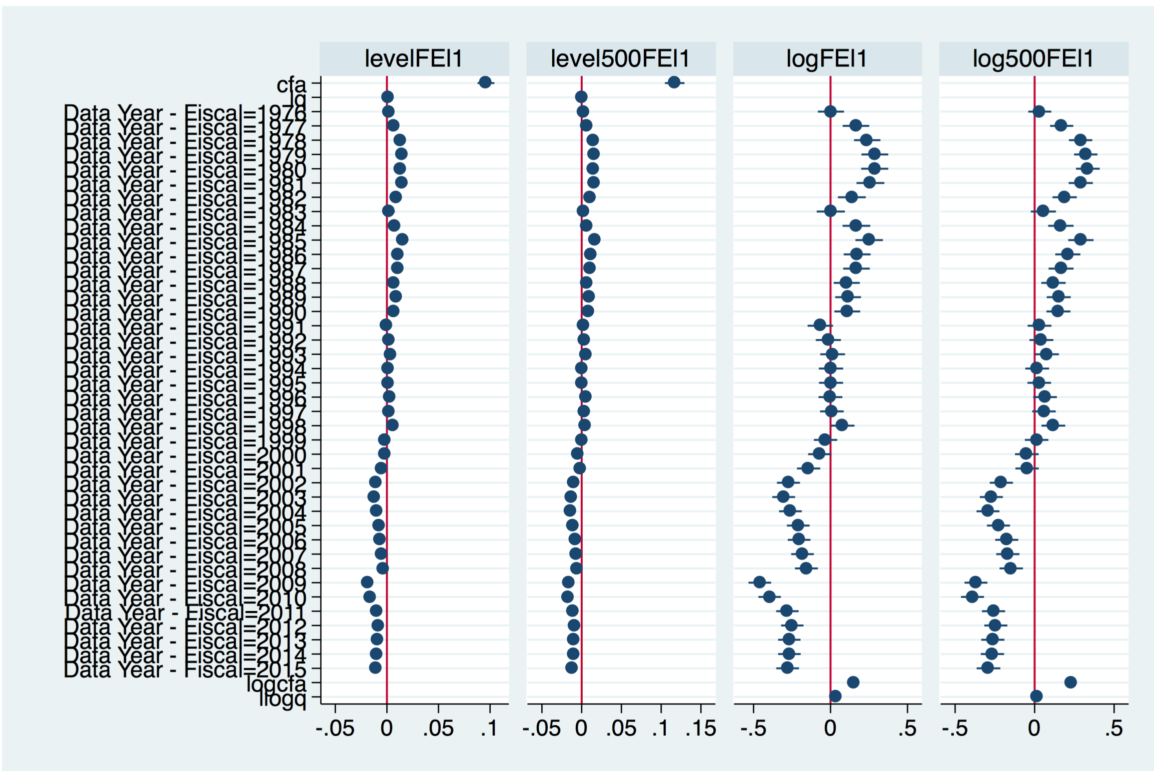

Figure 2: Regression year effects, in levels and logs, for the full sample and the top 500 sample. Authors' calculations from Compustat/CRSP data.

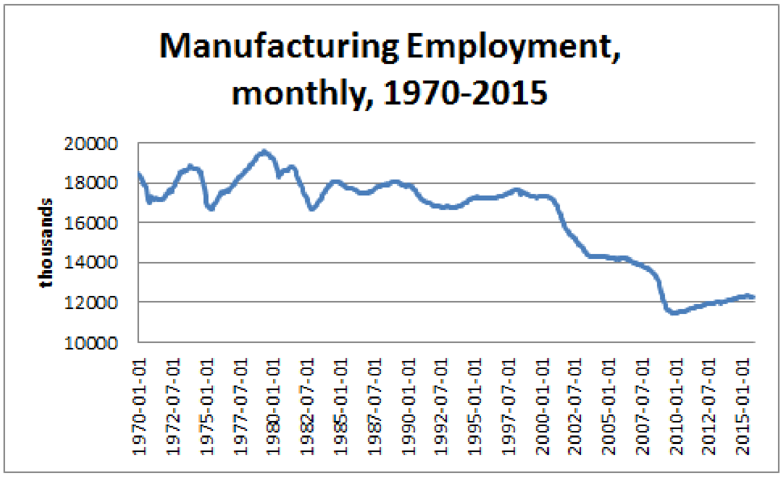

Figure 3: Manufacturing Employment, BLS data, 1970-2015.

investment.

3 Industry Composition

Research in labor economics has identified changing industry dynamics as a factor in declining labor demand. In particular, international competition and automation of routine tasks have contributed to declining demand for "middle skill" workers and the hollowing out of the wage distribution. We first examine whether a similar industrial reallocation is present in our sample of firms. We observe firms by industry, but the shifts evident in employment are also evident in industries. For example, the long-run decline of the manufacturing sector in the United States has been clearly evident in employment data for decades, as evidenced in Figure 3. From its peak in 1979, manufacturing employment fell 11.6 percent over the following 20 years. But starting in 2000, manufacturing employment fell more sharply - declining 33.7 percent over the next 10 years, reaching a trough in February-March 2010 with employment less than 60 percent of the peak.

This reallocation is also evident in the firm level data, where we see a substantial reallocation out of manufacturing and into other industries. The Compustat data report standard SIC code, which we aggregate into single digit SIC codes to examine industry growth. Figure 4 shows the distribution of firms across single digit industries by market value.

The decline of manufacturing is evident across all size categories, replaced largely by services, but also by Trade and Mining/Energy to more variable degrees. Alternatively, we aggregate firms' four-digit SIC codes into industries using the Fama-French industry

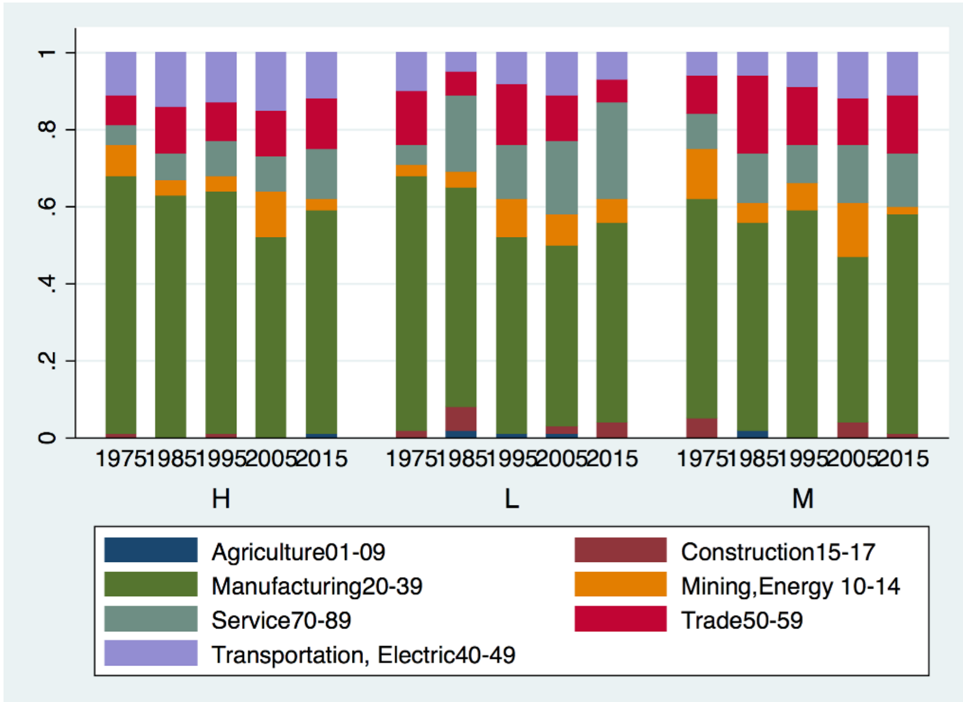

Figure 4: Industrial and Size Composition of Firms: H = highest size quintile, M = middle size quintile, L = lowest size quintile

classifications; these classifications better capture the move into technology in the latter part of the sample, which is not delineated separately in the SIC classifications. Appendix 8 lists the Fama French classifications.[2]

These classifications emphasize the decline in Manufacturing, together with Durable and Nondurable production, especially for the largest firms.[3] Manufacturing's dominance is replaced by High Technology, Telecommunications, Shops (Wholesale and Retail Trade), and to some extent Energy. Energy includes Refining, as well as Oil and Gas extraction, which will be important to our subsequent discussion. Health, which plays a large role in employment dynamics and the growing role of services, is not dominant in the market value data.[4] To give some examples of the importance of the reclassification, Facebook and Microsoft (SIC code 73) are SIC Service firms, but because they provide computer-related services, Fama-French include them in High Technology. Similarly, technology producers like Apple (SIC 35) are SIC manufacturing firms, but are in Fama-French High Technology.

[2] There are ten Fama-French industries, but since we exclude Finance, we report only nine of the ten.

[3] Nondurables, durables, and manufacturing as defined by Fama-French include manufacturing SIC codes (20s and 30s) plus Agriculture (01-10).

[4] The Fama-French Health category includes SIC codes for pharmaceuticals, medical instruments and devices, and health services.

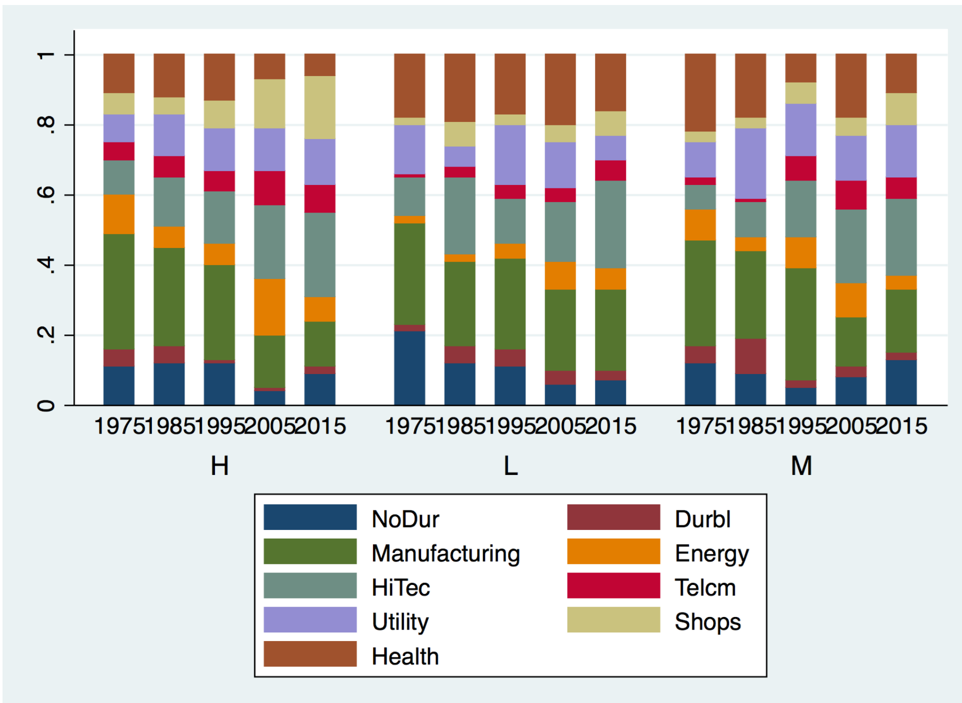

Figure 5: Composition of firms by size and industry using Fama-French 10 industry classifications. H = highest quintile of firm size, M = middle quintile of firm size, and L = lowest quintile of firm size.

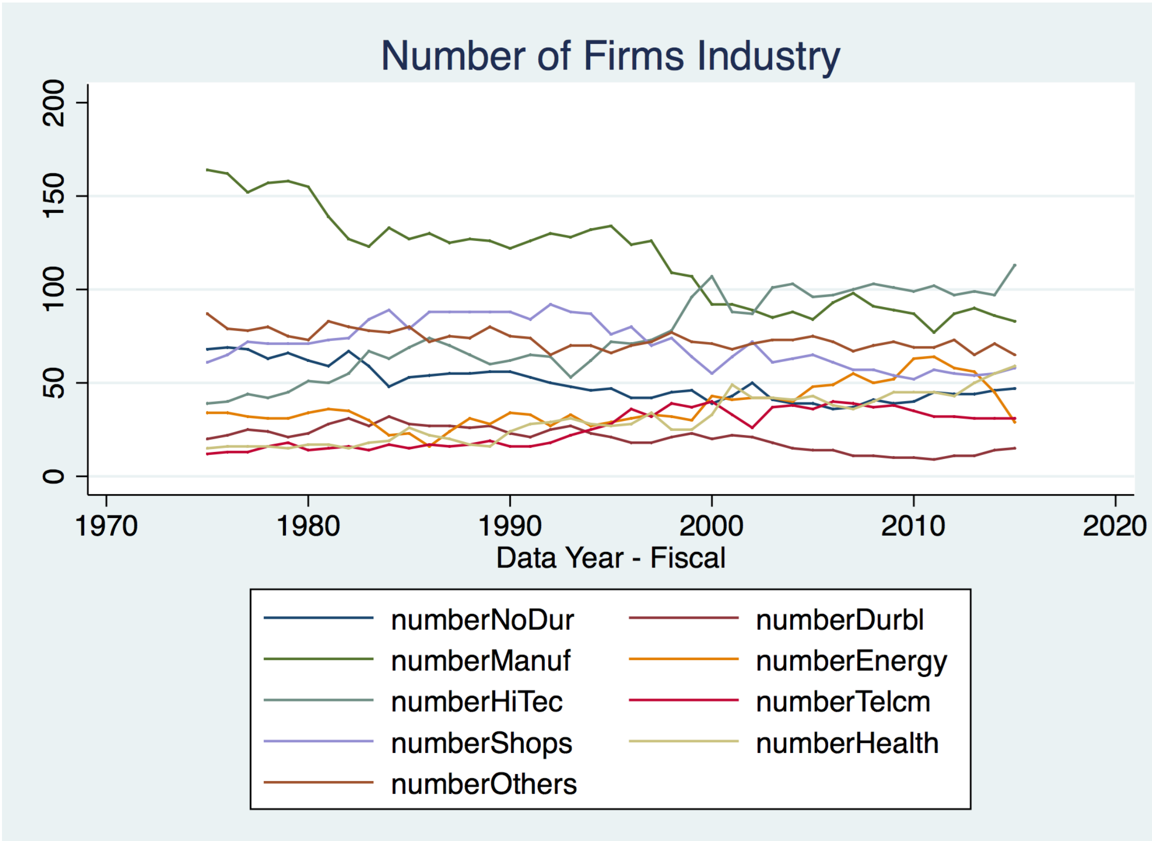

Figure 6: Number of firms per Fama-French 10 industries, 1975-2015, based on top 500 sample

Amazon, on the other hand, is a retail SIC code (SIC code 59) and remains included in "Shops" in the Fama-French classification.

These data suggest that the decline of manufacturing may not be as uniform as suggested by the employment data. The traditional SIC codes mask dynamism within SIC 20-30 (Manufacturing), which is declining on average, but is buoyed by growth in high tech and telecommunications.

Alternative measures of industry size show a similar picture. The data above measures industry size by total market value in an industry. We also examine the total number of firms by industry among the top 500 Compustat firms. Within the top 500 firms, this approach gives an "equal-weighted" view of firms' activity by sector. Using this approach to aggregating firms by industry, Figure 6 gives a similar picture of the decline of manufacturing and production sectors and the rise of other industries - especially High Tech, Energy, Telecomm, and Health.

4 Reallocation of Investment across Industries

The work of Autor, Katz and Kearney (2006) and others has pointed to a realignment of employment and the role of skills in the labor market. They emphasize that when work can be off-shored and labor can be replaced by automation, some skills are more vulnerable than others. To the extent that some services are nontradeable, workers in these fields are less vulnerable to off-shoring. Similarly, cognitive and non-routine tasks are more difficult to automate. Hence they point to non-routine and cognitive tasks as being relatively more robust to off-shoring and automation and hencing having a stronger employment outlook. They find employment growth is more concentrated in these fields in the 1990s and in the 2000s - especially in service fields that can neither be off-shored nor automated. If correct, this explanation also has implications for investment. Industries that cannot be off-shored should exhibit relatively more investment, while those that can be offshored are more likely to show declining capital investment, as capital follows firms off-shore. Automation could work in the opposite direction, however, since capital may replace labor, resulting in higher investment.

We categorize industries using an approach analogous to Autor (2010), identifying industries that cannot be offshored, those that can, and those that are more high skilled. Specifically, we group together industries that require a local presence, such as Oil and Gas Extraction and Mining, as well as Telecommunications (transmission, not devices) and Retail Shops. Manufacturing, on the other hand, can locate production more flexibly, as can producers of Consumer Durables and Nondurables. We allocate High Technology and Health to the cognitive sectors. While health services are allocated to the nontradeable sector in employment, for investment purposes, health is dominated by pharmaceutical and device firms, while health service firms play a small role in investment.[5]

Figure 7 shows the change in the investment share of these industries, with the nontradeable sectors on the left, the manufacturing and production sectors in the center, and cognitive sectors on the right. The ordering is intended to mirror the job characteristics identified by Autor (2010), with nontradeables on the left, routine tradeables in the center, and high skill sectors on the right. The vertical axis measures the change in the share of investment in each sector, by decade. There are both parallels and contrasts with employment patterns. In the 1980s and 90s, the profile is relatively flat, with little reallocation among sectors, though the decline in manufacturing appears already in the 1980s. But as with employment, more dramatic change begins with the turn of the millennium, in 2000 and beyond. Investment in manufacturing shrinks, with an almost 10 percentage point decline in investment share. The nontradeable sectors of energy and telecommunications increase

[5] We did break out Health Services, but it made no difference to our results given its small size.

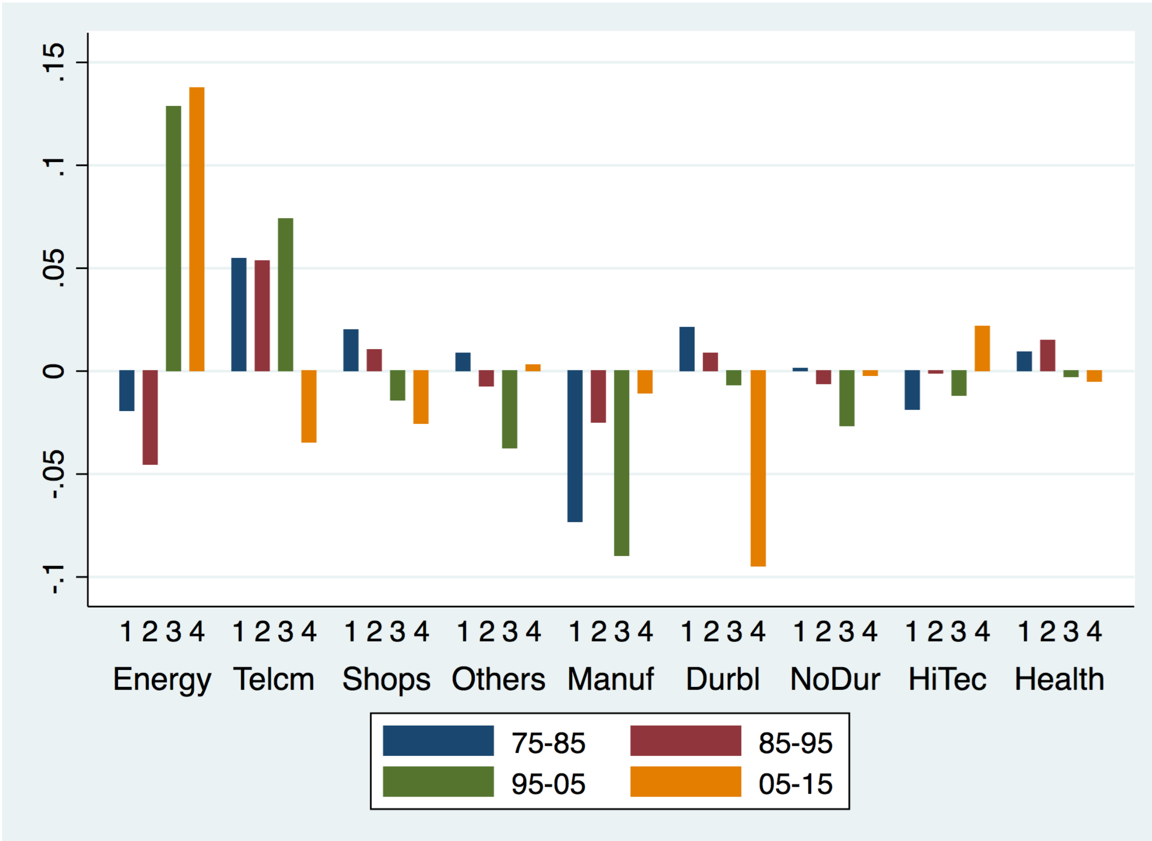

Figure 7: Change in the share of total investment by decade, 1=1980-89, 2=1990-99, 3=2000-09, and 4=2010-15. Industries are defined by the Fama-French 10 categories.

by about 10 percentage points each. This trend continues after the financial crisis, with further growth in energy, and shrinkage in the production industries, primarily Durables, in the middle of the chart.

While the left-hand side of the graph shows the rising investment share for nontradeables that corresponds with job growth, in contrast, there is little growth in the investment share of "cognitive" fields. Autor's (2010) results show growth in cognitive/non-routine employment in the 1980s and 90s, consistent with skill-biased technological change, but a slowdown in employment growth in high skill fields in the 2000s.

The pattern of changes in the distribution of investment across sectors reflects the interaction between shocks affecting the relevant industries, and the degree to which investment is "grounded" spatially. This interaction was noted by Blanchard and Wolfers (2000) in the context of European unemployment, where the pattern of shocks did not line up with the cross-country pattern of European unemployment, but the pattern of employment frictions was not consistent with the timing of rising unemployment across countries. However, the interaction of shocks with frictions is consistent with the panel data.

In this context, the large swings in energy sector's share of investment is not surprising. The ups and downs of investment in oil and gas extraction, and the way that investment is distributed in firm-level data, reflects swings in energy prices and the evolution of oil production technologies. The collapse of oil prices at the end of 1985 led to a sharp and protracted decline investment in this sector. This only started to reverse when real oil prices began to trend higher early in the last decade. The initial pick up in investment in this sector was led by large long-term production projects undertaken by the major integrated oil firms. However, the relatively new process of hydraulic fracturing – a.k.a. "fracking" – developed rapidly. Over the last decade these new techniques accounted for a rising share of investment in oil and gas extraction globally. This investment was concentrated in the continental United States and most of it was carried out by relatively small independent drilling and production companies.[6]

Of course energy extraction was not the only sector to grow rapidly in recent decades. But growth alone is not sufficient to sustain investment. Rapid growth in sectors such as high technology and healthcare has not increased their share of investment. Growth in the some sectors – energy extraction and telecommunications, for example – requires investment in specific locations. It is "grounded" spatially. Investment of those sectors will respond differently to shocks than investment in sectors where the location of investment is more flexible.

For two decades starting in roughly the mid 1980s global trade grew substantially faster than global GDP. The expansion of "global value chains," i.e., the increasing disaggregation of production spatially, seems to have been important factor in contributing to the rapid growth in trade over this period.[7] This trend probably contributed the "off-shoring" and "hollowing out" effects that have been evident in labor markets. But this trend has also had the effect on the how investment in some sectors, particularly manufacturing, has responded to shocks.

Figure 8 shows the average investment to asset ratio in each of the Fama-French industries from 1975 to 2015. While volatile, Energy is the only sector that maintains its level of investment post 2000. All of the other industries, even those that are growing in market

[6] Decker, R., A. Flaaen, and M. Tito (2016). "Unraveling the Oil Conundrum: Productivity Improvements and Cost Declines in the U.S. Shale Oil Industry". Federal Reserve Board, FEDS Notes, March 22.

[7] Since the Global Financial Crisis in 2008-2009 the growth of global trade relative to global GDP has slowed. For a discussion of these trends, and the role of "global value changes see: IMF (2016), "Global Trade: What's behind the Slowdown?," International Monetary Fund, World Economic Outlook, Chapter 2, (October.); and Haugh, D, A. Kopoin, E. Rusticelli, D. Turner, and R. Dutu, (2016) "Cardiac Arrest or Dizzy Spell: Why is World Trade So Weak and What can Policy Do About It?" OECD Economic Policy Paper, No. 18 (September.)

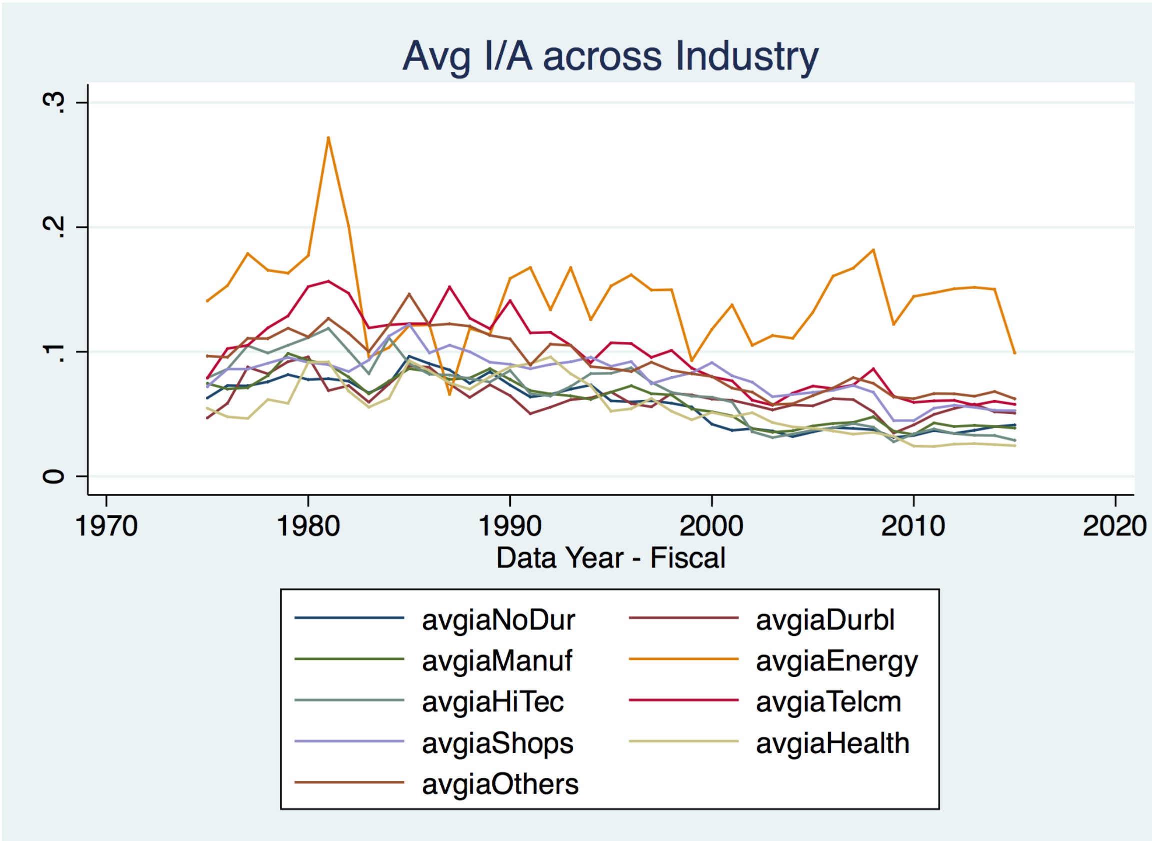

Figure 8: Average investment across Fama-French industries, by year, 1975-2015. Authors calculations from Compustate data.

value and number of firms, show a shrinking propensity to invest in physical capital.[8]

5 Asset Composition

The shift in industry composition and technological change suggests that the types of assets in firms' production functions may be changing. Earlier, Figure 2 indicated the growing role of intellectual property investment, which we graph explicitly below. As Hall (2014) indicates, intellectual property has a long upward trend, even as fixed investment as tended to decline relative to GDP.

We explore this notion further in the Compustat data on intangible capital at the firm level. Measurement is admittedly murky in this area, as intangibles include intellectual

[8]The decline in Energy investment at the end of sample fits the pattern we noted earlier wherein investment follows energy prices. The decline in energy-sector investment has been cited as the reason that the recent decline in energy prices has not been more economically stimulative (Baumeister and Kilian 2016).

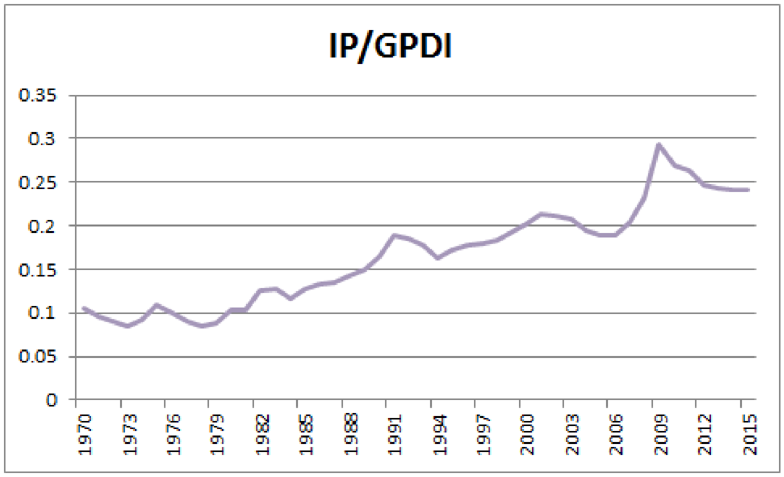

Figure 9: Intellectual Property products investment as a share of total gross private domestic investment. Source: BEA.

property, as well as investments in brand and other non-specific value acquired in corporate mergers and acquisitions. So we take care not to over-interpret our findings when exploring these data.

Figure 10 reports the average share of intangible assets in total assets by industry from 1975 to 2015, for the Fama-French 10 industry classifications. The intangibles share of assets trends upward in most industries. The highest intangibles shares are in Telecommunications, Nondurables, Health, and High Technology. Manufacturing also exhibits an upward trend that is interrupted (flat) in the early and mid-2000's before resuming after 2009. Durables, Shops, and Others show weaker growth in intangibles, and the intangible capital share in the Energy sector is nearly flat.

These average results correspond to the upward trend in the aggregate data for intellectual property, and also to the downward trend in fixed (nonresidential) investment in the aggregate and firm-level data. These opposing trends raise the question of whether, for example, intangible capital substitutes for fixed capital in production. In order to examine this possibility, we include intangibles in our earlier investment regressions to see whether it can account for the downward trend in fixed capital. As is evident from Table 3, the share of intangible capital has a negative effect on fixed investment.

Moreover, adding intangibles reduces the time effects, as shown in Figure **??**. In the early part of the sample, intangible capital has virtually no effect on the year dummies, and in the 1990s the effect is positive but insignificant. Starting around 2000, however, the time dummies are significantly increased - by 40 to 50 percent - reducing the magnitude of the negative time effects in the 2000s. That is, the previously unexplained trends in

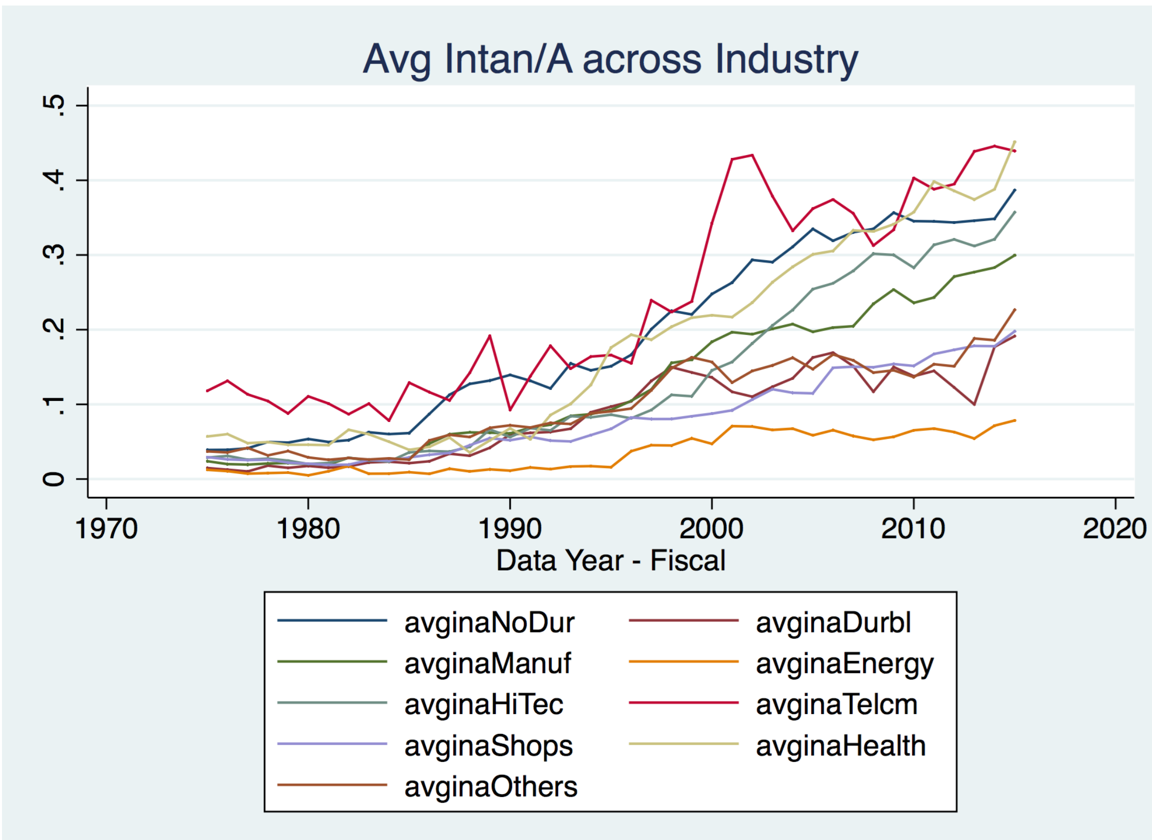

Figure 10: Average intangible assets as a share of total assets by industry, using the Fama-French 10 industries and the sample of 500 top firms, by year.

Table 3: The effect of intangibles and entry on investment.

	Full Sample	Full Sample	Top 500	Top 500	Top 500
VARIABLES	log(I/A)	log(I/A)	log(I/A)	log(I/A)	log(I/A)
log(CF/A)	0.153***	0.145***	0.232***	0.220***	0.232***
	(0.00535)	(0.00535)	(0.00841)	(0.00842)	(0.00841)
log(Q)	0.0369***	0.0468***	0.0141*	0.0233***	0.0144*
	(0.00512)	(0.00513)	(0.00766)	(0.00765)	(0.00766)
log(In/A)		-0.0604***		-0.0588***	
		(0.00369)		(0.00475)	
NewGround*Log(In/A)					-0.0295
					(0.0341)
NewProduction*Log(In/A)					0.0123
					(0.0345)
NewTech*Log(In/A)					-0.107**
					(0.0423)
Constant	-2.747***	-2.990***	-2.555***	-2.797***	-2.562***
	(0.0359)	(0.0387)	(0.0339)	(0.0390)	(0.0342)
Observations	33,699	33,699	14,323	14,323	14,323
R-squared	0.101	0.109	0.176	0.186	0.177
Number of gvkey	3,732	3,732	1,512	1,512	1,512
Firm FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

The table reports panel data regressions of the investment-asset ratio I/A on Q, CF/A and $\log(I/A)$ on $\log(Q)$, $\log(CF/A)$ respectively. Columns (1) and (2) give the whole sample estimation. In columns (3) and (4), we re-estimate column (1) (2) using Top 500 firms by Market value each year. In column (5), we replace Log(In/A) three more variables: NewGround*Log(In/A) is the interaction term of NewGround and Log(In/A). NewGround is a categorical variable that is equal to 1 if the firm enters the Top 500 sample after 2000 and belongs to Energy, Telcm, Shops or Others, using Farma-French 10 industries definitions. NewProduction is a categorical variable that is equal to 1 if the firm enters the Top 500 sample after 2000 and belongs to NoDur, Durbl or Manuf. NewTech is a categorical variable that is equal to 1 if the firm enters the Top 500 sample after 2000 and belongs to Tech or Health. Standard errors are in parentheses. *** indicates the coefficient is different from zero at 1% level, ** at the 5% level, and * at the 10% level.

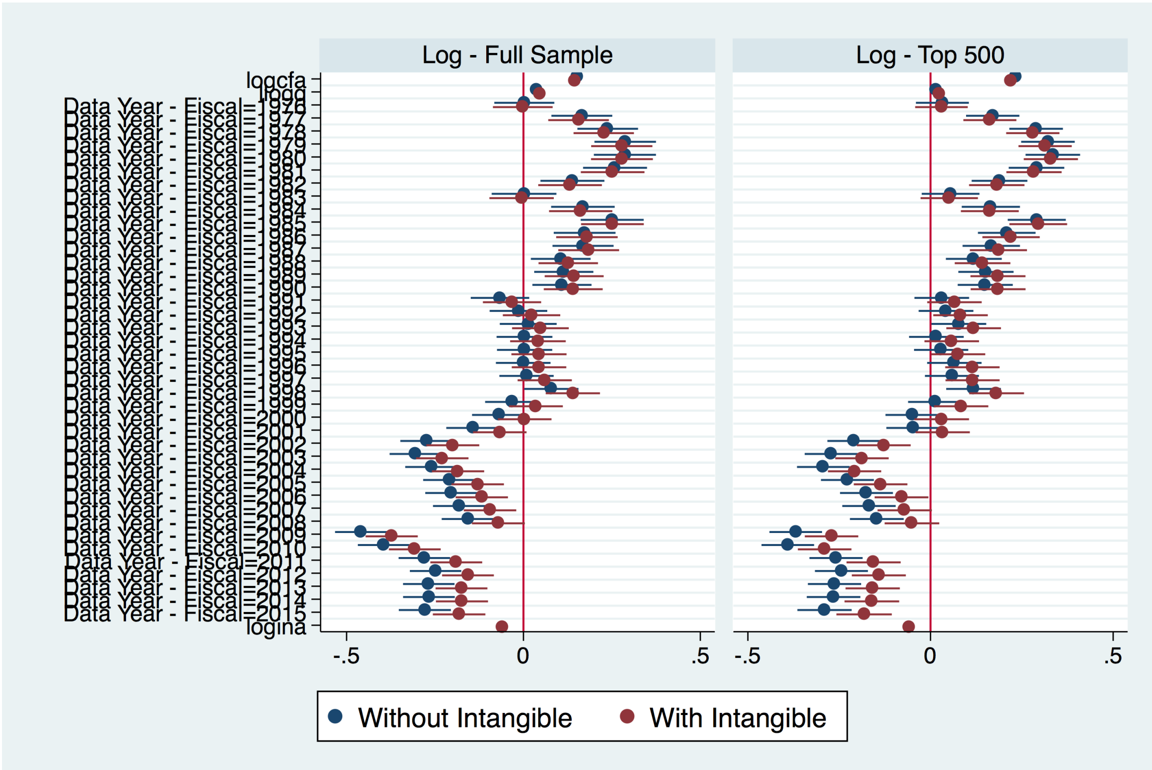

Figure 11: The effect of intangible capital on the time trend in physical capital.

fixed investment that are picked up by the year effects in the panel regressions are partially accounted for by the increasing role of intangible capital.

However, the data graphs make clear that the trends differ across industries, so we do not want to rely exclusively on a level effect to capture the potential interaction between physical and intangible capital. Moreover, as we noted earlier, the entry of new firms varies by industry. If new firms incorporate new production technologies as they enter and grow, then we might expect those industries with more new firms to exhibit a great transformation - in this case, from tangible to intangible capital. We focus on entry post 2000, when the investment slowdown occurs in our initial benchmark regressions. Figure 12 shows the new entrants into the top 500 firms post-2000, by 2 digit SIC code, from 1 to 89, excluding financial firms. Entry is fairly concentrated, with about a quarter of entry in high tech, and half of those entrants in business services (like Facebook and Microsoft), SIC 73. 10 percent of entry is from each of Energy and Telecomm, and 2/3 of the Energy entrants are in SIC 13 (Oil and Gas Extraction).

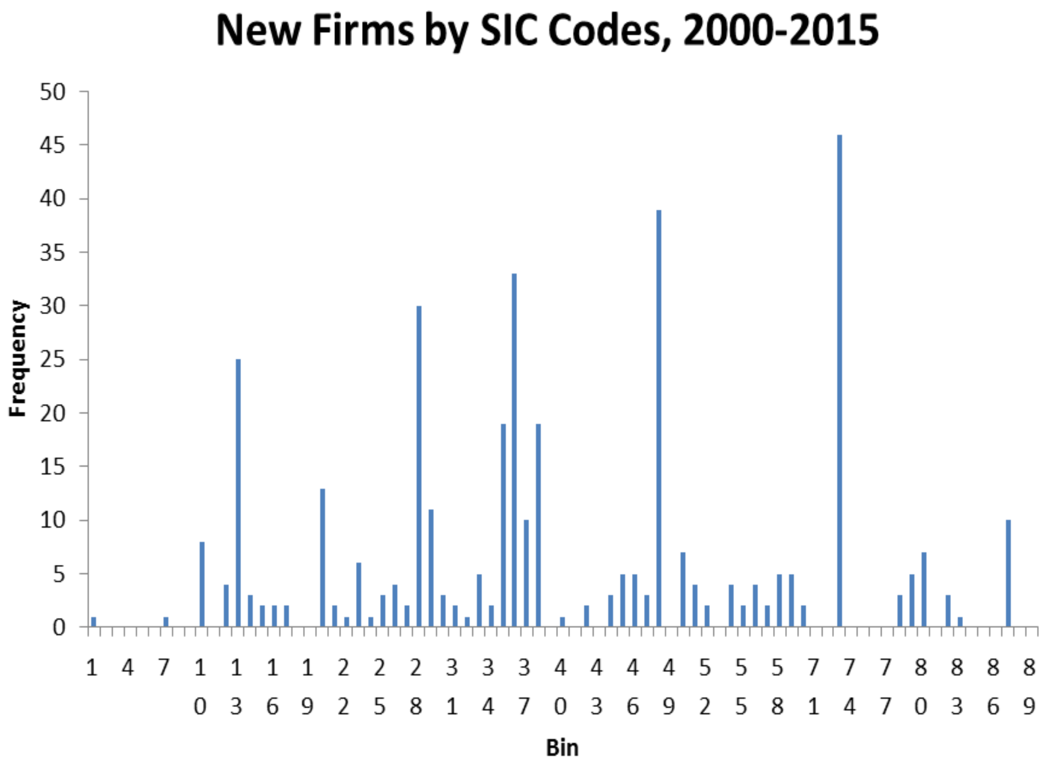

Figure 12: New entrants in the top 500 sample. The most new entrants occur in SIC 73 = Business Services; SIC 48 = Communications; SIC 36 = Electronics; SIC 28 = Chemicals and Allied Products (includes Pharmaceuticals); SIC 13 = Oil and Gas Extraction; SIC 35 = Machinery and Computer Equipment; SIC 38 = Instruments (includes Medical Devices). Authors' calculations from Compustat data.

6 Conclusion

The decline in physical capital, especially notable post-global financial crisis in the United States, has raised questions among macroeconomists about productivity and expected future demand at the aggregate level. Looking at a panel of firms and bringing the cross-section of industries to bear, we show that the changing structure of industries and capital composition provide a different perspective. Investment has remained stronger and grown as a share of total investment in industries which are "grounded" and cannot be off-shored, such as energy extraction and telecommunications transmission. In this sense, investment is like employment in showing growth in non-tradeable industries. On the other hand, where employment long exhibited skill-biased technological change, with growing employment in high skill fields, investment does not expand in high tech fields (like high technology and health). The share of investment in these fields grows slightly, but is largely stable. Yet, the market value and number of firms grows substantially in these sectors. Our results show that in these sectors, the composition of capital shifts toward intangibles and away from fixed capital. In this way, investment is susceptible to substitution, just as employment in routine jobs is susceptible to automation, which substitutes capital for labor.

Of course, investment has slowed globally, not just in the US.[9] The slowdown in global investment is part of a broader discussion relating to factors that are keeping interest rates so low around the world.[10] The results of this paper provide some insight into these debates, but the relationship is not simple. The roll of "off shoring" in the slowdown in investment by US firms does not seem likely to be an important factor in explaining the why investment has slowed globally. If anything, the recent slowdown in global trade suggests that this particular factor has been less, not more, important since the global financial crisis. On the other hand, the evidence we find that the shift in economic activity towards parts of the economy that rely more heavily on intangible assets is probably more relevant to the broader global trends in investment and interest rates.

Our results are largely description at this stage and bear further work, including breaking out the composition of intangibles. The aggregate BEA data shows an upward trend in Intellectual Property investment, which has been robust during and after the Great Recession. This is intriguing, but our data do not have the compositional detail to further explore this trend in firm-level data.

We also suspect that firm-level effects in intangible investment may explain heterogeneity across firms that is difficult to explain with industry effects, since firms' adoption of new

[9]See IMF (2015), "Private Investment: What's The Holdup?," International Monetary Fund, World Economic Outlook, Chapter 2, (April).

[10]See, for example, Lukasz, R. and T. Smith. (2015) "Secular drivers of the global real interest rates," Bank of England Staff Working Paper No. 571.

technologies and strategies in the face of disruptive change are unique. We explore this possibility in other, on-going work.

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7 Appendix: Data

We use a panel of Compustat firms with annual data for the period 1975-2015. The sample includes 5434 firms and 50984 firm-year observations. Nominal values are adjusted using the implicit price deflator for nonresidential investment for investment and capital variables and the GDP deflator for the remaing variables, such as cash flow and asset values.

7.1 Description of Variables

1. Cash Flow CF: Income Before Extraordinary datas(IB, data 384) + Depreciation and Amortization(DP, data 236).
2. Market Value: closing stock price times number of common shares outstanding (end of period) plus redemption value of preferred stock (end of period) = prc * shrout/1000 + PSTKRV(data 677)
3. Capital K: PPEGT data 650.
4. Long-term Debt: dltt data230
5. Tobin's Q: $\frac{MarketValue_t + dltt - INVT}{K_t}$
6. Intangibles: Intan data 401
7. Investment I:CAPXV data 123
8. R&D: XRD data 971
9. Inventory: INVT data 423
10. Employee: EMP: data 290
11. Account Receivables: ARTFS data 91
12. Total Asset: AT data 94
13. DLRSN: Research Company Reason for Deletion. "01" implies M&A, which will be excluded from the sample.

7.2 Sample Selection

Starting from the CRSP/Compustat Merged database, the following filters were applied:

1. IB (data 384) or DP (data 236) missing
2. Tobin's Q: $q_t < 0$ (or missing)
3. $intan < 0$ (or missing)
4. Investment missing
5. DLRSN = 01: M&A are excluded.
6. Debt missing
7. Tobin's Q > 15
8. The following firms are excluded: Financial firms($6000 <= SIC <= 6999$), regulated Utilities ($4900 <= SIC <= 4999$) as well as firms being described as public service, international affairs, or non-operating establishments ($SIC >= 9000$)

8 Appendix: Industry Classifications

We use the Fama French 10 industry classifications for SIC codes. The list below provides the ten Fama-French categories and associated four-digit SIC codes.

1 NoDur Consumer NonDurables – Food, Tobacco, Textiles, Apparel, Leather, Toys

0100-0999

2000-2399

2700-2749

2770-2799

3100-3199

3940-3989

2 Durbl Consumer Durables – Cars, TV's, Furniture, Household Appliances

2500-2519

2590-2599

3630-3659

3710-3711

3714-3714

3716-3716

3750-3751

3792-3792

3900-3939

3990-3999

3 Manuf Manufacturing – Machinery, Trucks, Planes, Chemicals, Off Furn, Paper, Com Printing

2520-2589

2600-2699

2750-2769

2800-2829

2840-2899

3000-3099

3200-3569

3580-3629

3700-3709

3712-3713

3715-3715

3717-3749

3752-3791

3793-3799

3830-3839

3860-3899

4 Energy Oil, Gas, and Coal Extraction and Products

1200-1399

2900-2999

5 HiTec Business Equipment – Computers, Software, and Electronic Equipment

3570-3579

3622-3622 Industrial controls

3660-3692

3694-3699

3810-3839

7370-7372 Services - computer programming and data processing

7373-7373 Computer integrated systems design

7374-7374 Services - computer processing, data prep

7375-7375 Services - information retrieval services

7376-7376 Services - computer facilities management service

7377-7377 Services - computer rental and leasing

7378-7378 Services - computer maintanence and repair

7379-7379 Services - computer related services

7391-7391 Services - R&D labs

8730-8734 Services - research, development, testing labs

6 Telcm Telephone and Television Transmission

4800-4899

7 Shops Wholesale, Retail, and Some Services (Laundries, Repair Shops)

5000-5999

7200-7299

7600-7699

8 Hlth Healthcare, Medical Equipment, and Drugs

2830-2839

3693-3693

3840-3859

8000-8099

10 Other Other – Mines, Constr, BldMt, Trans, Hotels, Bus Serv, Entertainment, (excluding Finance)