Why Do U.S. Firms Invest Less Over Time?*

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Abstract

The ratio of capital expenditure to total assets of U.S. firms decreases by more than half from 1980 to 2012. The decline in capital investment is pervasive; it has occurred for firms in most industries and is robust to firms of different size, investment opportunity, profitability, access to external financing, and expense on R&D or acquisitions. The decline is not explained by time variation in firm characteristics, corporate lifecycle, or public listing cohorts. Our further evidence suggests that it is related to the transition of U.S. economic structure and the globalization of the world economy. Firms over time invest less in fixed assets and more in intangible assets, as fixed assets are less demanded in firm production. International evidence shows that countries with similar economic development to the U.S. (G7 and OECD countries) have also incurred significant declines in capital investment while emerging economies such as BRICS have not.

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1. Introduction

Capital investment is a necessary input of a firm's production process and a critical factor for the firm to survive and grow. At the macro level, it is also a fundamental driver of economic growth. In this paper, we document a persistent decline in capital investment of U.S. public firms in the period of 1980-2012. For example, the median firm's capital expenditure relative to its total assets drops from 7.80% in 1980 to 3.14% in 2012 – a cut by more than half. In a regression of this ratio on a constant and a time variable, the time variable has a negative and statistically significant coefficient estimate. Our further analysis suggests that the decline is pervasive; it has occurred in varying degrees for firms of almost all industries and is robust to firms of different asset size, investment opportunity, profitability, access to external financing, and whether or not expense on R&D or acquisitions.

Why do U.S. firms invest less and less over time? The neoclassical economic theories suggest that a firm's optimal investment is solely determined by its investment opportunities. In a frictionless capital market, a firm should invest whenever a profitable investment opportunity arises. By taking all positive net-present-value (NPV) projects, the firm maximizes its value. However, imperfect market conditions, due to taxes, adjustment costs, information asymmetry, and interest conflicts among stakeholders, etc., often lead to suboptimal investment. For example, firms may not be able to invest in a positive NPV project when they are financially constrained. Firms may delay investment when the adjustment costs are high. Managers may underinvest to maximize shareholders' interest only instead of maximizing the overall firm value or overinvest for their own interest at the expense of shareholders.

Empirically, a firm's capital investment has been shown to be positively related to its investment opportunities and cash flows, and negatively related to firm size in the cross-section. The positive relation between investment and investment opportunity is obvious. There are, however, at least three different reasons for firms with high cash flows to invest more. A high cash flow could signal more profitable investment opportunities, a relaxation of financial constraint, or an aggravation of agency problems; all of them predict more investment. The negative relation between investment and firm size is largely mechanical since investment is deflated by firm size. It is also consistent with the diminishing marginal return of investment.

We examine if the decline in capital investment is explained by these firm characteristics. Do U.S. firms' investment opportunities, or cash flows, also decline persistently during our sample period? Alternatively, is the investment decline concentrated in firms of certain characteristics? While we confirm the cross-sectional relations between these characteristics and corporate investment, our empirical analysis suggests that changes in these firm characteristics have limited power in explaining the time-series decline in investment. First, we do not find that firm characteristics vary over time to the extent that U.S. firms have experienced diminishing investment opportunities or tightening financial constraints. Investment opportunity, measured by the market-to-book ratio of assets, generally improves during our sample period. The median ratio of cash flow to assets is rather flat over the same period. Second, we divide firms each year into two groups based on asset size, the market-to-book ratio of assets, sales growth, cash flow to assets, leverage, whether or not firms pay dividends, have (investment-grade) bond ratings, or spend on R&D or acquisitions, and find significant investment declines in all groups. Third, in regressions of investment that control for (the time-series and cross-sectional variations of) these characteristics, we still observe a significantly negative time trend in investment.

We rule out several other potential explanations. First, the investment decline is not explained by the change of firm composition over time. Firms listed in different decades often exhibit different features such as tendency to pay dividends and issue long-term debt (e.g., Custodio, Ferreira, and Laureano, 2013; Fama and French, 2001). However, we find that the investment decline is robust to the control of the fixed effects of public listing cohorts. Firms of different listing cohorts do not seem to have different levels of investment after controlling for firm characteristics and industry fixed effects. Second, corporate lifecycle does not appear to explain the investment decline either. We show that while firms invest a lot immediately after incorporation and, relatively, reduce investment afterward, the reduction in investment does not persist after five years of incorporation. Moreover, U.S. firms are not getting older on average as many new firms are founded and get listed. The investment decline is therefore not consistent with the corporate lifecycle explanation which suggests that maturing U.S. firms experience diminishing investment opportunities and consequently cut their investment. Third, the price of investment goods, especially equipment and software, reduces as technology advances (Greenwood, Hercowitz, and Krusell, 1997, Cummins and Violante, 2002). We find that, while the price reduction plays a non-negligible role, it leaves the dominant part of the investment decline unexplained.

Our further results suggest that the investment decline is related to the transition of U.S. economy toward more service-orientated productions (e.g., Lee and Wolpin, 2006; Buera and Kaboski, 2012). We have witnessed substantial variations in industry composition in the past decades, largely due to technological progress. Some traditional industries shrink while some new industries boom. First, industry-level analysis shows that, although most industries experience investment declines, the expanding industries incur significantly larger declines than the shrinking industries. Second, we find that the sensitivity of corporate capital investment to investment opportunities reduces over time. A new investment opportunity in the more recent years, relative to that in the earlier years, demands firms to invest less in fixed assets and more in intangible assets. In other words, investment in fixed assets becomes less important in the production of the new economy. Our examination on the assets structure confirms this hypothesis. Fixed assets as a proportion of total assets reduce significantly over time, as a result of the persistent reduction in capital expenditure. On the other hand, intangible assets increase its share in the assets structure. This is consistent with some recent studies that suggest the increasing importance of intangible assets in firm production (Lustig, Syverson, and Van Nieuwerburgh, 2011; Eisfeldt and Papanikolaou, 2013). Finally, using the data from Bureau of Economic Analysis's Annual Industry Accounts, we find that industries experiencing the largest drop in the use of materials as an input incur the largest reduction in capital expenditure.

Additional evidence suggests that the globalization of the world economy also plays an important role in the decline of investment. We find an increasing proportion of sales by foreign firms in most industries over our sample period, and industries with greater increases in the foreign sales reduce capital investment by more. Moreover, we find in international data that the investment decline is not unique to U.S. firms. Firms in developed economies such as G7 and OECD incur investment declines similar to U.S. firms. In contrast, firms in fast-growing economies such as BRICS have not incurred investment declines. This is consistent with the hypothesis that more developed economies have been experiencing a gradual shift in their economic structure from production-based towards more service-orientated. The latter would demand less investment in fixed assets and more in intangible assets and human capital. As a result, much of the production in the traditionally capital expenditure heavy industries has been shifted to less developed economies with relatively cheaper labor.

Our study contributes to the literature as follows. First, we are the first to examine capital investment of U.S. firms in a long horizon and identify a robust and pervasive, and somewhat puzzling, decline over the last three decades. Existing theories of investment, due to their micro perspective, fall short in explaining the decline trend. Second, we document a significant time-series variation of the sensitivity of firm capital expenditure to investment opportunity. It suggests a dynamic view of firms' investment behavior and its determinants, and has important implications to investment theories. Third, we show a significant impact of the transition of US economy and globalization on corporate policies such as capital investment. We also add to the burgeoning literature on the role of intangible capital in firm production and asset pricing (e.g., Carlin, Chowdhry, and Garmaise, 2011; Eisfeldt and Papanikolaou, 2013; Faria, 2008; and Lustig, Syverson, and Van Nieuwerburgh, 2011). Intangible capital plays an increasingly important role in firm production and mitigates firms' reliance on fixed assets.

The rest of our study is organized as follows. Section 2 presents the evidence of the time-series decline in corporate investment. Section 3 reviews the theory and empirical literature of corporate investment. Section 4 investigates whether firm characteristics explain the time-series decline in investment. Section 5 explores various implications of economic structure changes on capital investment. Section 6 investigates the impact of globalization and international evidence. Section 7 concludes.

2. The time series evidence of corporate capital expenditure

Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (Standard Industry Classification (SIC) codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded because of regulations of their corporate policies. We require the information of firm total assets (A) and capital expenditure (CAPX) available in the Compustat fundamental annual file. Our base sample consists of 13,386 unique firms with 111,965 firm-year observations.

Our primary variable of capital investment is a firm's annual capital expenditure divided by its total assets at the end of the previous fiscal year (CAPX/A).[1] Table 1 presents the median, mean, and aggregate ratios of capital expenditure to assets from 1980 to 2012, which are also plotted in Figure 1 for a more intuitive view. The aggregate ratio is calculated as the sum of dollar capital expenditure across all firms in a given year divided by the sum of these firms' total assets at the previous fiscal year end. All three ratios in Figure 1 decline substantially even though there are some minor reversals in the middle 1990s and several years before the 2008 financial crisis. Like many other corporate financial ratios, the capital investment ratio is positively skewed – the mean tends to be higher than the median. The number of firms in our sample starts with 3,111 in 1980, peaks at 4,945 in 1997, and declines to 2,643 in 2012, exhibiting an inverse U-shape.

Next we employ the Dicker-Fuller test to examine the time trend formally. We run the following time-series regression,

$$\Delta\left(\frac{CAPX}{A}\right)_{t+1} = \alpha + \beta * Trend_t + \gamma * \left(\frac{CAPX}{A}\right)_t + \theta_1 * \Delta\left(\frac{CAPX}{A}\right)_t$$

$$+\theta_2 * \Delta\left(\frac{CAPX}{A}\right)_{t-1} + \theta_3 * \Delta\left(\frac{CAPX}{A}\right)_{t-2} + \theta_4 * \Delta\left(\frac{CAPX}{A}\right)_{t-3} + \varepsilon. \quad (1)$$

The dependent variable is the difference in the capital expenditure ratios between the two subsequent years, t+1 and t. The explanatory variables on the right-hand side include a time variable of fiscal year (Trend), the level of capital expenditure in fiscal year t, and four lagged changes in capital expenditure.[2] The coefficient on Trend, β, captures the time trend of CAPX/A. Regression results are reported in Table 2, in three columns respectively corresponding to the median, mean, and aggregate ratios of capital expenditure. Confirming a decreasing time trend, the coefficient estimates of Trend in all three regressions are negative and statistically significant at the 5% level. The economic magnitude

[1] Capital expenditure in Compustat is a consolidated figure. It includes capital expenditure made by U.S. firms' overseas subsidiaries, for example, P&G's investment in their Indian division. The same is for total assets. Capital expenditure also includes costs of capital leases. While operating lease is not accounted in capital expenditure (it is often accounted as operating expenses in income statement), it does not affect the denominator, total assets, either.

[2] Our empirical results are robust to controls of one to four lags of capital expenditure changes.

is substantial and fairly consistent across different measures. The ratio of corporate investment to assets decreases by 0.070%, 0.137%, or 0.149% per year during the 33 years of our sample, respectively, for the median, mean, and aggregate ratios.

Our main sample consists of U.S. public firms traded at the three major stock exchanges. It is interesting to know whether the decline is subsumed if we include investment made by private firms. We examine this possibility using data from U.S. Bureau of Economic Analysis (BEA). BEA collects private non-residential fixed investment (PNFI) data, which contains annual investment in fixed assets by both private and public corporations. We compare the average ratio of PNFI relative to fixed assets of all firms with that of public corporations, and find they are very close in magnitude and both experience a similar decline in our sample period. We therefore rule out the possibility that including investment of private firms would change our results.[3]

Technological improvement in the post-war period has been remarkable. Technological advances have made corporate investment-specific equipment less expensive in general (Gordon, 1990; Greenwood, Hercowitz, and Krusell, 1997, Cummins and Violante, 2002). One potential implication is that our finding of the decline in dollar amount of capital expenditure could be a result of cheaper investment goods. To control the impact of the decreasing price of investment goods, we adjust the numerator of our CAPX/A ratio by a price index of investment goods, which was originally constructed in Gordon (1990).[4] We report the adjusted CAPX/A ratios in the last three columns of Table 1 and also plot them in Figure 2 in comparison with the raw time series. Reduced price of investment goods indeed accounts for part of the decline in capital expenditure. For example, comparing the median CAPX/A in 2012 to that of 1980, the drop is about 60% before the price adjustment while the drop reduces to 48% after the adjustment. The effect of adjustment is similar for the other two ratios of CAPX/A as reported in the last row of Table 1. We therefore conclude that the decreasing price of investment goods has a significant impact on the magnitude of the investment decline but it does not completely explain the time-series decline.

[3] The graph of PNFI/Fixed Assets based on the BEA data is available upon request from the authors.
[4] The price index of investment goods is originally constructed in Gordon (1990) for the period of 1947-1983, extended to 2000 in Cummins and Violante (2002), and extended further to 2013 by Riccardo DiCecio for his work (2009). We appreciate Riccardo DiCecio for kindly sharing his data with us.

Next we investigate if the finding of investment decline is concentrated in certain industries. We perform the regressions in equation (1) at the industry level, where the sample is classified into 44 Fama and French (1997) industries.[5] In Table 3, we report the estimates of β and the associated *t*-statistics for each industry. Based on the industry median CAPX/A, out of 44 industries in total, 41 industries (93.2%) show a declining trend in capital expenditure and in 30 of them (68.2%), the declining trend is statistically significant. Only three industries (coal; petroleum and natural gas; fabricated products) yield a positive β for the time variable but none of them is statistically significant. The examination on the industry mean ratio shows that the decline occurs to 43 industries and is statistically significant in 35 of them. The results based on the industry aggregate CAPX/A are very similar –declines are observed for 42 industries and 33 of them are statistically significant. The evidence suggests that the decline in investment is pervasive; in the meantime, we observe substantial variations in the decline magnitude across industries.

3. What determines corporate investment?

In this section, we review the literature of corporate investment. Assuming firm value maximization, the neoclassical theory of investment (Keynes, 1936; Jorgenson, 1963; 1967) suggests that a firm's optimal investment is made until the present value of expected future cash flows, at the margin, equals the opportunity cost of capital. Accounting for the adjustment cost of capital, Brainard and Tobin (1968) and Tobin (1969) develop the neoclassical theory to the *q*-theory of investment. The *q*-theory predicts that investment is a positive function of the ratio of the capital shadow price to its replacement cost and the optimal amount of investment is made until the ratio equals 1. The ratio is thereafter referred to as marginal *q* or Tobin's *q*. Tobin's *q*, often measured empirically as the market-to-book ratio of assets, has become a very popular measure of investment opportunities.[6] Empirical

[5] The Fama-French scheme classifies firms into 49 industries, but five industries including utilities, banking, insurance, real estate, and trading are excluded in our sample.

[6] In theory, investment should be made until the marginal *q* equals one, where marginal *q* is the marginal return on capital relative to the cost of capital. The market-to-book ratio of assets is a measure of average return on capital. Hayashi (1982) however shows that average *q* equals marginal *q* when the firm is in a competitive market and its production function is homogenous.

studies confirm a positive relation between capital investment and Tobin's q – firms invest more if they have more investment opportunities.

In the q-theory, Tobin's q is a sufficient statistic for investment. However, studies find that investment is also positively related to the firm's cash flow, even if q is included as an explanatory variable.[7] Cash flow is measured as the sum of earnings and depreciation. The interpretation of this finding is however controversial. Fazzari, Hubbard, and Petersen (1988), for example, interpret it as evidence of financing constraint affecting corporate investment. As a result of an imperfect capital market, due to all sorts of market frictions, external financing such as equity and debt is often more expensive than internal funds. Some firms are restricted of the access to the external financing market. These financially constrained firms tend to investment more when they generate more cash flow, generating high investment-cash flow sensitivity. The critics point out the endogeneity problem, namely, a firm's cash flow may contain information about its investment opportunities that, due to measurement errors, Tobin's q fails to capture.[8]

Capital market imperfections also lead to leverage being related to investment. Myers (1977) describes a debt overhang problem, in which a firm may under invest relative to the optimal amount when its debt level is high. This is because interest conflicts between equity and debt holders discourage decision-making equity holders from investing on even positive NPV projects if the benefits of investment mainly go to debt holders. It predicts a negative relation between investment and leverage – high leverage and financial distress result in underinvestment.

The agency conflicts between managers and shareholders, on the other hand, predict overinvestment. Jensen (1986; 1993), for example, argues that managers' empire-building preferences will cause them to invest excessively and abundant internal fund exacerbates the problem (i.e., free cash flow problem). This leads to the prediction that investment is increasing in internal fund. Jensen

[7] Fazzari, Hubbard, and Petersen (1988), Hoshi, Kashyap, and Scharfstein (1991), Whited (1992), among others. Hubbard (1998) provides a comprehensive review of the literature.

[8] This interpretation is controversial, for example, Gomes (2001), Alti (2003), Cooper and Ejarque (2003), and Abel and Eberly (2011) theoretically demonstrate the positive relation between investment and cash flow in the absence of financing constraints. Hennessy, Levy, Whited (2007) show that the convex costs of external equity may lead to the positive relation between investment and cash flow. Kaplan and Zingales (1997) empirically challenge the positive relation between investment and cash flow as evidence of financial constraint. Erickson and Whited (2000) suggest that errors in measuring marginal q result in the positive relation between investment and cash flow.

suggests firms using debt to control the problem, because debt services make the firm obligated to pay out cash and thereby reduce managers' discretionary budgets. This also implies that investment decreases with leverage. Other managerial characteristics might also affect firm investment, such as short-termism, herding tendency, inertia, and overconfidence.[9]

Studies also suggest that, if the stock market is not perfectly efficient, mispricing could also affect corporate investment. For example, Stein (1996) hypothesizes that the investment of firms that are heavily dependent on external equity is more sensitive to stock mispricing than firms with plenty of cash. In particular, the equity-dependent firms tend to issue equity and invest more when their stock prices are (overly) high. Baker, Stein, and Wurgler (2003) provide evidence supportive of this prediction, as well as similarly in Polk and Sapienza (2009). This predicts a positive relation between investment and stock valuation (return). However, it is worth mentioning that high stock return or valuation may suggest anticipation of positive investment opportunities.

Corporate investment is also affected by macroeconomic factors. Bernanke and Gertler (1989) suggest that a positive shock to the economy improves firms' profits and retained earnings; this in turn leads to increased investment and output. The mechanism amplifies the upturn. Kiyotaki and Moore (1997) further argue that this kind of acceleration effect could also function through the movement in firms' asset values, in addition to just cash flows. Corporate investment is also affected by the easiness of the credit market, which is a function of the central bank monetary policy and the banking industry performance. Firms invest more when they are easy to borrow capital in the market. Bernanke and Gertler (1995) provide a survey for the literature. Recent studies show that a country's financial development, at least partly driven by the country's legal protection and accounting standards, is a strong predictor of its growth, capital accumulation and investment (King and Levine, 1993; LaPorta et al., 1997; 1998; Rajan and Zingales, 1998; Demirguc-Kunt and Maksimovic, 1998). Financial development protects investors better and thus relaxes external financing constraint.

[9] See Stein (2003) for a survey of the literature. These managerial characteristics predict either over or under investment. For example, inertia predicts managers prefer "a quiet life", so they don't invest when good investment opportunities arise and are reluctant to liquidate poor projects that are already invested. The empirical support for these hypotheses is mostly in the cross-section. For the interest of our paper, we assume that these managerial characteristics are more or less stable over time and unlikely to lead to the secular decline in firm investment.

In summary, corporate investment is positively related to Tobin's *q*, cash flow, stock return (valuation), and negatively related to leverage. In addition to these firm-level factors, it is also affected by the general market environment, such as business-cycle fluctuations, productivity (technology) shocks, credit easiness in the market, and the institutional development of the financial market.

4. Firm characteristics and the decline in corporate investment

In this section, we explore the relation between corporate investment and various firm characteristics, as motivated by existing theories of investment. We then investigate if the time-series decline in investment is explained by the time-series variation in firm characteristics, or concentrated in (driven by) firms of certain characteristics. We employ both univariate analysis and multiple regressions.

4.1. Univariate Analysis

4.1.1. Investment opportunity

Investment opportunity is perhaps the most important determinant of corporate investment. The *q*-theory predicts that a firm should invest until the marginal benefit of investment equals its replacement cost. Investment opportunity is thus measured by the marginal *q* in theory. Firms should invest more if their marginal *q* is higher in the cross-section. Empirically a firm's marginal *q* is often measured by its market-to-book ratio of assets. We compute the ratio as (book value of total assets – book value of equity + market value of equity)/book value of total assets. As an alternative, we also measure investment opportunity by sales growth – the percentage change in sales from the previous fiscal year. If the time-series decline in investment is driven by investment opportunity, we expect to observe: (1) The average and aggregate investment opportunities of U.S. firms shrink over time; and (2) the decline is more evident in firms with fewer investment opportunities.

To investigate if investment opportunities of U.S. firms decrease over time, we compute the median and mean market-to-book asset ratio (V/A) of a given year and plot them in a panel of Figure 3. We find that, on average, investment opportunities slightly increase during our sample period. In unreported time-series regressions, we confirm the increasing trend in V/A. This evidence challenges shrinking investment opportunity as a potential reason for the decline in investment.

To examine the investment trend across firms of different investment opportunities, we cut the sample each year into two subsamples of high and low investment opportunities, based on the median market-to-book ratio of assets (or sales growth) in that year. Table 4 presents the averages of the median CAPX/A ratio for the high and low investment opportunity subsamples during the 5-year subperiods (the initial and final subperiods have 7 and 8 years) and the full period. Consistent with the *q*-theory, firms with more investment opportunities invest more in the cross-section. The CAPX/A ratio is higher for the subsample of firms with higher market-to-book asset ratios or sales growth. Comparing across the subperiods, we find that CAPX/A decreases significantly in both high and low investment opportunity subsamples. The last two columns of this table report the coefficient estimates of the trend variable and the associated p-value using the model specification (1). However, the magnitude of decline is about three times larger for firms with more investment opportunities. In other words, the decline in investment is more evident in firms with more investment opportunities. It is somewhat surprising that firms with relatively more investment opportunities do not keep up their capital expenditure as suggested by their investment opportunities.[10] The results also cast doubt on time variation in investment opportunity as an explanation for the time-series decline in investment.

4.1.2. Financial constraint

Studies have shown that, controlling for investment opportunities, a firm's capital investment is also positively related to its cash flow. One interpretation for the positive cash flow-investment sensitivity is financial constraint. Asymmetric information implies a higher cost of external capital than internal funds, resulting in financial constraint for some firms that are more dependent on external financing. These constrained firms increase investment when they realize a higher cash flow. Our univariate analysis reported in Table 4 seems consistent with the effect of financial constraint on investment. The literature generally suggests that large firms, firms producing high cash flows, firms with high cash payout, and firms with (investment-grade) credit ratings are less subject to the adverse selection problem and thus are less financially constrained. We find that these firms tend to invest

[10] We revisit this issue in Sections 5.

more than their counterparts in the cross-section, as shown in Table 4. Over time, both groups of firms incur significant time-series declines in capital investment. More interestingly, the magnitudes of declines are not consistent under the different proxies of financial constraint. We find that small firms, firms with high cash flow, low payout, and good credit ratings tend to reduce investment by more. The evidence thus does not support financial constraint as a potential explanation for the time-series decline in investment.

4.1.3. Agency problems

Agency problems predict a positive relation between internal funds and investment since overinvestment is more likely when internal funds are abundant. Leverage, as a way to leash overinvestment, is expected to be negatively related to investment. Moreover, high leverage may lead to debt overhang and underinvestment, which reinforces the negative relation. Our univariate analysis in the whole sample, however, generates little evidence for a positive relation between cash holding and investment or a negative relation between leverage and investment. But if we take a closer look at different times, it is true that, in the early periods, high cash holding and low leverage are associated with large corporate investment. This cross-sectional evidence seems to reverse in the later periods. Our trend analysis in subsamples confirms a larger time-series investment decline for firms with high cash holding or low leverage. Since agency problems, if any, are supposed to be worse in these firms, the evidence of larger investment declines does not seem to be explained by agency concern. Moreover, if low internal fund and high leverage also characterize financial constraint, the larger investment declines for firms that are not financially constrained are inconsistent with tightening financial constraint over time.

4.1.4. Capital productivity

In a conventional production function such as the Cobb-Douglas function, economic output is a function of labor and capital inputs. The parameters reflect technology and the relative importance of the inputs. If a firm's production is labor intensive, it relies less on capital investment. For a given amount of output, its average capital productivity, measured by sales divided by PP&E (i.e., plants, property, and equipment), is usually higher. On the other hand, a firm with capital intensive production generally has lower average capital productivity. In other words, average capital productivity often signals the importance of capital investment in a firm's production. Our univariate analysis confirms that firms with lower capital productivity tend to invest more than firms with higher capital productivity in the cross-section. In the time-series, we find that firms with both high and low capital productivities experience significant declines in capital investment. If any, the magnitude of decline is larger for capital-intensive firms.

4.1.5. R&D and acquisitions as substitutes

In a broader sense, corporate investment could also include expenses on research and development (R&D) and acquisitions. In accounting, capital expenditure (CAPX) increases a firm's fixed assets (i.e., plants, property, and equipment), while R&D increases a firm's expected intangible assets. Depending on the nature of the target firm and the accounting method (pooling vs. purchasing), an acquisition could increase both tangible and intangible assets. It is a natural conjecture whether there is a substitution between capital expenditure and R&D as well as acquisition expenses.

We investigate this conjecture as follows. We divide the sample into two groups depending on if a firm has incurred any R&D expenses during our sample period 1980-2012. So the non-R&D group consists of firms that have never reported any R&D expenses in the four decades. Similarly we divide firms into the acquirer and non-acquirer groups.[11] Table 4 presents the median CAPX/A ratios for each group in each subperiod, as well as for the whole period. The time-series decline in investment is statistically significant for firms in both the non-acquirer and non-R&D groups, though the magnitude is larger for the acquirer and R&D groups. The evidence suggests that the substitution story, at best, provides a partial explanation for the investment decline and is limited in certain firms.

In short, the univariate analysis largely confirms the cross-sectional relations between corporate investment and various firm characteristics. However, none of these factors fully explains the time-series decline in investment. The decline occurs in firms with both high and low investment opportunities, in both large and small firms, in firms that seem financially constrained or not seemingly constrained, in firms with both high and low cash holdings, in firms regardless of whether expense on R&D and acquisitions.

[11] In our sample during 1980-2012, 49.70% of the firms have not reported any R&D expenses and 40.20% of the firms have not reported any acquisition expenses.

4.2. Multiple regressions

Next we investigate the relation between capital investment and various firm characteristics in multiple regressions. The purpose is to analyze if the investment decline can be attributed to time-series changes in firm characteristics. This method has been used in Bates, Kahle, and Stulz (2009) in examining time-series changes in corporate cash holding and Custodio, Ferreira, and Laureano (2013) in examining time-series changes in corporate debt maturity. Our dependent variable, CAPX/A, is each firm's capital expenditure deflated by its total assets in the previous year. The independent variables in our basic regressions, motivated by existing theories and empirical evidence of corporate investment, include investment opportunity measured by the market-to-book asset ratio, cash flow relative to its assets, and firm size measured as the natural log of total assets. All explanatory variables are lagged by a fiscal year. Table 5 reports the regression results. Results from the first model confirm the findings of earlier studies that capital investment is positively related to investment opportunity and cash flow and negatively related to firm size.

In the second model, we include in the baseline model a set of dummy variables corresponding to the five-year subperiods. For example, the 1985-1989 dummy equals one if the dependent variable investment is dated in fiscal year 1985 to 1989 and equals zero otherwise. The regression constant thus captures the investment in the first subperiod 1980-1984 that is not explained by these firm characteristics. The coefficient estimates for these subperiod dummy variables capture the differences in constants against that of the period 1980-1984. The results in Table 5 suggest that, relative to the first subperiod, firms in all the other subperiods experience significant declines in investment, and the magnitude of declines generally increase over time. The regression evidence is consistent with the graph in Figure 1 – firms invest less and less over time.

In the third model, we employ a linear time trend as the only explanatory variable. The coefficient estimate indicates a significant decrease in CAPX/A of 0.21% per year. This is consistent with our findings in Table 2. Unlike the Dickey-Fuller time-series tests which focus on the mean, median, or aggregate measure of investment ratios, our following tests are able to control the firm-level variations in investment determinants. This allows us to evaluate if the declining trend detected in Tables 2 and 3 is explained by variations in firm characteristics.

Model 4 is such an example. After controlling for the variations in firm characteristics, the trend coefficient is still 0.21% and remains significant at the 1% level. The coefficient estimates for characteristics are also similar to those obtained from Model 1. Model 5 includes industry dummies and Model 6 controls firm fixed effects. The results are similar to those of Model 4, even though the magnitude of decline reduces slightly. In short, controlling for (the time-series and cross-sectional variation of) various firm characteristics, we still observe a significant declining trend in investment with similar magnitude. The characteristics that are important cross-sectional determinants of corporate investment explain little of the time-series decline.

To test the robustness of our finding, we also control for other characteristic variables including market leverage, capital productivity, R&D expenses, credit rating dummy, payout ratio, and sales growth. In addition, to control for the potential impact of macroeconomic factors on corporate investment, we employ a set of macroeconomic variables including GDP growth, credit spread, short interest rate, term spread, unemployment, inflation, and a recession dummy. Most of these variables have significant impact on investment, as indicated by their statistically significant coefficient estimates; however, the trend coefficient remains negative and statistically significant even with these additional controls. The regression results for various specifications are reported in Table 6.

4.3. Impact of corporate lifecycle

Studies have shown that corporate lifecycle is an important factor behind many firm decisions such as financing and dividend policies. It is also known that a firm's investment opportunities are abundant in its early life but diminishes over time as it matures. For example, Pastor and Veronesi (2003) show a convex decline in a typical firm's market-to-book ratio along its age. It is possible that our findings reflect a maturing process of typical U.S. firms and their diminishing investment opportunities.

We therefore investigate the impact of another firm characteristic, i.e., firm age, on the firm's capital expenditure. We measure firm age in two different ways: age since the firm is founded or since it is listed and included in the CRSP data. The results are plotted in Figure 4. The top panel plots the average founding or listing (at CRSP) age of our sample firms. Note that the samples are different for the two definitions of firm age; firms with available founding age data are much fewer.

We observe the average age of U.S. public firms are about 15 to 25. There is a slightly increasing trend of firm age for both age definitions. The bottom panel shows the median CAPX/A for firms of different ages. For both age definitions, we find that firms indeed invest more during the first three to five years and quickly cut down investment. However, the decline in investment does not persist beyond the five-year period; firms instead maintain a flat pace of investment afterwards. The evidence suggests that corporate lifecycle is unlikely to be an explanation for the time-series investment decline, since most of the firms are much older than five. Nevertheless, to account for the potential impact of corporate life cycle on investment (at least in the first few years), we control for firm age in subsequent regressions.

4.4. New listing effect

IPOs in the U.S. come in waves. Firms cluster to go public in certain "hot" years while IPO activities subside in other "cold" years. Firms listed in different decades often exhibit different features in many aspects. Pastor and Veronesi (2005) suggest that technology innovations could be the underlying driver behind these waves, which explains that firms going public at different decades have their specific characteristics. For example, many IPO firms in 1990s are internet firms. The specific characteristics may affect optimal corporate policies. Fama and French (2001), for example, find that newly listed firms tend not to pay dividends. Custodio, Ferreira, and Laureano (2013) suggest that newly listed firms in recent decades use more short-term debt and are responsible for U.S. firms' general decrease in debt maturity. We thus investigate if the decline in investment is similarly driven by newly listed firms.

To capture the potentially different levels of investment for firms of different listing cohorts, we include in the investment regressions six dummy variables that indicate the decade when a firm was listed. For example, the 1950-1959 dummy is set to be one if a firm was listed in 1950s and zero otherwise. If our finding of the investment decline is driven by newly listed firms, we expect the coefficient of the time trend variable to become insignificant after controlling for these listing cohort dummies. The results of this analysis are reported in Table 7. In all regression models, the coefficient estimates of the time trend variable are always significantly negative, and the magnitudes are even larger than the magnitude of the estimate from the regression without additional controls (Column 3 of Table 5). This evidence shows that the decline trend of investment is robust to controls of public listing cohorts.

There are also interesting findings regarding the investments of firms in different listing cohorts. In the first model of Table 7 that includes the listing dummy variables in addition to a time trend variable, the listing dummies have positive and significant coefficient estimates for firms listed in 1970s and after. This suggests that average investment does vary across listing groups and newer firms tend to have higher average investment than firms listed earlier than 1970s. In models that we control for the CRSP firm age, all the listing dummies become insignificant, due to the high correlation between the CRSP age and listing dummies.

5. Transition of the U.S. economy and the decline in fixed assets investment

Technological progress can transform economic structure in a fundamental way (Greenwood and Seshadri, 2005). Anecdotal observations suggest a substantial variation in industry composition in the past few decades. For instance, industries such as construction materials and steel have contracted significantly in the U.S. economy. On the other hand, computer software, as an industry that barely exists in the 1970s, has evolved into a crucial component of the economy in the new century. Moreover, studies have documented substantial growth of the service sector and an increasing demand for more skilled labor in the U.S. economy (Lee and Wolpin, 2006; Buera and Kaboski, 2012). For instance, Buera and Kaboski (2012) illustrates that the ratio of services relative to commodities increases from 1.6 in 1980 to almost 3.0 in 2000. The transition of economic structure would require U.S. firms to invest less in fixed assets and more in human capital and intangible assets. Recent studies have shown that a firm's dependence on intangible assets becomes increasingly important (e.g., Eisfeldt and Papanikolaou, 2013 and 2014; Falato, Kadyrzhanova, and Sim, 2014). A new investment opportunity today may require a firm to invest more in R&D and developing human capital, rather than investing more in fixed assets.

Anecdotal observations seem to confirm this hypothesis. Retail firms such as Macy's traditionally need to invest much to own or lease store spaces in expensive commercial districts. Current online stores are able to consolidate and build their warehouses in much cheaper areas without sacrificing access to potential customers. Studios in entertainment industries now can use computers to achieve much of the graphical effects for which they used to spend a great amount of capital expenditure. IBM, known as a computer and hardware manufacturer, is now according to Wikipedia "a computer technology and IT consulting corporation."

If the investment decline is related to the transition of U.S. economic structure, we expect to observe the following evidence: (1) The sensitivities of capital investment to firm characteristics, in particular, variables associated with investment opportunities, reduce over time. (2) Fixed assets as a proportion to the total assets reduce over time; in contrast, intangible assets increase its share in the asset structure. (3) The reduction in capital expenditure is more significant in expanding industries (than in shrinking industries), in traditionally capital expenditure heavy industries, and in industries which decrease its reliance on physical assets during the production.

5.1. The change in the sensitivities of capital investment to firm characteristics

To examine the first hypothesis, we construct dummy variables corresponding to each of the subperiods in Table 4 and make these dummies interact with firm characteristics on the right hand side of the regressions. Table 8 reports the regression results. The first column presents the coefficient estimates of these characteristics for the first subperiod 1980-1984 which is our benchmark, and the rest columns report the differences in sensitivities for every other subperiod with respect to the first one. We find that the sensitivities indeed vary substantially over time. In particular, the sensitivities to market-to-book asset ratio and to cash flow almost monotonically decrease since early 1980s. Firms do not increase capital expenditure in reaction to new investment opportunities or high profitability as much as they did in the early periods. This suggests the decreasing importance of fixed assets investment as an input in the production.

One fundamental change in U.S. corporations since 1970s is the widespread accumulation of intangible capital and its increasing importance in production. Examples of intangible capital include expenses on employee training, R&D, produce design system, business processing system, information sharing technology, etc. As intangible inputs that are distinct from physical capital, they combine physical capital and human skills into systems of production. Lustig, Syverson, and Van Nieuwerburgh (2011) suggest that intangible capital becomes more important in production because firm productivity growth evolves from vintage-specific growth, which only affects new firms, to more general productivity growth, which makes all firms more productive. Even for firms that traditionally rely heavily on physical capital, investment in intangible capital also helps to improve their production efficiency. Our finding in Table 8 that corporate capital investment over time responds less to investment opportunities is consistent with this phenomenon.[12]

5.2. The change in asset structure

If the U.S. economy growth relies more on intangible capital and firms spend less on fixed assets, we expect to observe secular changes in assets structure of U.S. firms. Capital expenditure is supposed to increase fixed assets, or frequently called plants, property, and equipment (PP&E) in accounting terms. If firms continue to reduce capital investment in the past decades, we expect to observe a drop in fixed assets as a proportion of total assets. To examine this hypothesis, we decompose total assets (AT) into three components: current assets (ACT), net plant, property, and equipment (PPENT), and intangible assets (INTAN). Figure 5 plots the mean, median, and aggregate ratios of each component relative to total assets. We find a persistent decline in PPENT/AT for all three metrics, as a result of the time-series reduction in capital expenditure. On the other hand, we find a substantial increase in intangible assets, confirming the increasing importance of intangible assets in firms' production. This is consistent with a recent study by Falato, Kadyrzhanove, and Sim (2014) who similarly find an increase in intangible capital of U.S. firms.

The ratios of current assets to total assets also decrease over time, which rules out that the decline in investment is explained by accumulation of more current assets. One might find the decline in current assets surprising since recent studies (e.g., Bates, Kahle, and Stulz, 2009) have shown that over this time period U.S. firms increase holdings of cash, which is an important component of current assets. A closer look reveals that, while increasing cash holdings, U.S. firms in the meantime reduce non-cash current assets, such as inventory, and the reduction in non-cash current assets outweigh in magnitude the increase in cash holdings.

5.3. The decline in capital investment at the industry level

[12] We confirm in data a significant relation between firms' accumulation of intangible capital and the weakened sensitivities of capital expenditure to investment opportunities. The results are available from the authors.

Next we investigate how the decline in capital investment is related to the change in industry composition, and the production technology change in each industry.. Table 9 Panel A reports, for each industry, the number of firms in the industry, the percentage of total assets of the industry relative to the whole sample, and the aggregate CAPX/A ratio, respectively, in 1980 and 2012. We then compute the changes in the asset weights and the investment ratios during the two time points. Indeed, we find substantial industry variations during our sample period. For example, computer software industry in 1980 has only 14 firms which consist of 0.02% in assets weight of the sample. The number of firms increases to 157 and their total assets weight increases to 4.01% in 2012. Other fast expanding industries include business services, communication, and pharmaceutical products. In contrast, the number of firms in steel industry reduces from 81 in 1980 to 36 in 2012 and the assets weight reduces from 5.28% to 1.73%. Similarly, the construction material industry reduces its firm number from 183 to 39 and the assets weight from 3.92% to 0.82%.

The results on assets weight could be fairly consistent with one's observation. However, comparison on the CAPX/A ratios between the two time points does not yield findings as clear as those of assets weight. First, consistent with Table 3, the capital expenditure ratio drops for all but two industries (Fabricated products and Precious metals), regardless of whether the industry is expanding or shrinking. Second, the drop does not seem necessarily smaller, or larger, in magnitude for expanding industries than shrinking industries. For example, the ratio drops by 3.59% for business services – one of the fastest growing industries and by 4.63% for steel – one of the most shrinking industries. The ratio drops by 7.76% for communication – one of the fastest growing industries and increases by 3.80% for fabricated products – one of the shrinking industries.

To examine whether the decline in capital expenditure is related to the change in industry composition, we perform a cross-industry regression of the change in CAPX/A on the change in relative asset weight from 1980 to 2012 ($\Delta(\%Assets)$), and the level of CAPX/A in 1980,

$$\Delta\left(\frac{CAPX}{A}\right) = a + b * \Delta(\%Assets) + c * \left(\frac{CAPX}{A}\right)_{1980} + e.$$

The results are reported in Panel B of Table 9. We find a statistically significant negative relation between the change in capital expenditure and the change in industry asset weight. In general, expanding industries incur larger declines in capital investment than shrinking industries. One salient example is computer software industry, its asset weight increases by almost 4% during our sample period but its CAPX/A drops by almost 18%, the largest among all industries. This indicates that these growing industries are able to grow their total assets without increasing capital expenditure on fixed assets. We also find a significantly negative coefficient for the beginning level of CAPX/A, suggesting that the drop in capital expenditure is larger in originally CAPX-heavy industries. The regression results in general support industry variation as a driver for the investment decline.

Bureau of Economic Analysis's (BEA) Annual Industry Accounts (AIAs) provide composition of intermediate inputs in dollar value at the industry level dating back to 1997. Industry intermediate inputs are aggregated into three cost categories – energy, materials, and purchased services. In reflecting their relative importance in firm production over time, the data shows a low and flat energy, a significant increase in services, and a significant decrease in materials as a proportion to the total gross output. Materials are perhaps the closest among these three to be associated with physical assets. We therefore examine if the industry-level reduction in capital expenditure is explained by the change in material as an input to the industry's gross output. The last column in Panel B reports the regression results. Indeed, industries experiencing the largest drop in the use of materials as an input incur the largest reduction in capital expenditure. The evidence is consistent with our previous findings that suggest the decreasing importance of physical assets and the increasing importance of services or intangible assets in the production.

6. The impact of globalization and international evidence of capital expenditure

Globalization is one of the most frequently mentioned characteristics of the world economy in the last few decades. There are several notable events affecting the U.S. economy, for examples, General Agreement on Tariffs and Trade (GATT) Tokyo Round and Uruguay Round, North American Free Trade Agreement, and China's entry into WTO. An obvious consequence of globalization is the flux of foreign products and foreign direct investment in US, which strengthens within-industry market competition. In an event study (results untabulated), we find a significant decrease in capital investment in US firms following China's entry into WTO, consistent with Mello and Wang (2012). Also, using data from Bureau of Economic Analysis's (BEA) Foreign Direct Investment in US that record activities of US affiliates of foreign multinational enterprises, we find that US affiliates of foreign multinationals account for an increasing proportion of sales in most industries over our sample period, and industries that have experienced greater increase in the foreign sales reduce capital investment by more.[13] The evidence suggests that competition from foreign firms is at least partially associated with the within-industry decline in capital investment.

If the U.S. firm investment decline is related to the transition of economic structure and the globalization of the world economy, we expect to observe similar patterns for firms in countries with similar economic development levels to the U.S. and different patterns in countries to which U.S. shifts the shrinking industries. We thus examine if the evidence of investment decline is unique to U.S. firms or similarly observed in other countries. It is often argued that globalization in the past decades leads many manufacturing industries in developed economies to emerging economies with relatively cheaper labor. A salient example is Apple Inc. Its U.S.-based headquarter is mainly responsible for design, marketing, and support of new products. Most of the product manufacturing has been outsourced to its Asian partner firms. In the apparel industry, few products of the U.S. firms such as Nike, Reebok, and Ralph Lauren are really made in the U.S.

Our international data, obtained from DataStream for the period 1980-2013, include 38 non-U.S. countries that have at least five years continuous data of at least 50 public-listed firms. Utilities, banks, and financial service firms are excluded. Table 10 describe the international sample, including the country name, number of firm-year observations, sample period, starting year to have at least 50 firms, and the median and aggregate ratios of capital expenditure to total assets (CAPX/A). The last column indicates if the country belongs to G7 (U.S. excluded), OECD, or BRICS. Clearly, our data tend to include more developed economies due to the poor coverage of emerging economies especially in the early decades.

We plot the median, mean, and aggregate ratios of CAPX/A from the international sample in Figure 6. We find declines in all three ratios similar to the U.S. evidence. The median ratio drops from

[13] See http://www.bea.gov/international/di1fdiop.htm. Formal results are untabulated but available upon requests.

6% in 1980 to less than 3% in 2013. The aggregate ratio however shows the least decline. Next we investigate the patterns by dividing the countries into two groups, based on if they belong to G7 (OECD / BRICS) countries or not. Figure 7 presents the patterns. In general, the decline in capital expenditure is most evident in G7 and OECD countries, which are also similar to the U.S. evidence, is less obvious in other countries and not found in BRICS – the five fastest-growing emerging economies. Note for the BRICS sample, we start in 1991 as there are less than 100 data points in the years prior to 1991.

Next for 31 countries that have at least 12 years data, we run the time-series regressions of the Dickey-Fuller test, as we did for the U.S. firms in Table 2. The regression coefficient for the time trend variable and its associated *t*-statistics are reported in Table 11. We find that most countries, especially developed economies, incur declines in capital investment. A casual look suggests that most developing economies, including BRICS and some other relatively smaller ones, do not experience significant investment declines. The results are consistent with our observations in Figure 6. We conclude that the decline in capital investment is not unique to the U.S. firms. It also occurred in other relatively more developed economies such as G7 and OECD countries, but less so for growing economies. The evidence is consistent with the hypothesis that more developed economies transfer their economic structure from a production-based one more to a services-orientated one and thus require less capital expenditure on fixed assets.

7. Conclusion

We document that the capital expenditure of U.S. public firms declines substantially since 1980s. The decline is pervasive: it occurs in almost every industry and is not concentrated in firms with certain specific characteristics. The decline is not explained by new listing effects, corporate lifecycle, or time-variation of investment opportunities and financial constraint. The decline seems to be related to the transition of the U.S. economic structure and globalization. When an investment opportunity arises, firms in the early period respond with more investment in fixed assets while this sensitivity reduces much for firms in the recent decades. Recent firms focus more on developing intangible assets and human capital through, e.g., spending on R&D and SG&A. Fixed assets as an input in firm production becomes less and less important, consistent with the findings of some recent studies. In addition, globalization of the world economy also plays an important role. Industries that incur more severe foreign competition tend to cut capital investment more. Firms in economies with similar development levels to the U.S. also experience declines in capital investment while firms in fast-growing emerging economies do not. Our findings have important implications in understanding the dynamics of corporate investment and firm production process, and more profoundly, the investment-related asset pricing.

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Appendix: Variable Definitions

Variable	Definitions
CAPX/A	The ratio of capital expenditure (CAPX) to the book value of total assets at the beginning of the year (A).
Firm size (log(A))	The natural log of book value of total assets (A), adjusted by the CPI.
Market-to-book asset ratio (V/A)	(book value of total assets – book value of equity + market value of equity)/book value of total assets.
Cash flow (CF/A)	Measured as the income before depreciation minus interests, taxes and dividends (OIBDP-XINT-TXT-DVC-DVP) to the book value of total assets.
Market leverage (D/V)	The ratio of total debt (DLTT+DLC) to the market value of assets (book value of total assets – book value of equity + market value of equity).
Cash holdings	The ratio of cash holdings (CHE) to the book value of total assets.
Capital productivity	The ratio of total sales (SALE) to the net property, plant and equipment (PPENT).
Rating dummy	Dummy variable that takes the value of one if a firm has a Standard & Poor's domestic long-term issuer credit rating (SPLTICRM) available since 1986.
Investment-grade dummy	Dummy variable that takes the value of one if a firm has a credit rating BBB- or above.
Speculative-grade dummy	Dummy variable that takes the value of one if a firm has a credit rating BB+ or below.
Payout ratio	Measured as the sum of dividends and repurchase (DVC+DVP+PRSTKC)/book value of assets.
Sales growth	Measured as the percentage change in the sales from previous year.
R&D	The ratio of R&D expenses (XRD) to the book value of total assets.
Age(CRSP)	Number of years since first appeared in the CRSP dataset.
Age(founding)	Number of years since foundation (Jay Ritter's website).
GDP growth	The percentage change in the nominal GDP from previous year (Bureau of Economic Analysis)
Credit spread	Difference between BAA- and AAA-rated corporate bond yields (Federal Reserve).
Short-term rate	Yield on 1-year government bonds (Federal Reserve).
Term spread	Difference between the yield on 10-year government bonds and the yield on 1-year government bonds (Federal Reserve).
Inflation	Annual percentage change in the consumer price index (Bureau of Labor Statistics).
Unemployment	Unemployment rate (Bureau of Labor Statistics)
Recession dummy	Dummy variable that takes the value of one if there are at least 1 month in a year designated as recession by the NBER.

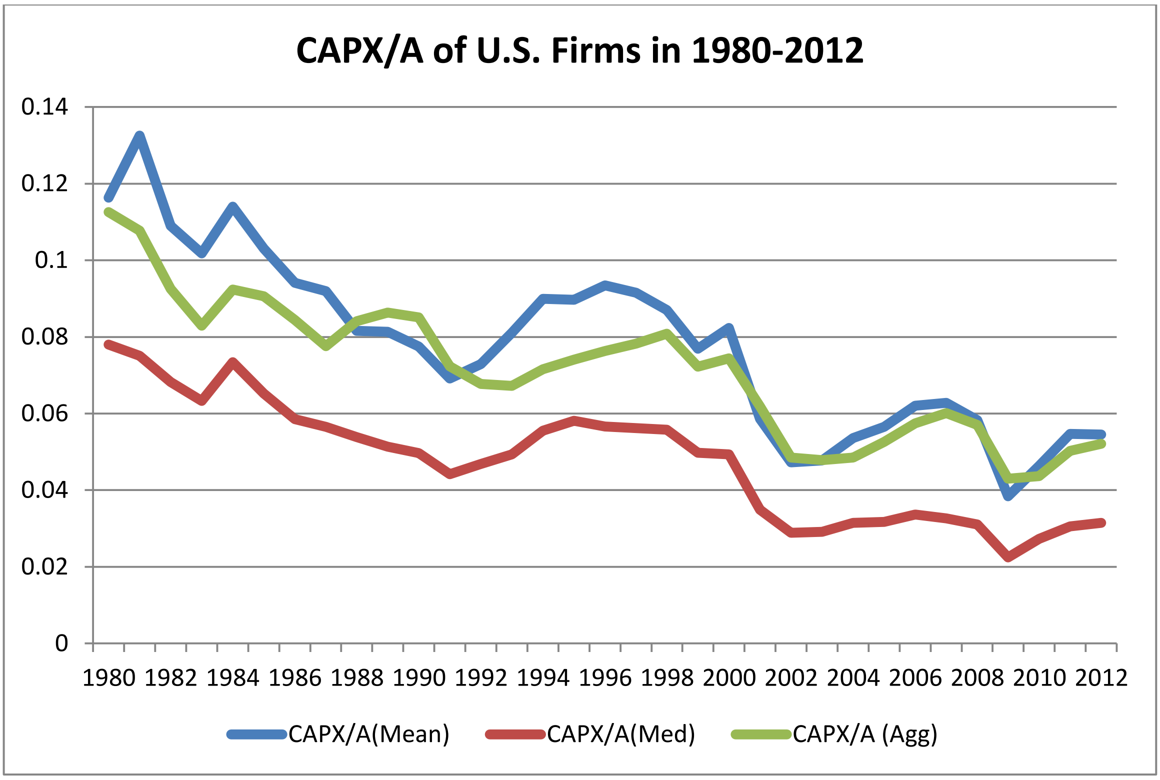


Figure 1
The ratios of capital expenditure to total assets for U.S. firms in 1980-2012

This figure plots the median, mean, aggregate ratios of capital expenditure to total assets (CAPX/A) for the sample firms during 1980-2012. The denominator, total assets, is measured at the beginning of the year. The aggregate ratio is calculated as the sum of dollar capital expenditure across all firms divided by the sum of these firms' dollar total assets at the beginning of the year. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012, with total assets (A) and capital expenditure (CAPX) information available at the Compustat fundamental annual file. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded.

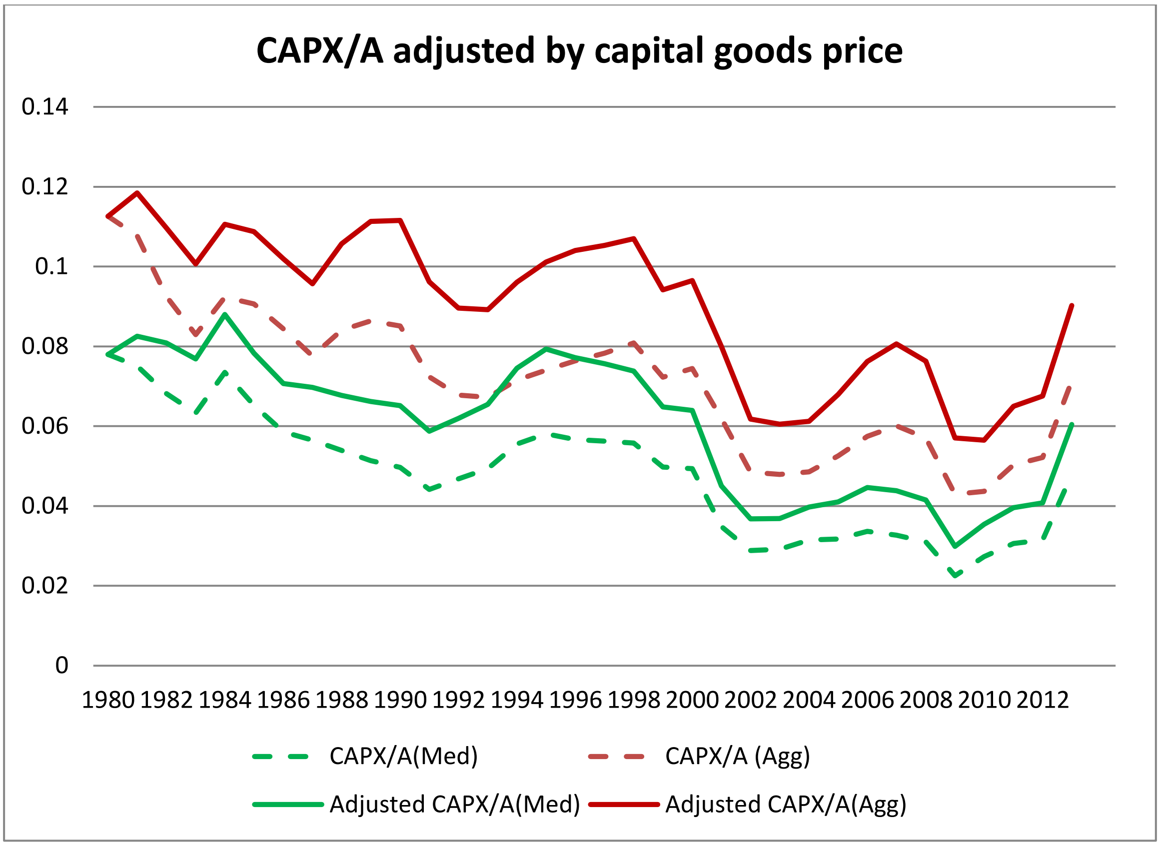


Figure 2
The ratios of capital expenditure to total assets for U.S. firms in 1980-2012 – adjusted by capital goods price index

The numerator of CAPX/A is adjusted by the price index of capital goods.

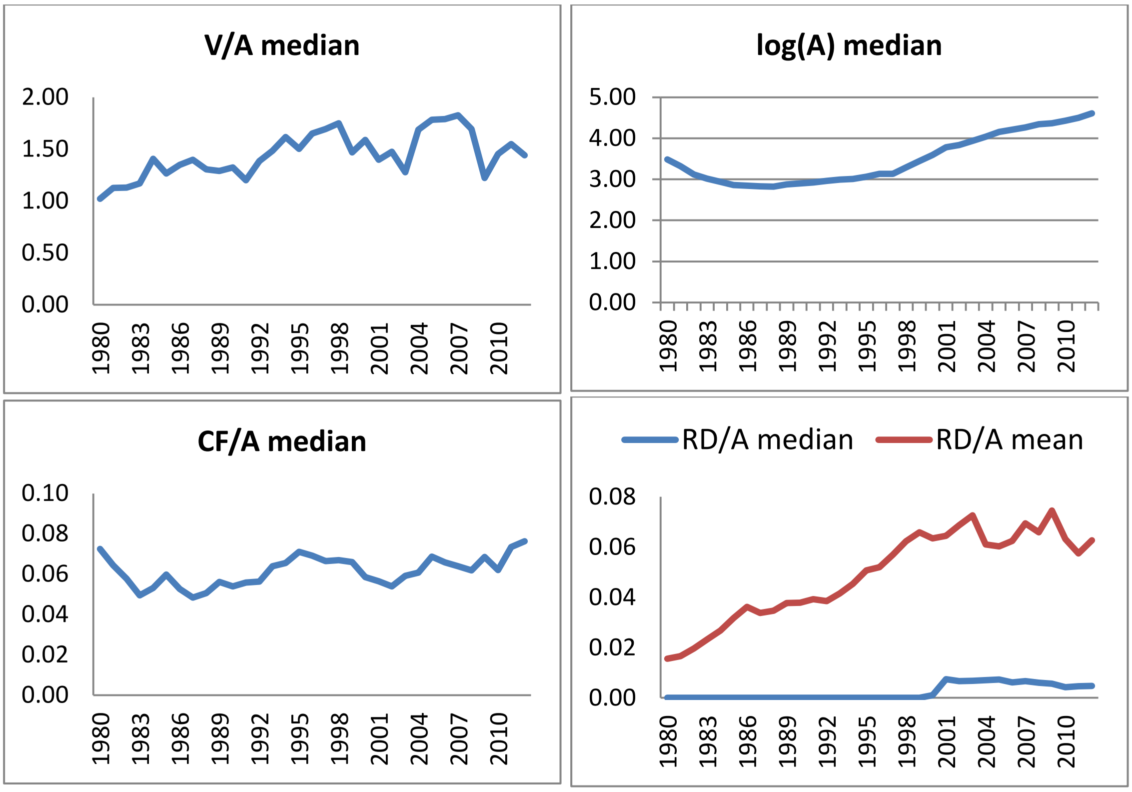
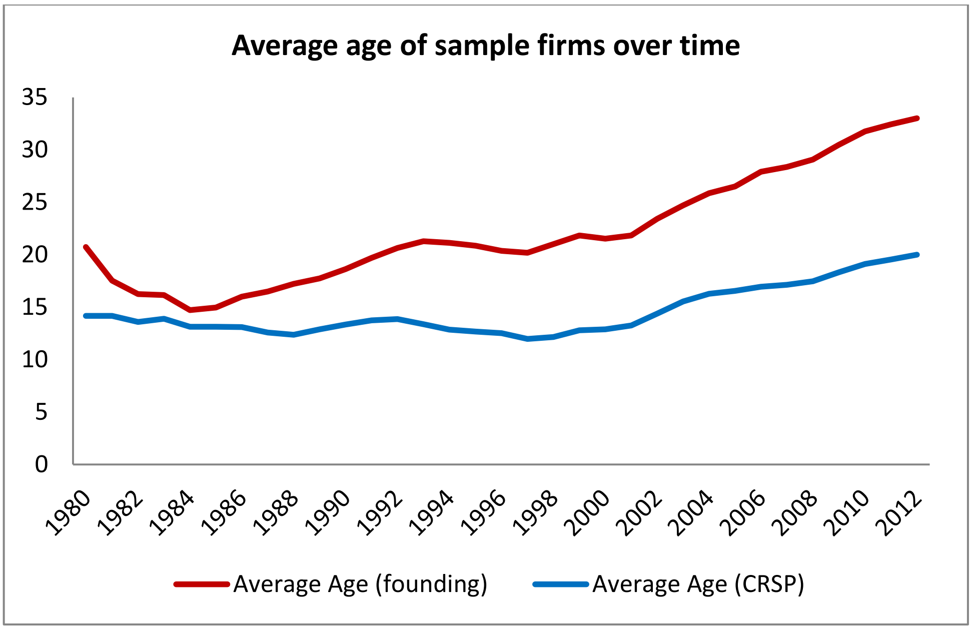


Figure 3
Variation of firm characteristics over 1980-2012

The top three figures plot the medians of market to book ratio (V/A), firm size (log(A)), and cash flow ratio (CF/A). The last figure plots both mean and median of R&D ratio (RD/A).



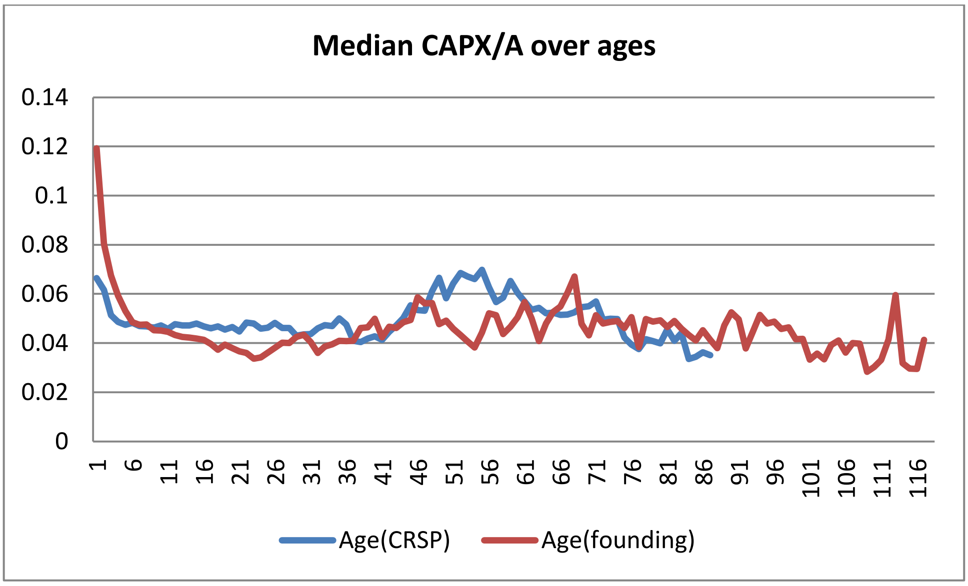


Figure 4
Corporate capital expenditure over the lifecycle

The top panel shows the average age for the sample firms in each year. The age is measured in two ways: age since founded or since first included in CRSP. The bottom panel shows the median capital expenditure to assets ratio (CAPX/A) at different age for the sample firms.

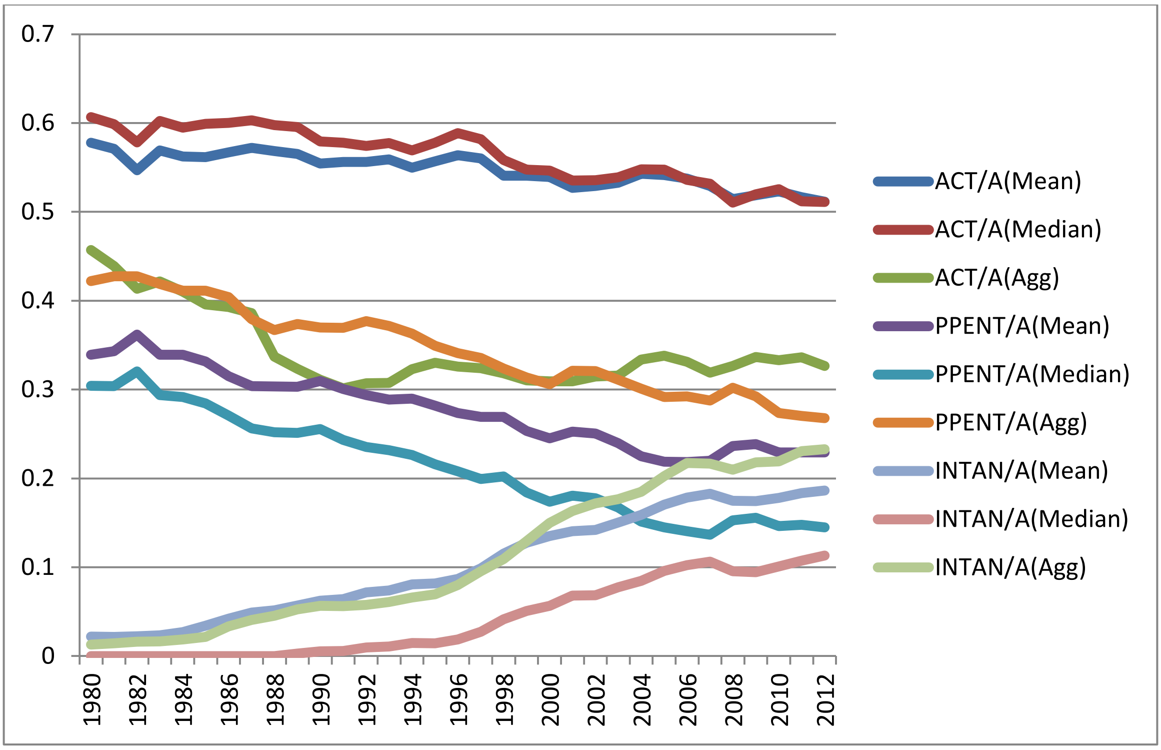


Figure 5
Variation of asset structure in 1980-2012

This figure plots the mean, median, and aggregate ratios of current assets (ACT), net plant, property, and equipment (PPENT), and intangible assets (INTAN) relative to total assets (A) for the sample.

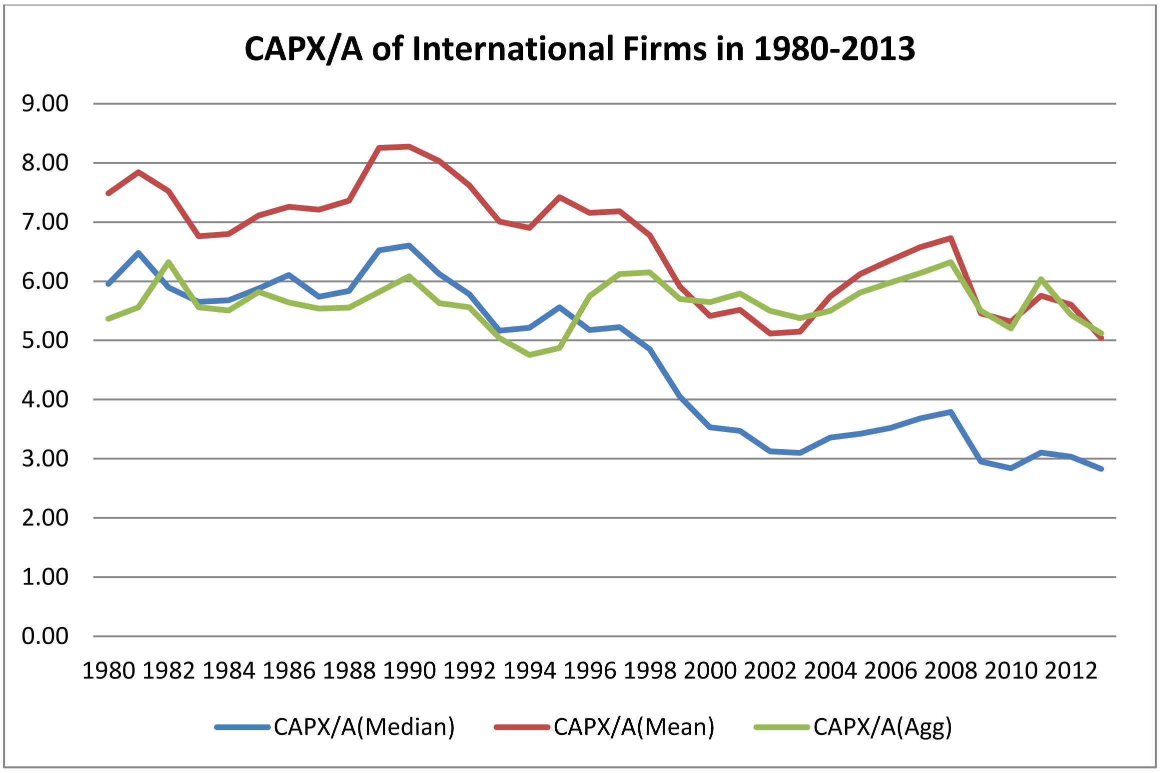


Figure 6
International Evidence

This figure plots the median, mean, and aggregate ratios of capital expenditure to total assets (CAPX/A) for international firms during 1980-2013. The denominator, total assets, is measured at the beginning of the year. The aggregate ratio is calculated as the sum of dollar capital expenditure across all firms divided by the sum of these firms' dollar total assets at the beginning of the year. Our international data, obtained from DataStream for the period 1980-2013, include 38 countries that have at least five years continuous data of at least 50 public-listed firms. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. More detailed information about the data is reported in Table 10.

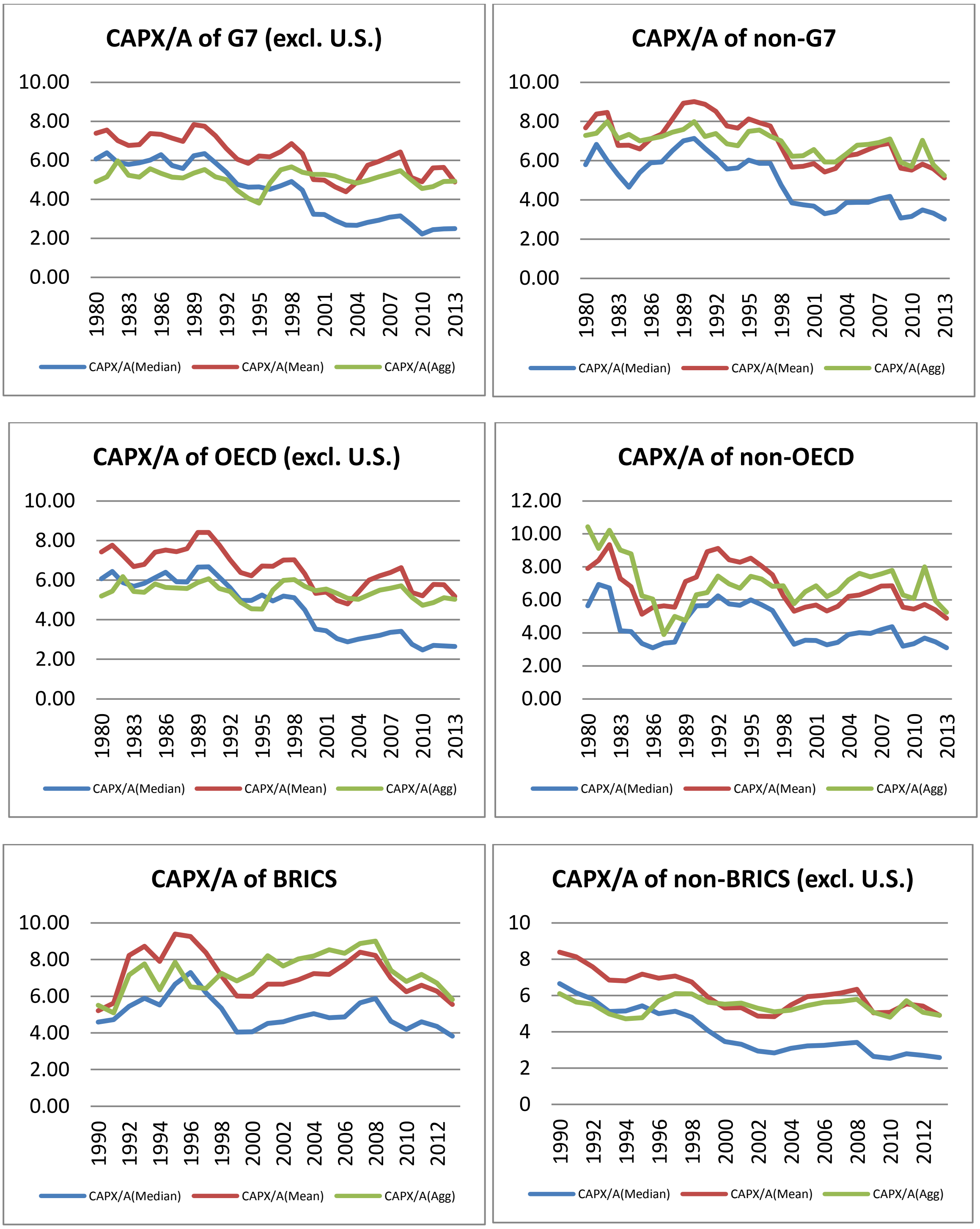


Figure 7
International evidence by groups

This figure plots the median, mean, and aggregate ratios of capital expenditure to total assets (CAPX/A) in 1980-2013 for international firms in different groups. We group firms from 38 countries based on if the country belongs to G7, OECD, or BRICS countries.

Table 1 - The ratio of capital expenditure to total assets by year: 1980-2012

This table presents the median, mean, and aggregate capital expenditure to total assets ratios (CAPX/A) for the sample firms from 1980 to 2012. The denominator, total assets, is measured at the beginning of the year. The aggregate ratio is calculated as the sum of dollar capital expenditure across all firms divided by the sum of these firms' dollar total assets at the beginning of the year. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. The last three columns report the capital expenditure ratios after adjusting the numerator, CAPX, by the price of capital goods due to technology advance.

		CAPX/A			Adjusted CAPX/A		
FYEAR	N	Median	Mean	Aggregate	Median	Mean	Aggregate
1980	3111	0.078	0.116	0.113	0.078	0.116	0.113
1981	3163	0.075	0.133	0.108	0.083	0.146	0.118
1982	3371	0.068	0.109	0.093	0.081	0.129	0.110
1983	3394	0.063	0.102	0.083	0.077	0.124	0.101
1984	3619	0.073	0.114	0.092	0.088	0.137	0.111
1985	3608	0.065	0.103	0.091	0.078	0.124	0.109
1986	3552	0.059	0.094	0.084	0.071	0.114	0.102
1987	3795	0.056	0.092	0.078	0.070	0.113	0.096
1988	3853	0.054	0.082	0.084	0.068	0.103	0.106
1989	3690	0.051	0.081	0.086	0.066	0.105	0.111
1990	3661	0.050	0.078	0.085	0.065	0.102	0.112
1991	3642	0.044	0.069	0.072	0.059	0.092	0.096
1992	3703	0.047	0.073	0.068	0.062	0.096	0.090
1993	3974	0.049	0.081	0.067	0.065	0.108	0.089
1994	4312	0.056	0.090	0.072	0.075	0.121	0.096
1995	4475	0.058	0.090	0.074	0.079	0.123	0.101
1996	4677	0.057	0.093	0.076	0.077	0.127	0.104
1997	4945	0.056	0.092	0.078	0.076	0.123	0.105
1998	4746	0.056	0.087	0.081	0.074	0.115	0.107
1999	4403	0.050	0.077	0.072	0.065	0.100	0.094
2000	4273	0.049	0.082	0.074	0.064	0.107	0.096
2001	4044	0.035	0.059	0.062	0.045	0.076	0.080
2002	3795	0.029	0.047	0.048	0.037	0.060	0.062
2003	3512	0.029	0.048	0.048	0.037	0.060	0.060
2004	3370	0.031	0.054	0.049	0.040	0.068	0.061
2005	3307	0.032	0.057	0.053	0.041	0.073	0.068
2006	3209	0.034	0.062	0.057	0.045	0.082	0.076
2007	3125	0.033	0.063	0.060	0.044	0.084	0.081
2008	3075	0.031	0.058	0.057	0.041	0.078	0.076
2009	2918	0.022	0.038	0.043	0.030	0.051	0.057
2010	2776	0.027	0.046	0.044	0.035	0.060	0.057
2011	2700	0.031	0.055	0.050	0.040	0.071	0.065
2012	2643	0.031	0.055	0.052	0.041	0.071	0.068
Average	3650	0.048	0.078	0.071	0.060	0.099	0.090
% Change from 1980 to 2012		-59.67%	-53.10%	-53.70%	-47.74%	-39.24%	-40.01%

Table 2 - Time-series regression of capital expenditure

This table reports the Dickey-Fuller test results of the following regression:

$$\Delta\left(\frac{CAPX}{A}\right)_{t+1} = \alpha + \beta * Trend + \gamma * \left(\frac{CAPX}{A}\right)_t + \theta_1 * \Delta\left(\frac{CAPX}{A}\right)_t + \theta_2 * \Delta\left(\frac{CAPX}{A}\right)_{t-1} + \theta_3 * \Delta\left(\frac{CAPX}{A}\right)_{t-2} + \theta_4 * \Delta\left(\frac{CAPX}{A}\right)_{t-3} + \varepsilon.$$

The dependent variable is the change in the capital expenditure ratio (CAPX/A) between fiscal year t+1 and t. The independent variables include the time trend variable (Trend), the CAPX/A in fiscal year t, and four lagged changes in the capital expenditure ratios. The regressions are respectively performed on the yearly median, mean, and aggregate ratios of capital expenditure to total assets. The table reports the regression coefficient estimates and the associated *t*-statistics in parentheses. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded.

	(1) Median	(2) Mean	(3) Aggregate
Trend*1000	-0.695**	-1.371***	-1.489***
	(-2.52)	(-3.36)	(-3.42)
CAPX/A(t)	-0.527***	-0.736***	-0.907***
	(-2.84)	(-3.75)	(-3.62)
CAPX/A(t)-CAPX/A(t-1)	0.326*	0.396**	0.749***
	(1.73)	(2.22)	(3.58)
CAPX/A(t-1)-CAPX/A(t-2)	0.177	0.156	0.217
	(0.97)	(0.88)	(1.06)
CAPX/A(t-2)-CAPX/A(t-3)	0.142	0.383**	0.105
	(0.82)	(2.35)	(0.61)
CAPX/A(t-3)-CAPX/A(t-4)	0.138	0.205	0.294
	(0.76)	(1.12)	(1.58)
Constant	0.037**	0.082***	0.092***
	(2.66)	(3.62)	(3.49)
Observations	33	33	33
R-squared	0.092	0.262	0.379

Table 3 - Industry-level test of time trend in capital expenditure

This table reports the Dickey-Fuller test results of the following regression for each industry:

$$\Delta\left(\frac{CAPX}{A}\right)_{t+1} = \alpha + \beta * Trend + \gamma * \left(\frac{CAPX}{A}\right)_t + \theta_1 * \Delta\left(\frac{CAPX}{A}\right)_t + \theta_2 * \Delta\left(\frac{CAPX}{A}\right)_{t-1} + \theta_3 * \Delta\left(\frac{CAPX}{A}\right)_{t-2} + \theta_4 * \Delta\left(\frac{CAPX}{A}\right)_{t-3} + \varepsilon.$$

The dependent variable is the change in CAPX/A between fiscal year t+1 and t. The independent variables include the time trend variable (Trend), the CAPX/A in fiscal year t, and four lagged changes in the capital expenditure ratios. The regressions are performed separately for each industry on its yearly median, mean, and aggregate capital expenditure ratios. The aggregate ratio is calculated as the sum of dollar capital expenditure across all firms in the industry divided by the sum of these firms' dollar total assets at the beginning of the year. Industries are classified as in Fama and French (1997). Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded.The coefficient on *Time Trend* is inflated by 1000. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively.

	CAPX/AT (median)		CAPX/AT (mean)		CAPX/AT (aggregate)	
Industry Name	Time Trend Coefficient	t-stat	Time Trend Coefficient	t-stat	Time Trend Coefficient	t-stat
Agriculture	-0.887*	(-1.99)	-3.043***	(-3.81)	-1.967**	(-2.66)
Aircraft	-0.481	(-1.59)	-0.579	(-1.61)	-0.659**	(-2.31)
Apparel	-0.068	(-0.63)	-0.421**	(-2.39)	-0.481***	(-2.97)
Automobiles and Trucks	-0.301	(-1.53)	-0.316	(-1.61)	-0.781**	(-2.47)
Beer & Liquor	-0.953**	(-2.40)	-1.232**	(-2.26)	-1.179**	(-2.23)
Business Services	-0.742**	(-2.74)	-1.452***	(-3.62)	-0.774*	(-2.01)
Business Supplies	-1.609*	(-2.01)	-1.297	(-1.58)	-2.070*	(-1.87)
Candy & Soda	-0.956	(-1.46)	-1.131	(-1.60)	-0.661	(-1.20)
Chemicals	-0.850**	(-2.17)	-0.927*	(-1.80)	-1.040**	(-2.27)
Coal	0.462	(0.91)	-0.349	(-0.42)	0.099	(0.20)
Communication	-1.184*	(-2.00)	-1.642**	(-2.34)	-1.102**	(-2.21)
Computer Software	-1.058***	(-2.89)	-2.154***	(-3.46)	-1.339	(-1.64)
Computers	-0.539	(-1.45)	-1.117*	(-1.73)	-2.229***	(-3.65)
Construction	-1.063**	(-2.55)	-1.195**	(-2.26)	-0.606	(-1.65)
Construction Materials	-0.434*	(-1.77)	-0.579*	(-1.86)	-0.972*	(-1.99)
Consumer Goods	-0.482**	(-2.13)	-0.628**	(-2.57)	-1.528***	(-3.53)
Defence	-2.056***	(-4.15)	-1.745***	(-3.02)	-2.060**	(-2.45)

Electrical Equipment	-0.464*	(-2.02)	-0.892**	(-2.30)	-1.045**	(-2.77)
Electronic Equipment	-0.835**	(-2.77)	-1.111**	(-2.57)	-1.310**	(-2.13)
Entertainment	-1.370**	(-2.19)	-2.024**	(-2.62)	-3.143***	(-3.12)
Fabricated Products	0.085	(0.33)	-0.540	(-1.45)	0.996**	(2.73)
Food Products	-0.911**	(-2.44)	-0.878***	(-2.85)	-0.701**	(-2.68)
Healthcare	-1.158**	(-2.21)	-1.962***	(-3.61)	-1.950***	(-3.16)
Machinery	-0.620**	(-2.48)	-1.046**	(-2.76)	-0.844**	(-2.70)
Measuring and Control Equipment	-0.767**	(-2.56)	-1.373***	(-3.14)	-2.084***	(-3.15)
Medical Equipment	-0.835***	(-3.17)	-1.402*	(-2.00)	-1.461***	(-3.91)
Non-Metallic and Industrial Metal Mining	-0.397	(-0.73)	-2.116**	(-2.52)	-0.459	(-1.16)
Other - almost Nothing	-1.153**	(-2.47)	-1.416*	(-2.04)	-1.555**	(-2.25)
Personal Services	-0.730**	(-2.65)	-1.576**	(-2.07)	-0.517	(-0.50)
Petroleum and Natural Gas	0.806	(0.84)	0.405	(0.41)	0.332	(0.98)
Pharmaceutical Products	-2.741***	(-4.92)	-3.054***	(-4.70)	-0.237	(-1.57)
Precious Metals	-0.477	(-0.75)	-2.434*	(-1.93)	-1.945*	(-1.87)
Printing and Publishing	-0.975**	(-2.36)	-0.788**	(-2.76)	-0.726**	(-2.12)
Recreation	-0.642***	(-2.80)	-1.178***	(-3.41)	-1.190*	(-1.99)
Restaurants, Hotels, Motels	-1.686***	(-3.04)	-1.752***	(-2.79)	-2.429***	(-3.27)
Retail	-0.586**	(-2.42)	-0.643**	(-2.66)	-0.534**	(-2.40)
Rubber and Plastic Products	-0.674*	(-1.83)	-1.005*	(-1.90)	-0.405	(-0.96)
Ship Building, Railroad Equipment	-0.467	(-0.76)	-0.236	(-0.39)	-0.634	(-1.24)
Shipping Containers	-0.719	(-1.68)	-0.865	(-1.48)	-0.741*	(-1.72)
Steel Works	-0.381	(-1.52)	-0.475*	(-1.75)	-0.767**	(-2.35)
Textiles	-0.499	(-1.66)	-0.574*	(-1.90)	-0.805*	(-2.01)
Tobacco Products	-0.510*	(-2.01)	-0.582*	(-1.78)	-0.840**	(-2.42)
Transportation	-2.410***	(-3.04)	-2.731***	(-2.82)	-2.069**	(-2.55)
Wholesale	-0.449**	(-2.65)	-0.745***	(-2.91)	-0.299	(-1.65)
Number (%) of declines	**41**	(93.18%)	**43**	(97.73%)	**42**	**(95.45%)**
Number (%) of significant declines	**30**	(68.18%)	**35**	(79.55%)	**33**	**(75.00%)**

Table 4 - Capital expenditure by groups of firms

This table reports the time series average by groups of firms of the media capital expenditure ratio (CAPX/A). The breakpoint for high/low and small/large groups is the yearly 50th percentile of each firm characteristic. Non-R&D firms are firms which have never reported any R&D expenditure. Non-Acquirer firms are firms which have never reported any acquisition expenditure. We also run regression of the yearly median CAPX/A on a constant and a time trend variable for each group. The last two columns report the coefficient estimates for the time trend variable (inflated by 1000) and the associated p-value. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. Variable definitions are available in the appendix.

Characteristic Variables	Subsample	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2005-2012	1980-2012	Trend x1000	*p*-value
Market to Book Assets	Low	0.055	0.047	0.040	0.047	0.029	0.027	0.041	-0.107	0.000
	High	0.095	0.069	0.061	0.064	0.040	0.033	0.060	-0.311	0.000
Sales Growth	Low	0.054	0.049	0.041	0.047	0.029	0.026	0.041	-0.128	0.000
	High	0.088	0.065	0.058	0.063	0.040	0.034	0.058	-0.235	0.000
Cash Flow/Assets	Low	0.050	0.037	0.032	0.038	0.023	0.021	0.034	-0.257	0.000
	High	0.094	0.080	0.070	0.073	0.049	0.043	0.070	-0.161	0.000
Assets	Small	0.065	0.047	0.040	0.046	0.028	0.024	0.041	-0.253	0.000
	Large	0.076	0.065	0.058	0.063	0.040	0.035	0.057	-0.165	0.000
Payout Ratio	Low	0.071	0.050	0.043	0.052	0.032	0.027	0.045	-0.160	0.000
	High	0.072	0.062	0.054	0.058	0.036	0.033	0.053	-0.153	0.000
Bond Rating Dummy	Unrated		0.054	0.047	0.054	0.034	0.030	0.043	-0.160	0.000
	Rated		0.069	0.062	0.063	0.040	0.037	0.050	-0.153	0.000
Bond Ratings	Speculative		0.054	0.049	0.057	0.035	0.037	0.043	-0.113	0.000
	Investment		0.079	0.069	0.068	0.044	0.038	0.056	-0.205	0.000
Leverage	Low	0.084	0.063	0.054	0.056	0.033	0.027	0.053	-0.294	0.000
	High	0.061	0.052	0.044	0.054	0.035	0.033	0.047	-0.124	0.000
Cash Holdings	Low	0.067	0.056	0.048	0.057	0.037	0.035	0.050	-0.139	0.000
	High	0.077	0.058	0.051	0.053	0.031	0.025	0.049	-0.278	0.000
Capital Productivity	Low	0.100	0.074	0.066	0.074	0.047	0.045	0.068	-0.258	0.000
	High	0.053	0.045	0.037	0.043	0.026	0.022	0.037	-0.160	0.000
R&D	Non-R&D	0.073	0.059	0.051	0.062	0.042	0.040	0.056	-0.179	0.000
	R&D Firms	0.070	0.056	0.048	0.050	0.030	0.024	0.045	-0.213	0.000
Acquisition	Non-Acquirer	0.068	0.050	0.043	0.052	0.035	0.026	0.049	-0.204	0.000
	Acquirer	0.072	0.059	0.051	0.055	0.034	0.030	0.050	-0.201	0.000

Table 5 – Cross-sectional regressions of capital expenditure on firm characteristics

This table reports the estimates of OLS regressions of capital expenditure ratio (CAPX/A). The explanatory variables consist of a time trend variable and firm characteristics including size measured as the log of total assets (log(A)), market-to-book ratio of assets (V/A), and cash flow to assets ratio (CF/A). Firm characteristics are lagged by one fiscal year. In Model 2, we also include dummy variables for subperiods. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. Variable definitions are available in the appendix. The table reports the regression coefficient estimates and the robust t-statistics adjusted for firm-leveling clustering in parentheses. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively.

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) Industry Fixed Effects	(6) Firm Fixed Effects
Trend*1000			-2.065***	-2.078***	-1.857***	-1.524***
			(-33.25)	(-33.30)	(-33.37)	(-22.33)
log(A)	-0.004***	-0.001***		-0.001***	-0.002***	-0.019***
	(-10.92)	(-3.46)		(-2.99)	(-6.25)	(-22.65)
V/A	0.010***	0.011***		0.011***	0.012***	0.012***
	(26.59)	(29.09)		(28.78)	(31.66)	(28.20)
CF/A	0.101***	0.090***		0.090***	0.081***	0.064***
	(33.57)	(29.65)		(29.71)	(28.78)	(21.59)
1985-1989 dummy		-0.023***				
		(-14.25)				
1990-1994 dummy		-0.037***				
		(-21.50)				
1995-1999 dummy		-0.029***				
		(-15.86)				
2000-2004 dummy		-0.056***				
		(-32.48)				
2005-2012 dummy		-0.059***				
		(-32.22)				
Constant	0.075***	0.098***	0.114***	0.096***	0.050***	0.159***
	(44.02)	(46.90)	(87.64)	(53.55)	(9.11)	(46.64)
Observations	111,965	111,965	111,965	111,965	111,965	111,965
R-squared	0.049	0.083	0.032	0.079	0.200	0.116

Table 6 – Cross-sectional regressions of capital expenditure: additional firm characteristics and macroeconomic factors

This table reports the estimates of OLS regressions of capital expenditure ratio (CAPX/A). The explanatory variables consist of a time trend variable and firm characteristics including size measured as the log of total assets (log(A)), market-to-book ratio of assets (V/A), cash flow to assets ratio (CF/A), market leverage (D/V), capital productivity measured as sales divided by the gross property, plant and equipment (Sales/PPEGT), R&D expenses to assets ratio (RD/A), credit rating dummy, payout to assets ratio (Payout/A), sales growth, and a set of macroeconomic variables. Both firm characteristics and macroeconomic variables are lagged by one fiscal year. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. Variable definitions are available in the appendix. The table reports the regression coefficient estimates and the robust t-statistics adjusted for firm-leveling clustering in parentheses. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively.

	1	2	3	4	5	6	7	8	9	10	11
Trend*1000	-1.646***	-1.136***	-1.632***	-1.461***	-1.306***	-1.672***	-1.061***	-1.509***	-1.599***	-1.335***	-1.679***
	(-26.35)	(-14.73)	(-26.25)	(-23.79)	(-18.38)	(-28.00)	(-11.33)	(-23.22)	(-26.39)	(-18.52)	(-27.36)
log(A)	-0.003***	-0.003***	-0.002***	-0.002***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
	(-8.09)	(-7.04)	(-6.80)	(-4.70)	(-8.34)	(-8.03)	(-8.35)	(-8.35)	(-8.14)	(-8.50)	(-8.03)
V/A	0.010***	0.010***	0.010***	0.009***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***
	(27.22)	(22.78)	(27.53)	(21.54)	(27.12)	(27.02)	(27.21)	(27.06)	(27.31)	(27.34)	(27.04)
CF/A	0.072***	0.067***	0.070***	0.076***	0.071***	0.071***	0.072***	0.072***	0.072***	0.071***	0.071***
	(21.34)	(17.63)	(20.82)	(20.86)	(21.34)	(21.31)	(21.47)	(21.39)	(21.34)	(21.31)	(21.31)
D/V	-0.033***	-0.031***	-0.037***	-0.026***	-0.033***	-0.033***	-0.033***	-0.034***	-0.033***	-0.034***	-0.033***
	(-9.76)	(-8.01)	(-10.82)	(-7.62)	(-9.64)	(-9.76)	(-9.82)	(-9.98)	(-9.63)	(-9.86)	(-9.60)
Sales/PPEGT	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-33.00)	(-29.33)	(-33.04)	(-30.61)	(-33.01)	(-33.00)	(-33.07)	(-33.02)	(-33.04)	(-33.09)	(-32.96)
RD/A	-0.114***	-0.108***	-0.117***	-0.094***	-0.113***	-0.114***	-0.114***	-0.114***	-0.113***	-0.114***	-0.113***
	(-18.61)	(-16.31)	(-19.05)	(-14.90)	(-18.61)	(-18.61)	(-18.64)	(-18.68)	(-18.57)	(-18.73)	(-18.55)
Rating dummy		0.003*									
		(1.70)									
Payout/A			-0.084***								
			(-9.99)								
Sales growth				0.015***							
				(17.42)							

GDP growth					0.171***						
					(12.08)						
Credit Spread						-0.001					
						(-1.46)					
Short Term Rate							0.002***				
							(8.02)				
Term Spread								-0.003***			
								(-9.62)			
Unemployment									0.001***		
									(4.24)		
Inflation										0.160***	
										(6.93)	
Recession dummy											-0.005***
											(-6.77)
Constant	0.121***	0.112***	0.121***	0.106***	0.105***	0.123***	0.101***	0.123***	0.114***	0.110***	0.122***
	(58.62)	(45.50)	(59.07)	(52.33)	(44.15)	(52.19)	(33.08)	(59.03)	(45.98)	(45.60)	(59.60)
Observations	111,965	79,870	111,965	100,530	111,965	111,965	111,965	111,965	111,965	111,965	111,965
R-squared	0.124	0.109	0.126	0.129	0.125	0.124	0.125	0.125	0.124	0.125	0.125

Table 7 - Cross-sectional regressions of capital expenditure with new listing groups

This table reports the estimates of OLS regressions of capital expenditure ratio (CAPX/A). The explanatory variables consist of a time trend variable and firm characteristics including size measured as the log of total assets (log(A)), market-to-book ratio of assets (V/A), cash flow to assets ratio (CF/A), market leverage (D/V), capital productivity measured as sales divided by the gross property, plant and equipment (Sales/PPEGT), R&D expenses to assets ratio (RD/A), credit rating dummy, payout to assets ratio (Payout/A), sales growth, a set of listing dummy variables and firm age. Firm characteristics are lagged by one fiscal year. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. Variable definitions are available in the appendix. The table reports the regression coefficient estimates and the robust t-statistics adjusted for firm-leveling clustering in parentheses. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)
Trend*1000	-2.695***	-2.425***	-2.352***	-3.272***
	(-36.66)	(-11.07)	(-12.71)	(-26.51)
1950-1959 listing dummy	0.005	-0.001	0.002	
	(1.09)	(-0.20)	(0.38)	
1960-1969 listing dummy	-0.001	-0.011	-0.003	
	(-0.52)	(-1.42)	(-0.46)	
1970-1979 listing dummy	0.013***	0.002	0.004	-0.045***
	(5.45)	(0.19)	(0.50)	(-6.61)
1980-1989 listing dummy	0.026***	0.011	0.013	-0.056***
	(10.77)	(0.96)	(1.29)	(-12.35)
1990-1999 listing dummy	0.033***	0.015	0.020*	-0.042***
	(13.66)	(1.12)	(1.73)	(-9.38)
2000-2012 listing dummy	0.037***	0.017	0.022*	-0.036***
	(12.14)	(1.10)	(1.71)	(-7.39)
log(A)			-0.000	0.001
			(-0.39)	(1.63)
V/A			0.011***	0.009***
			(30.90)	(23.38)
CF/A			0.081***	0.067***
			(28.92)	(19.30)
Age(CRSP)		-0.000	-0.000	
		(-1.35)	(-1.01)	
Age(Founding)				-0.000***
				(-6.87)
Constant	0.103***	0.117***	0.048***	0.169***
	(48.89)	(11.36)	(4.59)	(14.73)
Industry Dummies	No	No	Yes	Yes
Observations	111,965	111,965	111,965	47,830
R-squared	0.043	0.043	0.206	0.229

Table 8 – The sensitivities of capital expenditure to firm characteristics across time

This table reports the change in the sensitivities of capital expenditure ratio (CAPX/A) to firm characteristics across different time periods. The explanatory variables consist of a time trend variable and firm characteristics including size measured as the log of total assets (log(A)), market-to-book ratio of assets (V/A), and cash flow to assets ratio (CF/A). Firm characteristics are lagged by one fiscal year. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. Variable definitions are available in the appendix. The table reports the regression coefficient estimates and the robust t-statistics adjusted for firm-leveling clustering in parentheses. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively.

	Estimate 1980-1984	Interaction 1985-1989	Interaction 1990-1994	Interaction 1995-1999	Interaction 2000-2004	Interaction 2005-2012
log(A)	-0.003***	0.002*	0.003***	0.002**	0.002**	0.003***
	(-3.64)	(1.95)	(3.19)	(2.51)	(2.56)	(3.79)
V/A	0.030***	-0.015***	-0.018***	-0.021***	-0.024***	-0.024***
	(18.61)	(-8.31)	(-10.05)	(-12.53)	(-14.80)	(-14.01)
CF/A	0.260***	-0.136***	-0.144***	-0.181***	-0.209***	-0.202***
	(16.00)	(-7.77)	(-8.17)	(-10.72)	(-12.52)	(-12.07)
Constant	0.002	-0.012**	0.007	-0.015***	-0.025***	0.065***
	(0.39)	(-2.38)	(1.27)	(-2.92)	(-4.86)	(14.64)
Observations			111,965			
R-squared			0.103			

Table 9 - Industry variation and the decline in capital expenditure

Panel A of this table reports the number of firms, the percentage of the industry assets relative to the total assets of all firms in the sample, and the aggregate capital expenditure ratio on each industry in 1980 and 2012. The aggregate capital expenditure ratio (CAPX/A) is calculated as the sum of dollar capital expenditure across all firms in the industry divided by the sum of these firms' dollar total assets at the beginning of the year. Our sample consists of U.S. firms with common stocks traded at the NYSE, AMEX, or NASDAQ during the period of 1980-2012. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded. Panel B reports the results from the cross-industry regressions of the change in CAPX/A on the change in asset weight from 1980 to 2012 and/or the level of CAPX/A at 1980. The last column of Panel B reports the industry-level panel regression results of the change in capital expenditures on the change in the ratio of materials as an intermediate input to the gross output. Industries are classified by 3-digit SIC codes and the sample is from 1997 to 2012. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively.

Panel A Industry composition and industry capital expenditure ratios

	Num. of Firms		%Assets			CAPX/A (aggregate)		
Industry	1980	2012	1980	2012	change	1980	2012	change
Agriculture	17	6	0.20%	0.04%	-0.16%	0.0782	0.0432	-0.0351
Aircraft	29	21	2.24%	2.77%	0.53%	0.0892	0.0244	-0.0647
Apparel	73	30	0.99%	0.61%	-0.38%	0.0576	0.0377	-0.0200
Automobiles and Trucks	66	52	5.00%	3.06%	-1.94%	0.0857	0.0547	-0.0310
Beer & Liquor	16	10	0.69%	0.32%	-0.37%	0.1268	0.0192	-0.1076
Business Services	160	254	2.00%	5.56%	3.56%	0.0713	0.0355	-0.0359
Business Supplies	44	38	2.68%	1.71%	-0.97%	0.1475	0.0503	-0.0971
Candy & Soda	17	12	0.73%	1.93%	1.20%	0.1286	0.0373	-0.0913
Chemicals	84	66	6.05%	3.50%	-2.55%	0.1302	0.0522	-0.0780
Coal	7	8	0.31%	0.73%	0.42%	0.1640	0.0648	-0.0992
Communication	35	88	2.24%	7.28%	5.04%	0.1381	0.0605	-0.0776
Computer Software	14	157	0.02%	4.01%	3.99%	0.2102	0.0319	-0.1783
Computers	84	58	2.79%	4.33%	1.54%	0.1229	0.0395	-0.0834
Construction	43	39	0.74%	0.88%	0.14%	0.0876	0.0174	-0.0702
Construction Materials	183	39	3.92%	0.82%	-3.11%	0.1013	0.0305	-0.0708
Consumer Goods	125	40	4.61%	1.82%	-2.79%	0.0973	0.0438	-0.0536
Defence	9	5	0.99%	0.06%	-0.93%	0.0931	0.0325	-0.0606
Electrical Equipment	51	50	1.17%	0.76%	-0.41%	0.0851	0.0292	-0.0559
Electronic Equipment	161	196	3.24%	5.33%	2.09%	0.1307	0.0368	-0.0940
Entertainment	30	38	0.59%	2.07%	1.48%	0.1418	0.0368	-0.1050
Fabricated Products	26	6	0.44%	0.06%	-0.38%	0.0274	0.0654	0.0380
Food Products	79	46	4.02%	2.63%	-1.39%	0.0807	0.0345	-0.0462
Healthcare	29	54	0.32%	1.58%	1.26%	0.1514	0.0459	-0.1056
Machinery	152	98	4.36%	4.51%	0.15%	0.0956	0.0463	-0.0492
Measuring and Control Equipment	81	61	0.74%	1.25%	0.51%	0.1117	0.0206	-0.0911
Medical Equipment	45	111	0.83%	2.32%	1.48%	0.1039	0.0305	-0.0733
Non-Metallic and Industrial Metal	16	9	1.03%	0.36%	-0.67%	0.1687	0.0754	-0.0932

Mining								
Other - almost Nothing	343	178	1.99%	1.02%	-0.96%	0.0854	0.0566	-0.0288
Personal Services	38	38	0.43%	0.72%	0.29%	0.1488	0.1064	-0.0424
Petroleum and Natural Gas	178	137	13.66%	10.06%	-3.60%	0.1625	0.1267	-0.0358
Pharmaceutical Products	44	184	2.84%	5.64%	2.80%	0.0746	0.0253	-0.0493
Precious Metals	8	10	0.04%	0.71%	0.67%	0.1067	0.1099	0.0033
Printing and Publishing	44	30	1.03%	1.10%	0.07%	0.0920	0.0184	-0.0736
Recreation	37	23	0.52%	0.22%	-0.30%	0.0994	0.0334	-0.0660
Restaurants, Hotels, Motels	67	54	1.16%	1.92%	0.75%	0.1574	0.0647	-0.0927
Retail	219	153	6.48%	7.76%	1.28%	0.0953	0.0527	-0.0426
Rubber and Plastic Products	43	15	0.44%	0.21%	-0.23%	0.0760	0.0422	-0.0338
Shipbuilding, Railroad Equipment	6	7	0.51%	0.56%	0.05%	0.1224	0.0281	-0.0942
Shipping Containers	40	9	1.93%	0.35%	-1.58%	0.1013	0.0404	-0.0609
Steel Works	81	36	5.28%	1.73%	-3.55%	0.0910	0.0447	-0.0463
Textiles	63	10	0.94%	0.11%	-0.83%	0.0796	0.0330	-0.0466
Tobacco Products	9	6	2.12%	1.01%	-1.11%	0.0796	0.0146	-0.0650
Transportation	80	65	5.53%	4.02%	-1.50%	0.1455	0.0798	-0.0657
Wholesale	135	96	2.12%	2.55%	0.43%	0.0688	0.0229	-0.0460

Panel B Regression of changes in CAPX/A

	1	2	3	4
Change in %Assets	-0.604**		-0.348*	
	(-2.19)		(-1.85)	
CAPX/A (1980)		-0.743***	-0.709***	
		(-7.56)	(-7.29)	
Change in Material/Output				0.158***
				(4.40)
Constant	-0.064***	0.017	0.014	-0.003***
	(-12.73)	(1.53)	(1.22)	(-7.33)
Observations	44	44	44	3843
R-squared	0.102	0.577	0.609	0.040

Table 10 – Descriptive statistics of international data

Our international data, obtained from DataStream, include 38 countries in the period 1980-2013 that have at least five years continuous data of at least 50 public-listed firms. Utilities, banks, and financial service firms are excluded. This table reports, respectively for the 38 countries in the international sample, the firm-year observation number, sample period, starting year to have at least 50 firms, and the median and aggregate ratios of capital expenditure to total assets (CAPX/A). The last column indicates if the country belongs to G7, OECD, or BRICS.

Country	Firm-Year Obs	Sample period	Starting Year with 50+ obs	Median CAPX/A	Aggregate CAPX/A	G7 / OECD / BRICS
Australia	14350	1980-2013	1994	3.706	7.965	OECD
Belgium	1465	1980-2013	1998	4.833	7.090	OECD
Brazil	2893	1987-2013	1998	4.056	6.819	BRICS
Canada	21114	1980-2013	1987	5.090	8.987	G7/OECD
Chile	1947	1985-2013	1998	4.594	5.807	OECD
China	23378	1991-2013	1995	4.559	6.565	BRICS
Denmark	1946	1980-2013	1995	4.844	7.035	OECD
Finland	2052	1980-2013	1996	4.991	5.753	OECD
France	8410	1980-2013	1987	3.547	4.884	G7/OECD
Germany	9341	1980-2013	1986	4.145	6.302	G7/OECD
Greece	1909	1985-2013	2001	2.563	5.193	OECD
Hong Kong	14116	1980-2013	1990	2.745	4.769	
India	19478	1989-2013	1992	5.028	8.650	BRICS
Indonesia	4712	1989-2013	1991	4.435	12.942	
Israel	2885	1992-2013	2001	2.111	5.068	OECD
Italy	2687	1980-2013	1996	3.008	4.698	G7/OECD
Japan	47524	1980-2013	1980	2.605	3.979	G7/OECD
Malaysia	10507	1980-2013	1991	2.696	5.704	
Mexico	1614	1980-2013	1997	4.204	6.001	OECD
Netherland	1955	1980-2013	1992	4.813	5.646	OECD
New Zealand	1149	1980-2013	2004	4.266	7.479	OECD
Norway	2010	1980-2013	1999	5.156	9.325	OECD
Pakistan	1637	1988-2013	1999	4.646	7.402	
Peru	1110	1987-2013	2000	3.620	8.131	
Philippine	1973	1988-2013	1998	3.006	7.221	
Poland	3263	1992-2013	2002	4.073	7.214	OECD
Russia	2319	1996-2013	2004	4.085	7.999	BRICS
Singapore	7556	1980-2013	1992	2.915	4.866	
South Africa	3407	1980-2013	1997	5.240	8.234	BRICS
South Korea	17444	1980-2013	1989	3.736	5.446	OECD
Spain	1728	1980-2013	1996	3.544	5.905	OECD
Sri Lanka	1462	1993-2013	2005	3.648	7.888	
Sweden	4222	1980-2013	1995	2.680	5.043	OECD
Switzerland	2967	1980-2013	1990	3.931	4.401	OECD
Taiwan	19275	1988-2013	1994	3.018	6.535	
Thailand	6380	1987-2013	1991	3.752	6.793	
Turkey	2918	1987-2013	1998	3.627	6.000	OECD
United Kingdom	17423	1980-2013	1980	3.443	6.010	G7/OECD

Table 11 – International evidence of trend in capital investment by countries

This table reports the Dickey-Fuller test results of the following regression for firms in each country:

$$\Delta\left(\frac{CAPX}{A}\right)_{t+1} = \alpha + \beta * Trend + \gamma * \left(\frac{CAPX}{A}\right)_{t} + \theta_1 * \Delta\left(\frac{CAPX}{A}\right)_{t} + \theta_2 * \Delta\left(\frac{CAPX}{A}\right)_{t-1} + \theta_3 * \Delta\left(\frac{CAPX}{A}\right)_{t-2} + \theta_4 * \Delta\left(\frac{CAPX}{A}\right)_{t-3} + \varepsilon.$$

The dependent variable is the change in CAPX/A between fiscal year t+1 and t. The independent variables include the time trend variable (Trend), the CAPX/A in fiscal year t, and four lagged changes in the capital expenditure ratios. The regressions are performed separately for each country on its yearly median, mean, and aggregate capital expenditure ratios. The aggregate ratio is calculated as the sum of dollar capital expenditure across all firms in the country divided by the sum of these firms' dollar total assets at the beginning of the year. We require the country to have at least 12 years qualified data and 31 out of 38 countries are qualified. Utilities (SIC codes between 4900 and 5000) and financial firms (SIC codes between 6000 and 7000) are excluded.The coefficient on Trend is inflated by 1000. Statistical significance of the 1%, 5%, or 10% level is marked by ***, **, and *, respectively.

	CAPX/A (median)		CAPX/A (mean)		CAPX/A (aggregate)	
Country	Time Trend Coefficient	t-stat	Time Trend Coefficient	t-stat	Time Trend Coefficient	t-stat
Australia	-0.050	-1.53	0.013	0.44	-0.041	-1.64
Belgium	-0.070**	-2.71	-0.054**	-2.5	-0.058	-1.43
Brazil	-0.049	-1.36	-0.036	-0.85	-0.066	-1.03
Canada	-0.052**	-2.08	0.062*	1.97	0.019	0.9
Chile	-0.108	-1.11	-0.132*	-1.88	-0.144*	-1.89
China	-0.004	-0.17	-0.018	-0.54	-0.072	-1.49
Denmark	-0.188***	-4.08	-0.104**	-2.74	-0.055**	-2.06
Finland	-0.259***	-4.98	-0.235***	-4.79	-0.250***	-4.89
France	-0.091***	-2.85	-0.089***	-3.64	-0.062***	-3.14
Germany	-0.070**	-2.37	-0.059**	-2.42	-0.076***	-3.72
Hong Kong	-0.163***	-4.39	-0.207***	-3.76	-0.059*	-1.78
India	-0.054	-1.38	-0.029	-0.63	0.026	0.33
Indonesia	0.110*	1.89	0.040	0.83	2.457**	2.4
Italy	-0.086***	-4.01	-0.090***	-4.34	-0.049**	-2.38
Japan	-0.080**	-2.52	-0.094***	-3.13	0.034*	1.85
Malaysia	-0.018	-1.27	-0.019	-0.91	0.001	0.04
Mexico	-0.027	-1.19	-0.037	-1.54	-0.039	-1.35
Netherland	-0.069***	-3.34	-0.086***	-3.14	-0.073***	-4.3
Norway	-0.255**	-2.33	-0.318***	-3.85	-0.069	-1.05
Pakistan	-0.042	-0.85	-0.042	-0.75	-0.091	-1.04
Philippine	-0.162	-0.94	-0.016	-0.12	-0.224	-1.51
Singapore	-0.018	-0.95	-0.021	-0.85	-0.081	-1.32
South Africa	-0.084**	-2.1	-0.045**	-2.62	0.011	0.67
South Korea	-0.079*	-1.73	-0.051*	-1.81	-0.019	-1.51
Spain	-0.079**	-2.68	-0.070**	-2.63	-0.166***	-3.04
Sweden	-0.095***	-2.97	-0.072**	-2.61	-0.032*	-1.79
Switzerland	-0.061***	-3.26	-0.070***	-3.47	-0.032**	-2.27
Taiwan	-0.152**	-2.55	-0.173***	-3.83	-0.128**	-2.39
Thailand	-0.030	-0.5	-0.020	-0.43	-0.107	-0.94
Turkey	-0.294**	-2.44	-0.286**	-2.6	-0.151**	-2.27
United Kingdom	-0.086**	-2.71	-0.099***	-3.53	-0.103***	-3.41

Number (%) of declines	30/31	(96.77%)	28/31	(90.32%)	25/31	(80.65%)
Number (%) of significant declines	19/31	(61.29%)	19/31	(61.29%)	14/31	(45.16%)