Corporate Investment: Propensities and Constraints

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ABSTRACT

This paper is primarily motivated by the dramatic shift over time in the investment propensities of U.S. firms away from capital expenditures and toward R&D. In analyses of corporate investment determinants, this shift prompts the need to account for individual firm's *ex ante* propensities to make alternative *types* of investment. We develop and test two modified 'q' models of investment that account for such propensities. We also glean and test novel hypotheses from financial constraint theory about: (a) R&D intensity (lagged cash balance) as a determinant (measure) of constraint; and (b) the coefficients of internal cash flow and external financing variables in investment regressions. Empirically, we have four principal findings. First, two common practices in prior empirical studies, (a) scaling capital expenditure investment by PP&E, and (b) using samples of 'manufacturing' firms for capital expenditure regressions without adjusting for R&D as an alternative investment type, result in severe biases. Second, our analysis of cash dynamics indicates that R&D intensity (lagged cash balance) is an important determinant (measure) of constraint, and constrained firms generally hoard cash from internal cash flow and external equity issues, but not from debt issues. Third, *propensity regression* provides stronger support for both 'q' and constraint theory than OLS/GLM regression alternatives. Fourth, propensity regression is robust to subsample analysis by firm size/age, Old vs. New Economy (1974-87 vs. 1988-2008), R&D intensity, and industry.

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Corporate Investment: Propensities and Constraints

Originally guided by Tobin's (1969) neoclassical 'q' theory, considerable attention has been focused on identifying determinants of corporate investment, typically measured empirically by capital expenditures. Yet since a seminal study by Fazzari, Hubbard, and Petersen (1988), researchers have struggled with the empirical finding that Tobin's q ratio is weak in explaining variation in capital expenditures. Many empirical studies have focused on two reasons for this weakness, (a) measurement error in Tobin's q, and (b) financial constraints that drive a wedge between the costs of internal vs. external capital. In addition, most extant empirical studies share two features: (i) They focus exclusively on capital expenditures, ignoring other types of investment such as research and development (R&D); and (ii) Samples include only 'manufacturing' firms, defined as firms with SIC code values of 2000-3999. We suspect that these two choices may be at the crux of problems that have emerged in explaining variation in corporate investment using either Tobin's q or financial constraint variables.

Why would these choices matter? Regarding Tobin's q, suppose firms in a researcher's sample vary in their propensities to make capital expenditure vs. R&D investment. Ideally, to test 'q' theory the researcher should measure each firm's q ratio with separate respect to physical (i.e., capital-expenditure-related) and intellectual (i.e., R&D-related) capital, and estimate separate regressions accordingly. However, this is not possible primarily because the market values of physical and intellectual property cannot be separately measured. So instead, a researcher estimates a regression of, say, capital expenditures on q, where q is measured (by convention) as the ratio of the firm's total market value to its total book assets. The coefficient of q will be biased because, while for some firms q varies primarily with their capital-expenditure-related investment opportunities, for others q varies primarily with their R&D-related investment opportunities. This bias can be viewed as an errors-in-explanatory-variables problem in that q is not properly measured with respect to the dependent variable.

One way to deal with this problem empirically is through sample selection. For instance, if a researcher wishes to test 'q' theory on capital expenditure investment, he or she could attempt to identify and include (exclude) firms that make, or more accurately are *expected* to make, capital expenditure

(R&D) investment. Indeed, perhaps it has been implicitly understood that 'manufacturing' firms would form an ideal sample in this regard. However, later we document that average R&D investment is actually *higher* for 'manufacturing' firms than non-'manufacturing' firms. So instead of dealing with the issue via sample selection, we develop modified 'q' models that incorporate individual firm's propensities to make alternative types of investment given that only a firm's overall q ratio is observable.

Regarding financial constraint, both (i) the identification of financially constrained firms and (ii) the effects of financial constraint on investment, have been contentious issues in the literature. Regarding (ii), most empirical studies focus exclusively on capital expenditure investment, and regarding (i) typical variables used to assess a firm's constraint status include past profitability, leverage, dividend-payment status, and relative cash balance. As we discuss in the next section, some studies find the predicted negative relationship between (capital expenditure) investment and constraint status, while other studies have actually found a *positive* relationship. As we see it, there is clearly a potential for R&D-intensive firms in a given sample to 'contaminate' the results of tests of the effects of financial constraint on (capital expenditure) investment. For instance, *ceteris paribus* R&D-intensive firms will be observed to be less profitable simply because R&D is a deductible expense. So if a researcher finds that less profitable firms have lower capital expenditures (even after controlling for q), is this because less profitable firms are constrained or because they tend to be R&D intensive rather than capital-expenditure intensive? Similarly, some constraint models predict that capital expenditure investment will be negatively related to leverage. However, if debt generally can be used to finance capital expenditures but not R&D investment, then we may well observe a *positive* relationship between leverage and capital expenditure investment due to differential investment propensities alone. Moreover, our review of recent theoretical literature leads us to suggest that R&D intensity *itself* imposes constraints, including higher average cash balance.

Both the general nature of the problem of alternative investment types and the structure of our main modified 'q' model suggest the use of *propensity regression* methodology to test proposed determinants of investment. In a propensity regression, variables proposed to explain variation in a given type of investment (i.e., state variables that determine the *amount* of investment) are weighted by a measure of the *ex ante* propensity of a given firm to make that type of investment. We test propensity regression against several OLS/GLM regression alternatives representing the extant literature.

Using data on U.S. firms for 1974-2008, our analysis yields several important findings. First, two common practices in prior empirical studies, (a) scaling capital expenditure investment by PP&E, and (b) using samples of 'manufacturing' firms for capital expenditure regressions without adjusting for R&D as an alternative investment type, result in severe biases. Second, our analysis of cash balance dynamics indicates that R&D intensity (lagged cash balance) is an important determinant (measure) of constraint, and constrained firms generally hoard cash from internal cash flow and external equity issues, but not from debt issues. Third, propensity regression provides stronger support for both 'q' and constraint theory than OLS/GLM regression alternatives. Fourth, propensity regression is robust to subsample analysis by firm size/age, Old vs. New Economy (1974-87 vs. 1988-2008), R&D intensity, and industry.

The paper is organized as follows. In Section 1 we: (a) review the corporate investment literature; (b) develop two modified 'q' models of investment; and (c) establish candidates for determinants and measures of constraint. Section 2 describes the data and discusses propensity regression methodology. In Section 3 we test determinants of investment propensities, analyze the 'scaling' issue, and ascertain determinants and measures of constraint via analysis of cash balance dynamics. In Section 4 we present the main propensity regression results. Section 5 presents analyses by industry. Section 6 summarizes.

1. 'q' Theory and Financial Constraint Theory: Review and Extensions

In this section, we review the extant literature on both 'q' and financial constraint theories of corporate investment, and also endeavor to extend each theory to account for alternative investment types.

1.1 'q' theory, measurement error, and modified 'q' models of investment

1.1.1 'q' theory in brief

We initially briefly restate what has come to be known as the 'q' theory of investment. Elegant expositions of the theory are given in Tobin's (1969) seminal article and elsewhere (e.g., Lucas and Prescott (1971); Hayashi (1982)). The key assumptions of 'q' theory are: (a) Capital markets are perfect (and thus financing and investment decisions are independent); (b) Fixed capital is homogeneous; and (c)

Adjustment costs are convex in net investment. We denote firm i's capital stock (or replacement cost) at date t-1 as $K_{i,t-1}$, its time t capital stock investment as $I_{i,t}$, the economic depreciation rate of the capital stock as δ_i, and the date t-1 ratio of the market value of existing real capital assets to their current replacement cost as $q_{i,t-1}$. Then 'q' theory states that at time t firm i will invest until, at the margin, $q_{i,t-1} = 1$:

$$\frac{I_{i,t}}{K_{i,t-1}} = \delta_i + \frac{1}{\alpha}\left(q_{i,t-1} - 1\right). \qquad (1)$$

Hayashi (1982) describes the conditions under which a firm's average q ratio, denoted here as $Q_{i,t-1}$, is equal to its marginal q ratio, $q_{i,t-1}$. Virtually all empirical studies of the relationship between investment and Tobin's q rely on Hayashi's stipulation for the simple reason that average Q is empirically observable (e.g., the ratio of the market value of the firm to the book value of its total assets). Thus, for our modeling analysis below, as well as later empirics, we utilize average Q.

1.1.2 Measurement error in Q: Literature review

The poor performance of Tobin's Q to explain variation in corporate investment has been a conundrum. Some researchers attribute this poor performance to measurement error in Q. As a classic errors-in-explanatory-variables problem, if Q is measured with error, its explanatory power will be reduced and its coefficient will be biased toward zero. Moreover, the coefficients and explanatory power of other variables in the investment regression, such as financial constraint variables, may be enhanced if these variables inadvertently serve as instruments for Q (e.g., Gomes, 2001).

Econometricians suggest two remedies for the errors-in-explanatory-variables problem: (1) Improve the measurement of the explanatory variable; or (2) Use an econometric model that yields a consistent, unbiased estimate of the coefficient of the mis-measured variable. Regarding remedy (1), researchers have devised and examined a variety of proxies for Q (e.g., Brainard, Shoven, and Weiss, 1980; Lindenberg and Ross, 1981; Klock, Thies, and Baum, 1991; Perfect and Wiles, 1994; Perfect, Peterson, and Peterson, 1995; Klock, Thies, and Baum, 1996; Lewellen and Badrinath, 1997; Lee and Tompkins, 1999; Erickson and Whited, 2006). Erickson and Whited (2006) conclude that most proxies for Q are poor. However, Klock, Thies, and Baum (1996) find that adding a measure of intangible capital in the calculation of Q improves its performance in their model of corporate investment. In our empirical analysis, our calculation of Q includes a measure of intangible (or *intellectual*) capital. Studies applying remedy (2) include Abel and Blanchard (1986), Blundell et al (1992), Cummins et al (1994), Gilchrist and Himmelberg (1995), and Erickson and Whited (2000).

1.1.3 Modifying 'q' models of investment to account for alternative investment types

Empiricists have generally interpreted the 'I' and 'K' in the eq. (1) as a firm's capital expenditure investment and property, plant & equipment (PP&E), respectively, even though these terms conceivably could refer to an alternative type of investment and its associated capital stock, such as R&D investment and intellectual capital stock.[1] This is a potential problem given that the U.S. economy has steadily evolved over the years from a 'bricks and mortar' economy dominated by capital expenditure investment toward an R&D-intensive 'knowledge' economy, as we document empirically later. Thus, we approach the problem of measurement error in Q from a different perspective. We suggest that a major source of measurement error in Q actually arises from ignoring cross-sectional variation in the *type* of investment, particularly capital expenditures vs. R&D, that individual firms would make given that market conditions, ideally measurable by Q but possibly involving financial constraint, prompt it to invest.[2]

To deal with this problem, we construct modified 'q' models of investment that allow for alternative types of investment.[3] Although our approach can be applied to multiple types of investment, for simplicity we consider only two: capital expenditures and R&D. In our setting each firm i at date t-1 is in a two-dimensional state with respect to: (a) its propensities to make time t capital expenditure or R&D investment; and (b) market conditions, measured by Q, which determine the *amount* of investment.

We begin with the following definitions: $V_{i,t-1}^{K}$ and $V_{i,t-1}^{IP}$ denote the date t-1 market values of firm i's physical and intellectual-property (IP) capital, respectively; $K_{i,t-1}$ and $IP_{i,t-1}$ denote the date t-1

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[1]All of the following empirical studies focus exclusively on capital expenditure investment and on 'manufacturing' firms (listed chronologically): Fazzari, Hubbard, and Petersen (1988); Whited (1992); Lang, Ofek, and Stulz (1996); Kaplan and Zingales (1997); Barnett and Sakellaris (1998); Erickson and Whited (2000); Bhagat, Moyen, and Suh (2005); Almeida and Campello (2007); Agca and Mozumdar (2008); Hovakimian (2009).

[2]Due to space limitations, we do not consider other types of corporate investment, such as advertising expenditures and investment via acquisition, though these also could be modeled with our approach.

[3] For alternative, and more formal, derivations of modified 'q' models of investment that allow for multiple types of investment, see Hayashi and Inoue (1991), Chirinko (1993), and Bond and Cummins (2000).

replacement costs of firm i's physical and IP capital, respectively; and $I_{i,t}^{K}$ and $I_{i,t}^{IP}$ denote firm i's time t physical and IP investment, respectively. The date t-1 Q ratios associated with firm i's physical and IP capital are given in eq. (2) and (3), respectively,

$$Q_{i,t-1}^{K} = \frac{V_{i,t-1}^{K}}{K_{i,t-1}} \tag{2}$$

$$Q_{i,t-1}^{IP} = \frac{V_{i,t-1}^{IP}}{IP_{i,t-1}}, \tag{3}$$

and, assuming independence and ignoring depreciation, q theory suggests the following separate investment-Q relationships:

$$\frac{I_{i,t}^{K}}{K_{i,t-1}} = \gamma_{i,t}^{K} Q_{i,t-1}^{K} \tag{4}$$

$$\frac{I_{i,t}^{IP}}{IP_{i,t-1}} = \gamma_{i,t}^{IP} Q_{i,t-1}^{IP}. \tag{5}$$

Unfortunately, as noted earlier we cannot observe the separate Q ratios for a firm's physical and IP capital. We can only observe the firm's overall Q ratio, denoted as $Q_{i,t-1}$, which we calculate as

$$Q_{i,t-1} = \frac{V_{i,t-1}^{K} + V_{i,t-1}^{IP}}{K_{i,t-1} + IP_{i,t-1}}. \tag{6}$$

Defining $p = IP_{i,t-1}/K_{i,t-1}$, $Q_{i,t-1}$ can be re-expressed as

$$Q_{i,t-1} = \frac{Q_{i,t-1}^{K}}{1+p} + \frac{Q_{i,t-1}^{IP}}{1+\frac{1}{p}}. \tag{7}$$

That is, $Q_{i,t-1}$ is a weighted average of the Q ratios associated with physical and IP capital.

We now consider the problem of modeling firm i's physical investment given that: (a) the firm may also have a propensity to make IP investment; and (b) only the firm's overall Q ratio, $Q_{i,t-1}$, is observable. Multiplying eq. (4) through by $K_{i,t-1}/\left(K_{i,t-1} + IP_{i,t-1}\right)$ and then substituting an expression for $Q_{i,t-1}^{K}$ that can be obtained from eq. (7), we obtain:

$$\frac{I_{i,t}^{K}}{K_{i,t-1}+IP_{i,t-1}} = \gamma_{i,t}^{K}\left(\frac{K_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)\left\{Q_{i,t-1}(1+p) - \left(\frac{1+p}{1+\frac{1}{p}}\right)Q_{i,t-1}^{R}\right\}. \tag{8}$$

With additional manipulations (not shown for brevity), eq. (8) can be re-expressed as

$$\frac{I_{i,t}^{K}}{K_{i,t-1}+IP_{i,t-1}} = \gamma_{i,t}^{K}\left(\frac{K_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1} - \gamma_{i,t}^{K}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)(Q_{i,t-1}^{IP} - Q_{i,t-1}). \tag{9}$$

Eq. (9) is a model relating firm i's physical investment to its overall Q ratio $Q_{i,t-1}$, with the same coefficient, $\gamma_{i,t}^{K}$, as in eq. (4). However, two additional features of this modified 'q' model are important. First, $Q_{i,t-1}$ is *weighted* by the fraction of firm i's 'total assets' (i.e., $K_{i,t-1} + IP_{i,t-1}$) accounted for by physical capital. This feature has strong intuitive appeal based on our earlier discussion because it indicates that a firm's capital expenditures depend not only on the Q ratio, but also on the firm's propensity to engage in capital expenditure investment, measured by the weighting factor.

Second, the second term in eq. (9) indicates that physical investment will be lower (higher) than as indicated by the first term to the extent that firm i has IP capital and $Q_{i,t-1}^{IP} > Q_{i,t-1}$ ($Q_{i,t-1}^{IP} < Q_{i,t-1}$). Unfortunately, in empirical tests of this model we will be forced to ignore the second term because $Q_{i,t-1}^{IP}$ is unobservable. However, bias due to this under-specification will be ameliorated if there is a strong negative cross-sectional correlation between physical and IP investment propensities (i.e., the weights in the first and second terms of eq. (9), resp.), and our data indicates a strong negative correlation.

Next, we ask whether an alternative modified 'q' model can be developed that relates a firm's physical investment to its overall Q ratio but sans the weighting factor in eq. (9). The question is important because all extant empirical studies relate a firm's physical investment (i.e., capital expenditures) to its overall Q ratio without a weighting adjustment.

The answer is yes. To do so, we initially re-express the second term in eq. (9) as

$$-\gamma_{i,t}^{K}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)(Q_{i,t-1}^{IP} - Q_{i,t-1}) =$$

$$\gamma_{i,t}^{K}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1} - \gamma_{i,t}^{K}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1}^{IP}\ . \tag{10}$$

Next, multiplying eq. (5) though by $IP_{i,t-1}/\left(K_{i,t-1} + IP_{i,t-1}\right)$ yields

$$\frac{I_{i,t}^{IP}}{K_{i,t-1}+IP_{i,t-1}} = \gamma_{i,t}^{IP}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1}^{IP}, \text{ or}$$

$$\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1}^{IP} = \left(\frac{1}{\gamma_{i,t}^{IP}}\right)\frac{I_{i,t}^{IP}}{K_{i,t-1}+IP_{i,t-1}}.$$

Substituting the RHS expression above into eq. (10) yields the following alternative expression for the second term in eq. (9):

$$\gamma_{i,t}^{K}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1} - \left(\frac{\gamma_{i,t}^{K}}{\gamma_{i,t}^{IP}}\right)\frac{I_{i,t}^{IP}}{K_{i,t-1}+IP_{i,t-1}}.$$

Finally, substituting this expression into eq. (9) and noting that

$$\gamma_{i,t}^{K}\left(\frac{K_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1} + \gamma_{i,t}^{K}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1} = \gamma_{i,t}^{K}Q_{i,t-1},$$

we obtain

$$\frac{I_{i,t}^{K}}{K_{i,t-1}+IP_{i,t-1}} = \gamma_{i,t}^{K}Q_{i,t-1} - \left(\frac{\gamma_{i,t}^{K}}{\gamma_{i,t}^{IP}}\right)\left(\frac{I_{i,t}^{IP}}{K_{i,t-1}+IP_{i,t-1}}\right). \quad (11)$$

The model in eq. (11) has appeal because it suggests that a regression of physical investment on a firm's overall Q ratio can yield the same coefficient, $\gamma_{i,t}^{K}$, as in eq. (4), even if the firm also engages in IP investment, at least so long as this 'opposing' investment is also included as a regressor. However, note that to obtain this model we must assume that the firm always makes the theoretically correct level of IP investment. Moreover, the derived coefficient of IP investment in eq. (11), $-\gamma_{i,t}^{K}/\gamma_{i,t}^{IP}$, is unwieldy, raising a question about the empirical robustness of this model. Nevertheless, we will test this model as well.

Models analogous to eq. (9) and eq. (11) can be developed for IP investment. These models are given below as eq. (12) and eq. (13), respectively:

$$\frac{I_{i,t}^{IP}}{K_{i,t-1}+IP_{i,t-1}} = \gamma_{i,t}^{IP}\left(\frac{IP_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)Q_{i,t-1} - \gamma_{i,t}^{IP}\left(\frac{K_{i,t-1}}{K_{i,t-1}+IP_{i,t-1}}\right)(Q_{i,t-1}^{K} - Q_{i,t-1}) \quad (12)$$

$$\frac{I_{i,t}^{IP}}{K_{i,t-1}+IP_{i,t-1}} = \gamma_{i,t}^{IP}Q_{i,t-1} - \left(\frac{\gamma_{i,t}^{IP}}{\gamma_{i,t}^{K}}\right)\left(\frac{I_{i,t}^{K}}{K_{i,t-1}+IP_{i,t-1}}\right). \quad (13)$$

We close our modeling discussion by noting a potentially important issue regarding the *scaling* of investment measures. Most empirical studies directly follow eq. (1), scaling capital expenditures by PP&E (as 'K'), though a few scale by total assets.[4] A scaling problem may arise when firms vary in their

[4]Studies that scale capital expenditures by PP&E include all studies cited in footnote 1 as well as Cleary (1999), Allayannis and Mozumdar (2004), Vogt (1994), Hennessy, Levy, and Whited (2007), Lyandres (2007), Bond and Cummins (2000), Himmelberg and Petersen (1994), and Cummins et al (2005). Studies that scale capital

propensities to make capital expenditure vs .R&D investment. Suppose a researcher focuses on determinants of capital expenditures and scales using PP&E. However, many of the firms in the researcher's sample have a greater propensity to make R&D investment, so that PP&E is a relatively small proportion of these firm's total assets. For such firms, small capital expenditure relative to total assets may be large relative to PP&E. Moreover, capital expenditures for an R&D-intensive firm, which may often consist of short-lived lab equipment, are hardly comparable to the property and plant of a physical capital-intensive firm. We suspect that scaling investment of either type by total assets will likely avoid distortions that may occur in using a sample of firms whose investment-type propensities vary. In the end, though, the scaling issue must be addressed empirically, as we will do.

1.2 Financial constraint theory: Review and extensions

The empirical shortcoming of 'q' theory led Fazzari et al (1988) to hypothesize that many firms face constraints on the use of external capital to finance investment due to agency costs (Jensen and Meckling, 1976) and/or information asymmetry problems (Myers and Majluf, 1984). Thus, investment by such financially constrained firms depends on current internal cash flow. In a regression context, their hypothesis is that constrained firms will exhibit greater *investment-cash flow (ICF) sensitivity*. They test this *financial constraint hypothesis* using a sample of 'manufacturing' firms for 1970-84, using dividend payout ratio as an inverse measure of constraint. They find that ICF sensitivity is negatively related to dividend payout ratio. In the ensuing literature, both (i) the identification of constrained firms and (ii) the interpretation of ICF sensitivities, have been contentious issues.

1.2.1 Identifying financially constrained firms

In pursuit of testing the financial constraint hypothesis, several studies have developed indexes to measure the financial constraint status of individual firms. These include the Kaplan and Zingales ('KZ') index (see Lamont et al., 2001) and the Whited and Wu ('WW') index (Whited and Wu 2006). Most recently, Hadlock and Pierce (2010) exploit the approach first used by Kaplan and Zingales (1997) to

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expenditures by total assets include Baker et al (2003), Minton and Schrand (1999), Brown and Petersen (2009), and Ovtchinnikov and McConnell (2009).

identify firm-characteristic variables associated with constraint, which involves using qualitative information gleaned from relevant statements by managers of individual firms in SEC filings. They then test their candidate measures against the 'KZ' and 'WW' indexes. They conclude that neither index is useful in identifying constrained firms, and instead recommend using firm *size* and *age* to identify constrained firms. Indeed, the idea that small and young firms are more constrained is not new. Fazarri et al (1988) discuss firm size as a measure of constraint, though they ultimately use dividend payout. In discussing the Fazarri et al paper, Blinder (1988) comments: "It seems to me that there are other ways to divide the sample-old versus young firms or small versus large ones…" Hubbard (1998) concurs: "…to be useful in empirical tests, sorting criteria should focus on a firm's characteristics that are associated with information costs. That is, these criteria should attempt to identify firms likely to face a significant spread between the cost of external financing and internal financing. Plausible characteristics in grouping strategies include the firm's size, its age, …" (p. 201) Consequently, in our empirical analyses we will use a dummy variable to identify firms that are both small and young.

Several studies argue that R&D-intensive firms generally face greater constraint than capital-expenditure-intensive firms because of the nature of IP and R&D investment, including Grabowski (1968), Himmelberg and Petersen (1994), and Brown, Fazzari, and Petersen (2009). For instance, Brown, Fazzari, and Petersen (2009) argue that: "… there is a financing hierarchy for R&D that consists almost entirely of internal and external equity finance, at least for young firms (this is surely not the case for capital investment with collateral value, for which debt presumably plays a more important role). The least-cost form of finance is internal cash flow. When cash flow is exhausted and debt is not an option, firms must turn to new share issues." (p. 158) All of these studies apply the aforementioned ICF sensitivity test to R&D investment, and all find a reliably positive coefficient. In our empirical tests, we will also use R&D intensity as a measure of constraint.

1.2.2 Interpreting ICF sensitivities

Kaplan and Zingales (1997) challenge Fazzari et al's interpretation of ICF sensitivities, stating that there is "…no strong theoretical reason for ICF sensitivities to increase monotonically with the degree of financing constraints." (p. 171). They examine the 49 firms that Fazzari et al identified as constrained. Using an index-based measure of constraint, they find: "…those firms classified as less financially constrained exhibit a significantly greater investment-cash flow sensitivity than those firms classified as more financially constrained." (p. 171) Cleary (1999) finds similar evidence using a constraint measure similar to Altman's (1968) Z score of bankruptcy probability.

Others suggest that the positive ICF sensitivity may be due to measurement error in Q. Hubbard (1998) states: "If cash flow is correlated with future profitability, a link between cash flow and investment for a given firm over time could reflect the link between expected profitability and investment emphasized by frictionless neoclassical models." (p. 200) Blundell et al (1992) and Gilchrist and Himmelberg (1995) both address the measurement error problem, and yet reaffirm the positive ICF relationship. In sharp contrast, Erickson and Whited (2000) find no ICF sensitivity, even for financially constrained firms, using their GMM methodology.

Almeida and Campello (2007) take a different approach to the analysis of ICF sensitivities in capital expenditure investment regressions. They argue that for constrained firms, ICF sensitivity should be increasing in the *tangibility* of firms' assets because tangible assets can be pledged to support additional borrowing (i.e., there is a credit multiplier effect). In other words, tangibility is an inverse measure of financial constraint.[5] Using data on 'manufacturing' firms for 1985-2000, they document evidence consistent with this argument. As we discuss later in this section, we and others argue that firms with high asset tangibility (especially, high PP&E) are almost inherently unconstrained, so on this point we agree with Almeida and Campello. However, we differ on the interpretation of their ICF sensitivity results. Eq. (9) suggests that capital expenditure investment will increase with asset tangibility (in product with $Q_{i,t-1}$) simply because asset tangibility is a proxy for a firm's *ex ante* propensity to make capital expenditure investment as opposed to R&D investment.

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[5] Relatedly, Livdan, Sapriza, and Zhang (2009) measure constraint by the shadow price of new debt.

Finally, Brown and Petersen (2009) find that ICF sensitivity in capital expenditure regressions has decreased dramatically over time, while for R&D investment they find that ICF sensitivity is fairly stable, though quite low, over time. To explain these results, they point to the changing composition of investment over time (i.e., the rise in R&D relative to capital expenditure investment) as well as the rising importance of external equity as a source of funds. It is noteworthy that they include debt and external equity issuance variables as additional regressors in their investment regressions, arguing that "…their inclusion helps address some concerns that have been raised about interpreting ICF sensitivities." (p. 972) We also include debt and external equity issuance variables in our empirical analyses, not only for the reason they state but moreover for reasons that we discuss later in this section.

1.2.3 Cash balance management, financial constraint, and corporate investment

Four recent papers, all concerning corporate cash balance dynamics, also influence our analysis. First, Minton and Schrand (1999) find that investment (capital expenditures, R&D, and advertising) is negatively related to cash flow *volatility*, and in turn cash flow volatility is associated with higher costs of accessing external capital. Second, Almeida, Campello, and Weisbach (2004) develop and test a model of a firm's demand for liquidity in which constrained firms have a greater tendency to save cash from current cash flow. Empirical results based on a large sample of 'manufacturing' firms for 1971-2000 are consistent with this prediction. Third, Bates, Kahle, and Stulz (2009) find that from 1980 to 2006 the average cash balance of U.S. industrial firms more than doubles. They also find that average firm-level cash-flow *volatility* increases over this period, suggesting that the increase in average cash balances is driven at least in part by precautionary motives. They also document an increase in average R&D intensity over these years, and suggest links among R&D intensity, financial constraint, and cash balance.

Fourth and most recently, Bolton, Chen, and Wang (2009) develop a dynamic theoretical model in which financial constraint is defined by the volatility of a firm's internal cash flow. A constrained firm rationally coordinates its investment and financing decisions via dynamic 'risk management' of its cash balance. Their model produces the familiar result that constrained firms will tend to save cash out of current earnings to reduce the probability, and cost, of future external financing of investment. Also, when external financing is involved, debt financing, if available to the firm, is *contingent-continuous* (i.e., is used contemporaneously 'as needed' and thus would not involve a temporary saving component), while 'last resort' equity financing involves high fixed costs, is therefore lumpy, and would generally involve a temporary saving component. Their model suggests: (a) Firms with higher cash flow volatility will carry higher cash balances; (b) Firms that can employ debt financing will have lower cash balances; and (c) Firms that must rely on costly, lumpy external equity financing will carry higher cash balances.

1.2.4 Overall inferences

We draw three main inferences from our review of the financial constraint literature. First, it is important to accurately identify firms that are constrained before testing the effects of constraint on investment. Recent literature suggests two alternative determinants of constraint that we will examine: (a) firm size/age; and (b) R&D intensity. Second, the relationship between ICF sensitivity and constraint may be more complex than Fazzari et al's (1988) original hypothesis suggests. For instance, ICF sensitivity may be *lower* for constrained firms if they tend to hoard cash from operations. Third, constrained firms will tend to hold higher cash balances to finance future investment, so that lagged cash balance is itself a measure of constraint. Moreover, the higher cash balance for a constrained firm will tend to originate from past internal cash flow and lumpy past external equity issues, but not from past debt issues.

2. Data and Methodology

2.1 Data

Our universe of firms includes all U.S.-incorporated, publicly traded NYSE, AMEX, and NASDAQ firms on the Compustat fundamentals annual database for fiscal years 1974-2008, with a check that their stock has a Center for Research in Security Prices (CRSP) share code value of 10 or 11 (common stock of a U.S.-incorporated firm).[6] We exclude financial firms (SIC code values of 6000-6999) and utility firms (SIC code values of 4900-4949). We also exclude 'unseasoned' firms by requiring that a firm has accounting and market data for fiscal years t-2 and t-1 as well as fiscal year t. To avoid the undue

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[6]Our first year is 1974 both because NASDAQ firms began to appear in 1973 and the Financial Accounting Standards Board (FASB) required the immediate expensing of R&D expenditures as of 1974.

influence of very small firms, each year we exclude firms that are in the smallest 5% in terms of either total assets or market equity value. The final sample includes 94,056 firm-year observations.

For each firm and fiscal year, we collect the following balance sheet and share-related variables from Compustat for years-end t: total assets (TA_t); cash and equivalents ($CASH_t$); net property, plant & equipment ($PPENT_t$); intangible assets ($INTAN_t$); total long-term debt ($DLTT_t$); common equity book value (BEV_t); price per share (PRC_t); and common shares outstanding ($CSHO_t$). All other booked assets, denoted as $OTHER_t$, is calculated as $OTHER_t=TA_t-CASH_t-PPENT_t-INTAN_t$. Year-end t market equity value, MEV_t, is calculated as $MEV_t= PRC_t*CSHO_t$, We also collect the following flow variables for fiscal years indicated by subscripts: operating activity net cash flow ($OANCF_t$ and $OANCF_{t-1}$); total dividends paid (DIV_t); capital expenditures ($CAPX_t$); and R&D expenditures ($R\&D_t$, $R\&D_{t-1}$, …, $R\&D_{t-5}$). We measure internal cash flow as NCF_t, calculated as $NCF_t=OANCF_t-DIV_t+XRD_t$. This calculation reflects: (a) our treatment of dividends as a a *de facto* firm commitment to shareholders; and (b) the adding-back of R&D so that it has status as a *decision variable* rather than a *fait accompli*.

We also need an estimate of a firm's R&D capital (because R&D is expensed, rather than capitalized). For this measure we follow Chan, Lakonishok, and Sougiannis (2001), who estimate R&D capital using a 20% straight-line depreciation rate on past R&D spending. Our measure for fiscal year-end t is denoted as $R\&DCAP_t$.[7] We then calculate an augmented measure of a firm's fiscal year-end t total assets: $TA'_t=TA_t+R\&DCAP_t$. Except for early analysis where we deal with the scaling issue, all variables are scaled by TA'_{t-1}. This includes Tobin's Q, Q_t, calculated as $Q_t=(TA'_t-BEV_t+MEV_t)/TA'_t$, and leverage, LEV_t, calculated as $LEV_t=DLTT_t/TA'_t$. All scaled variables are winsorized at the 1% and 99% levels.

[7]A potential alternative measure of IP capital is booked intangible assets, $INTAN_t$. As we show later, average values of $R\&DCAP_t$ and $INTAN_t$ grew roughly in tandem over the years 1974-2008. Thus, one may erroneously assume that the growth of intangible assets is the *direct* result of the growth in R&D expenditures. That is, a given firm engages in R&D expenditures, and later the firm books intangible assets (patents, copyrights, etc.) as their 'value' is realized. However, accounting rules severely limit the booking of in-house 'realized' IP. Instead, intangible assets, including but not limited to goodwill, primarily emerge in the balance sheets of *acquiring* firms. Specifically, any excess of the price paid for a firm and the overall estimated fair value of the firm is booked as goodwill (as of 1988). Indeed then, to a great extent IP is not recognized on the balance sheets of U.S. firms, individually or in composite, unless and until a given firm is acquired. In results not shown (but available from the corresponding author), we find that, at the firm level, yearly changes in intangible assets closely track contemporaneous acquisitions.

We also need each firm's SIC code value for various industry analyses. SIC code values are available in Compustat only after 1987, so we use SIC code values from CRSP, and use Compustat SIC code values only if the CRSP value is missing. For analyses by industry in Section 5, we use the five categories defined on Ken French's website: Consumer; Manufacturing & Energy; High-tech; Healthcare; and Other.

Finally, we will test whether R&D intensity or small/young firm status are underlying determinants of financial constraint. For the latter, we will use the dummy variable $SMYG_{t-1}$, which is the product of two other dummy variables, $SMALL_{t-1}$ and $YOUNG_{t-1}$. In turn, $SMALL_{t-1}$ has a value of 1 (0) if a firm's MEV_{t-1} is below (above) the median MEV_{t-1} of all firms in its industry, and $YOUNG_{t-1}$ has a value of 1 (0) if at year-end t-1 the firm has been publicly traded for six or fewer (seven or more) years.

2.2 Methodology

Our main methodological challenge is to identify a regression design that accommodates both (a) the structure of the main modified 'q' model developed in Section 1, and (b) the determinants and measures of constraint that we will test. Fortunately, such a regression design exists, called *propensity regression*. As applied in the present context, in propensity regression variables hypothesized to affect of the *amount* of a given type of investment (i.e., Q and constraint measures) are weighted by the firm's *ex ante* propensity to make that type of investment. As such, propensity regression is consistent with the structure of our main modified 'q' model (eq.'s (9) and (12), sans the second terms in each). Regarding constraint, we will be testing two *determinants* of constraint, R&D intensity and firm size/age, and two main *measures of the effects of constraint*, lagged cash balance ($CASH_{t-1}/TA'_{t-1}$) and current net cash flow (NCF_t/TA'_{t-1}). We test R&D intensity by comparing the coefficients of $CASH_{t-1}/TA'_{t-1}$ and NCF_t/TA'_{t-1} in propensity regressions of capital expenditure vs. R&D investment. We test firm size/age by comparing the coefficients of $CASH_{t-1}/TA'_{t-1}$ and NCF_t/TA'_{t-1} in propensity regressions of a given investment type (capital expenditures or R&D) generated using separate data for large/mature firms vs. small/young firms.

We also assess the efficacy of propensity regression by comparing results to those of (un-weighted) OLS/GLM regression alternatives used to represent the extant literature. We suspect that OLS/GLM regression will perform relatively poorly (in terms of adjusted R^2) and may produce incorrect inferences.

For instance, consider an OLS regression of capital expenditure investment on Q where the data is mixed in terms of individual firm's propensities to make capital expenditure vs. R&D investment. The presence of R&D-intensive firms in the sample will clearly bias downward the coefficient of Q, and reduce the regression R^2, in this regression relative to *true* results that would obtain if the sample is purged of R&D-intensive firms. (Note that the weighting design in propensity regression obviates the need for such purging.) Next, consider adding lagged cash balance ($CASH_{t-1}/TA'_{t-1}$), as a constraint measure, to this regression and suppose that R&D-intensive firms in a sample generally have high lagged cash balances (as well as low capital expenditures). Then the observed coefficient of $CASH_{t-1}/TA'_{t-1}$ may well be *negative* due to the presence of R&D-intensive firms in the sample, whereas the *true* coefficient of $CASH_{t-1}/TA'_{t-1}$, as it would apply purely to constrained physical capital-intensive firms, may be positive.

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Some background on propensity regression is in order. Rubin (1974) and Rosenbaum and Rubin (1983, 1985) developed a *propensity score matching* (PSM) technique to deal with the 'missing data' problem in nonrandomized (as opposed to experimental) settings. In such a setting it is difficult to attribute differences in responses, Y, to treatment X if an unobserved intervening variable Z covaries with both X and Y. To alleviate this problem, the researcher tests the effect of X on Y using pairs of observations that are matched in terms of 'scores' based on proxies for Z.

PSM has been used in many disciplines, including economics and finance. In economics, Dehejia and Wahba (1999), Heckman, Ichimura, and Todd (1997) and Lechner (1999, 2000) all use PSM in the context of job training analysis. In finance, Li and Zhao (2006) use PSM to investigate the abnormal performance of firms following seasoned equity offerings, Hellman, Lindsey, and Puri (2008) use PSM to investigate the relationship between a bank’s venture capital investments and its subsequent lending, Lin and Su (2008) use PSM to investigate the relationship between diversification and firm value, and Ivanov and Xie (2009) use PSM to determine when venture capitalists add value to startups.

Freedman and Berk (2008) explain the related concept of *propensity regression* as a two-step process: "Step 1. A model (typically logit or probit) is used to estimate the probability of selection into the treatment and control groups… Step 2. Estimated probabilities from the first step are used to construct weights. The weights are then used to fit the causal model…" (p. 11) Our propensity regression design follows in spirit Freedman and Berk's two-step process. However, we must modify the process because our intervening variable, *ex ante* propensity to engage in a given type of investment, is naturally continuous, rather than binary as in studies with 'treatment' vs. 'control' groups. Also, theory discussed earlier suggests strong candidates for proxies for not only the intervening variable but also the ultimate regression weight; specifically, $PPENT_{t-1}/TA'_{t-1}$ and $R\&DCAP_{t-1}/TA'_{t-1}$ for capital expenditure and R&D regressions, respectively. Nevertheless, in a preliminary analysis we examine the efficacy of these variables against other firm characteristic variables as determinants of *ex ante* investment propensities.

3. Evidence on Investment Propensities and Determinants and Measures of Financial Constraint

In this section, we conduct several empirical analyses that are important precursors to the main analyses of determinants of corporate investment conducted in Sections 4 and 5. Here we focus on (a) determinants of investment propensities, and (b) determinants and measures of financial constraint.

3.1 Time series perspectives on the data

Figures 1 and 2 provide initial time series perspectives on the data. Figure 1 shows annual average values of $CASH_t/TA'_t$, $PPENT_t/TA'_t$, $INTAN_t/TA'_t$, $OTHER_t/TA'_t$, and $R\&DCAP_t/TA'_t$. Figure 2 shows annual average values of $CAPX_t/TA'_{t-1}$, $R\&D_t/TA'_{t-1}$, NCF_t/TA'_{t-1}, $NETDT_t/TA'_{t-1}$, $NETEQ_t/TA'_{t-1}$, and Q_t. These figures show that U.S. firms collectively were undergoing a gradual, though profound, transformation in asset composition and investment over the sample years 1974-2008.

Figure 1 shows that average values of $CASH_t/TA'_t$, $INTAN_t/TA'_t$, and $R\&DCAP_t/TA'_t$ ($PPENT_t/TA'_t$ and $OTHER_t/TA'_t$) generally rose (fall) over the years. The substantial increase in average $CASH_t/TA'_t$ is consistent with Bates, Kahle, and Stulz (2009), while the substantial decrease (increase) in average $PPENT_t/TA'_t$ ($R\&DCAP_t/TA'_t$) attests to the transformation of the U.S. economy away from (toward) physical-capital (R&D) intensity. In Figure 2, the most notable trends are that average $CAPX_t/TA'_{t-1}$ generally decreases over time, while average $R\&D_t/TA'_{t-1}$ generally increases over time. These trends parallel those of $PPENT_t/TA'_t$ and $R\&DCAP_t/TA'_t$ noted above, and also attest to the transformation of the U.S. economy away from (toward) physical-capital (R&D) intensity.

In subsequent analyses, we often divide the sample into two subperiods that we call the 'Old Economy,' 1974-87, and the 'New Economy,' 1988-2008. The dividing year for the split is admittedly somewhat arbitrary because the trends in Figures 1a and 1b are gradual. We start the New Economy in 1988 in part because this is the first year in which average R&D investment ($R\&D_t/TA'_{t-1}$) is at least one-third of average capital expenditures ($CAPX_t/TA'_{t-1}$). In addition, Figure 1b shows that in the Old Economy average $NETDT_t/TA'_{t-1}$ generally exceeds average $NETEQ_t/TA'_{t-1}$, while in the New Economy, we have the reverse. Combined with the trends in capital expenditure and R&D investment, the results indicate that debt (external equity) is more closely associated with capital expenditure (R&D) investment, consistent with Almeida and Campello (2007) and Brown, Fazzari, and Petersen (2009).

3.2 Proxies for *ex ante* investment propensities

Next, we address the problem of establishing proxies for *ex ante* investment propensities. We do so using OLS regressions in which the dependent variable is an *ex post* investment measure. In choosing regressors (i.e, propensity proxy candidates), on one hand we clearly do not want to include *ex ante* variables that we will be using to test hypotheses about determinants of the *amount* of a given type of investment that a firm will make *given its propensity to make that type of investment*, such as Q_{t-1}, $CASH_{t-1}/TA'_{t-1}$, and $SMYG_{t-1}$. On the other hand, as noted earlier we already have strong candidates in $PPENT_{t-1}/TA'_{t-1}$ and $R\&DCAP_{t-1}/TA'_{t-1}$. In addition to these, we test: $INTAN_{t-1}/TA'_{t-1}$, LEV_{t-1}, and NCF_{t-1}/TA'_{t-1}.

The results are displayed in Table 1 Panels A and B for regressions of $CAPX_t/TA'_{t-1}$ and $R\&D_t/TA'_{t-1}$, respectively. Each panel shows regression results for each of three sample periods: all years, the Old Economy, and the New Economy. For each sample period, Panel A (Panel B) shows the results of alternative regressions in which: (a) $PPENT_{t-1}/TA'_{t-1}$ ($R\&DCAP_{t-1}/TA'_{t-1}$) is the sole regressor; (b) all regressors *except* $PPENT_{t-1}/TA'_{t-1}$ ($R\&DCAP_{t-1}/TA'_{t-1}$) are included; and (c) all regressors are included.

The results of the first regression in Panel A are consistent with our expectation that $PPENT_{t-1}/TA'_{t-1}$ would be a strong propensity proxy for capital expenditure investment, as the coefficient is positive and highly significant, and the adjusted R^2 is substantial (0.264). In the second regression, the coefficients of all other candidates are highly significant, though the adjusted R^2 is much lower (0.121). While the signs of the coefficients of these variables are interpretable,[8] for our purpose the results of the second regression are rendered moot by the results in the third regression, which includes all regressors. There the coefficient of $PPENT_{t-1}/TA'_{t-1}$ has a similar value as in the first regression, while the magnitudes of the coefficients of all other regressors are much smaller than in the second regression. Moreover, the adjusted R^2 of the third regression, 0.276, is only slightly higher than the adjusted R^2 of the first regression, 0.264, indicating that the other regressors add very little to explanatory power. We obtain similar results using separate data for the Old and New Economies, as shown in the remainder of Panel A. Thus, we conclude that $PPENT_{t-1}/TA'_{t-1}$ alone is an adequate proxy for capital expenditure investment propensity.

The results in Panel B, for R&D investment, follow a similar pattern, allowing us to make the analogous conclusion that $R\&DCAP_{t-1}/TA'_{t-1}$ alone is an adequate proxy for R&D investment propensity. A notable difference, though, is that the adjusted R^2s are substantially higher in Panel B than in Panel A, suggesting that R&D investment has greater persistence. These results underscore Hubbard's (1998) argument that the "…costs of adjusting R&D are very high, even relative to physical capital." (p. 215)

Finally, we use this setting to initially address the scaling issue discussed in Section 1. Panels C and D show results of the same series of regressions as in Panels A and B, except that the dependent variables reflect alternative scaling: $CAPX_t/PPENT_{t-1}$ and $R\&D_t/R\&DCAP_{t-1}$, respectively. The differences in the results vis a vis Panels A and B are dramatic in two respects. First, the adjusted R^2s in Panels C and D are much lower than their corresponding values in Panels A and B. Second, the coefficient of $CAPX_t/PPENT_{t-1}$ ($R\&D_t/R\&DCAP_{t-1}$) as a sole regressor in Panel C (Panel D) is *inconsistent* with its role as a measure of capital expenditure (R&D) investment propensity, as the coefficient is reliably *negative*

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[8] The negative coefficient of $R\&DCAP_{t-1}/TA'_{t-1}$ suggests that R&D-intensive firms are less likely to make capital expenditure investment. The negative coefficient of $INTAN_{t-1}/TA'_{t-1}$ suggests that firms that are acquisitions-intensive are less likely to make capital expenditure investment (i.e., they tend to 'buy' rather than 'build'). The positive coefficient of LEV_{t-1} (combined with the decimation of this coefficient in the third regression) suggests that leverage is associated with physical-capital intensity (consistent with Almeida and Campello's (2007) tangibility argument). Finally, the positive coefficient of NCF_{t-1}/TA'_{t-1} may indicate that this variable is a proxy for Q_{t-1}.

(unstable) in the various regressions. These results support our conjecture in Section 1 that, when firms in a sample vary in their propensities to make physical versus IP investment, scaling investment of a given type by the associate capital stock may produce distortion. For instance, in Panel C the negative coefficient of $PPENT_{t-1}/TA'_{t-1}$ in all regressions suggests that firms that are *higher* in physical capital-intensity consistently have *lower* capital expenditures. We conjectured that such distortion may occur if the R&D-intensive firms in the sample often make capital expenditures (e.g., for new lab equipment) that are large relative to their physical capital stock, even though both the capital expenditures and physical capital stock are small relative to total assets. The reliably positive coefficient of $R\&DCAP_{t-1}/TA'_{t-1}$ in the second regression in each Panel C series also supports this conjecture.

3.3 Analyses of average values of corporate investment measures and related variables

Next, we calculate average values of corporate investment measures and related variables for various sorts of the data. Our purpose is twofold: (a) to further investigate the scaling issue; and (b) to provide preliminary evidence on hypothesized relationships among investment, Tobin's Q, and financial constraint variables. Initially, we use data alternately for: (a) all firm-years; (b) the Old and New Economies; and (c) firms sorted into classes by ranges of $PPENT_{t-1}/TA'_{t-1}$. (Results of sorting firms by ranges of $R\&DCAP_{t-1}/TA'_{t-1}$, not shown, mirror those of sort (c)). The results are displayed in Table 2 Panel A.

The first two rows in Panel A show average values of capital expenditure and R&D investment, both scaled by $PPENT_{t-1}$ to make them directly comparable. The results for $CAPX_t/PPENT_{t-1}$ are problematic in two respects. First, average $CAPX_t/PPENT_{t-1}$ is actually slightly higher in the New Economy (0.293) than the Old (0.276), contrary to the trends in Figures 1a and 1b. Second, the sorts by ranges of $PPENT_{t-1}/TA'_{t-1}$ indicate that $CAPX_t/PPENT_{t-1}$ is strongly *negatively* related to $PPENT_{t-1}/TA'_{t-1}$, consistent with regression results in Table 1 that we recognized as problematic. Interestingly, the sorts by $PPENT_{t-1}/TA'_{t-1}$ provide indirect evidence consistent with 'q' theory as applied to capital expenditures because both $CAPX_t/PPENT_{t-1}$ and Q_{t-1} (shown in the fifth row) are strongly negatively related to $PPENT_{t-1}/TA'_{t-1}$, and therefore positively related to each other. However, this interpretation is confounded because $R\&D/PPENT_{t-1}$ is also negatively related to $PPENT_{t-1}/TA'_{t-1}$, and therefore positively related to Q_{t-1}.

In sharp contrast, when capital expenditure and R&D investment are scaled by TA'_{t-1}, interpretation of the results is straightforward: Average $CAPX_t/TA'_{t-1}$ ($R\&D_t/TA'_{t-1}$) is lower (higher) in the New Economy than the Old Economy, consistent with trends in Figures 1a and 1b, and average $CAPX_t/TA'_{t-1}$ ($R\&D_t/TA'_{t-1}$) increases (decreases) sharply with $PPENT_{t-1}/TA'_{t-1}$, which we would expect if firms tend to bifurcate in terms of capital expenditure vs. R&D investment propensities.

While scaling by TA'_{t-1} appears to be the better choice, from a 'q'-theoretic viewpoint the results across ranges of $PPENT_{t-1}/TA'_{t-1}$ are potentially problematic for capital expenditure investment (though not for R&D investment) because average Q_{t-1} *decreases* with $PPENT_{t-1}/TA'_{t-1}$. However, these results can be explained as follows. Suppose we have data in which firms tend to bifurcate in their propensities to make capital expenditure vs. R&D investment, though for each firm (and thus investment type propensity), investment tends to increase with Q. If we then sort the data into classes by ranges of a propensity measure associated with one investment type (in Table 2, this measure is $PPENT_{t-1}/TA'_{t-1}$, although $R\&DCAP_{t-1}/TA'_{t-1}$ serves the purpose as well), the sort will of course produce strong opposing trends across the classes in average values of capital expenditures vs. R&D investment. However, whether Q tends to increase or decrease across the classes simply depends on which investment type is generally associated with higher Q values (i.e., which investment type is generally associated with greater investment opportunities). For our data, that investment type apparently is R&D, which in turn explains the time trends in Figure 1b away from capital expenditures and toward R&D.

Variations in the average values of other variables in Panel A are also informative. For instance, average $CASH_{t-1}/TA'_{t-1}$ is substantially higher in the New Economy (0.139) than the Old (0.094), consistent with Bates, et al (2009). Moreover, average $CASH_{t-1}/TA'_{t-1}$ decreases strongly across the ranges of $PPENT_{t-1}/TA'_{t-1}$, from 0.234 for the lowest values of $PPENT_{t-1}/TA'_{t-1}$ to 0.067 for the highest. (Similar results, not shown, are obtained using separate data for the Old and New Economies.) According to theory discussed in Section 1, lagged cash balance is a measure of constraint (via its relationship with cash flow uncertainty). As such, the results indicate that physical-capital (R&D) intensity is a strong inverse (direct) determinant of financial constraint. Also, average LEV_{t-1} is strongly positively related to

$PPENT_{t-1}/TA'_{t-1}$, consistent with: (a) Almeida and Campello's (2007) argument that firms can employ leverage only to the extent that they have tangible assets; and (b) Brown, Fazzari, and Petersen's (2009) argument that debt is not an option for R&D-intensive firms.

Finally, we briefly discuss the results in Panels B and C for 'manufacturing' and non-'manufacturing' firms, respectively. All inferences drawn from our analysis of results in Panel A also apply to the results in Panels B and C, attesting to their robustness. However, the results in Panels B and C differ in one important respect: the relative sizes of average values of capital expenditure, R&D investment, PP&E, and estimated R&D capital. For all years combined as well as for the Old and New Economies, average $CAPX_t/TA'_{t-1}$ and $PPENT_{t-1}/TA'_{t-1}$ ($R\&D_t/TA'_{t-1}$ and $R\&DCAP_{t-1}/TA'_{t-1}$) are substantially *lower* (*higher*) for 'manufacturing' firms than for non-'manufacturing' firms. These results are surprising given the large number of studies that have used 'manufacturing' firms in studies of capital expenditure investment (see ftnt. 1). Apparently, subsequent studies simply followed Fazarri et al's (1988) lead in choosing 'manufacturing' firms, perhaps assuming that 'manufacturing' firms, as defined, represent the ideal class of firms for studying capital expenditure investment. If so, they did so despite Poterba's (1988) caveat in his comments on Fazarri et al: "It is even more difficult to generalize to nonmanufacturing firms, which held over 70 percent of corporate plant and equipment at the end of 1986." (p. 204) In any event, the relatively high R&D intensity of 'manufacturing' firms suggest that the hypothesized confounding effects of alternative investment types that we have discussed, both theoretically and thus far empirically, are actually *more likely* to pose a problem for 'manufacturing' firms, and thus for interpretation of the results of many previous studies of capital expenditure investment.

Next, we analyze average values of capital expenditure and R&D investment (both scaled here and henceforth by TA'_{t-1}), as well as related variables, after sorting by combinations of: (a) Economy; (b) ranges of $CAPX_t/TA'_{t-1}$; (c) ranges of $R\&D_t/TA'_{t-1}$, and (d) the size/age dummy $SMYG_{t-1}$. Our primary purpose is to provide better initial perspectives on the effects of financial constraint on the financing of corporate investment than can be obtained from Table 2. The results are shown in Table 3. Results of using data for Old Economy large/mature firms, Old Economy small/young firms, New Economy large/mature firms, and New Economy small/young firms are shown in Panels A-D, respectively.

Regarding $CAPX_t/TA'_{t-1}$ and $R\&D_t/TA'_{t-1}$, three observations are important. First, in both Economies the average values of each are very similar for large/mature firms and small/young. In three of the four comparisons by investment type involved when holding Economy constant, average investment is *higher* for small/young firms than large/mature firms. Though these comparisons do not control for other determinants of investment, the results are *per se* inconsistent with the hypothesis that firm size/age is an important determinant of financial constraint. Second, average $CAPX_t/TA'_{t-1}$ ($R\&D_t/TA'_{t-1}$) is substantially lower (higher) in the New Economy than the Old for both large/mature firms and small/young firms, attesting to the breadth of the transformation of U.S. firms over time in terms of investment propensities. Third, variations in average $CAPX_t/TA'_{t-1}$ and $R\&D_t/TA'_{t-1}$ across the ranges of the *opposing* investment measure indicate increasing bifurcation of U.S. firms in terms of investment type over time. Across the ranges of $CAPX_t/TA'_{t-1}$ ($R\&D_t/TA'_{t-1}$), average $R\&D_t/TA'_{t-1}$ ($CAPX_t/TA'_{t-1}$) is fairly flat in Panels A and B, but decreases sharply in Panels C and D.

The average value of Q_{t-1} is slightly lower (higher) for large/mature firms than small/young firms in the Old (New) Economy, and average Q_{t-1} increases substantially from the Old to the New Economy for firms in both firm size/age classes. In all panels, average Q_{t-1} increases across the ranges of both $CAPX_t/TA'_{t-1}$ and $R\&D_t/TA'_{t-1}$, consistent with 'q' theory. However, in every panel the rate of increase in average Q_{t-1} is much more substantial across $R\&D_t/TA'_{t-1}$ ranges than $CAPX_t/TA'_{t-1}$ ranges, additional evidence of the value dominance of R&D investment noted earlier. The variation in average Q_{t-1} across the $CAPX_t/TA'_{t-1}$ ranges contrast with results in Table 2, where average Q_{t-1} *decreases* across ranges of our *ex ante* measure of capital expenditure investment propensity, $PPENT_{t-1}/TA'_{t-1}$. We interpret the difference in results as follows. In Table 2, we only control for a fim's *ex ante* propensity to make capital expenditure investment, whereas in Table 3 sorting on individual firms' *ex post* capital expenditure decisions controls for both ex ante propensity and Q.

Average values of $CASH_{t-1}/TA'_{t-1}$ are higher for small/young firms vs. large/mature firms in both the Old Economy (0.120 vs. 0.090) and the New (0.159 vs. 0.134), suggesting that small/young firms generally are more constrained. However, variation in average $CASH_{t-1}/TA'_{t-1}$ across the ranges of $R\&D_t/TA'_{t-1}$ is greater, especially in the New Economy. To establish this point we refer to the High-Low difference statistics for $CASH_{t-1}/TA'_{t-1}$ shown in the last column of the 'Ranges of $R\&D/TA'_{t-1}$' display. For the Old Economy data in Panels A and B, the difference statistics are 0.041 and 0.043 for large/mature and small/young firms, respectively, both of which are larger than the Old-Economy difference in average $CASH_{t-1}/TA'_{t-1}$ for small/young firms vs. large/mature firms (0.030=0.120-0.090). For the New Economy data in Panels C and D, the difference statistics are more impressive, 0.168 and 0.174 for large/mature and small/young firms, respectively, both of which are substantially larger than the New-Economy difference in average $CASH_{t-1}/TA'_{t-1}$ for small/young firms vs. large/mature firms (0.025=0.159-0.134). Indeed, on two bases we conclude that the increase in average $CASH_{t-1}/TA'_{t-1}$ for R&D-intensive firms is a major driver of the overall increase in average $CASH_{t-1}/TA'_{t-1}$ for U.S. firms from the Old to the New Economy. First, the increase in average $CASH_{t-1}/TA'_{t-1}$ was much greater for R&D-intensive firms than physical-capital intensive firms. Second, the relative prevalence of R&D-intensive firms increased from the Old to the New Economy, as the 'N as %' figures in Table 3 indicate.

We gain initial insight into firms' cash balance management policies by examining variations in average lagged values of net internal cash flow (NCF_{t-1}/TA'_{t-1}), net debt financing ($NETDT_{t-1}/TA'_{t-1}$), and net external equity financing ($NETEQ_{t-1}/TA'_{t-1}$), all potential contributors to year-end t-1 cash balance. Panels A and C show that for large/mature firms NCF_{t-1}/TA'_{t-1} is the largest of the three, while Panels B and D show that for small/young firms $NETEQ_{t-1}/TA'_{t-1}$ is the largest.

The spreads by ranges of $CAPX_t/TA'_{t-1}$ and $R\&D_t/TA'_{t-1}$ allow us to better assess the potential contributions of each of the following cash-flow variables to finance year t investment: lagged net internal cash flow, lagged debt, and lagged external equity (all working through the cash balance account), as well as current net internal cash flow, current debt, and current external equity. For these assessments, we focus again on High-Low difference statistics.

In Panel A (large/mature firms in the Old Economy), the High-Low statistics for $CAPX_t/TA'_{t-1}$ suggest that NCF_t/TA'_{t-1}, NCF_{t-1}/TA'_{t-1}, and $NETDT_t/TA'_{t-1}$ rank first, second, and third in importance in financing capital expenditures, while the High-Low statistics for $R\&D_t/TA'_{t-1}$ suggest that NCF_t/TA'_{t-1}, NCF_{t-1}/TA'_{t-1}, and $NETEQ_t/TA'_{t-1}$ rank first, second, and third in importance in financing R&D. In Panel B (small/young firms in the Old Economy), the High-Low statistics for $CAPX_t/TA'_{t-1}$ suggest that NCF_t/TA'_{t-1}, $NETDT_t/TA'_{t-1}$, and NCF_{t-1}/TA'_{t-1}, rank first, second, and third in importance in financing capital expenditures, while the High-Low statistics for $R\&D_t/TA'_{t-1}$ suggest that NCF_t/TA'_{t-1}, $NETEQ_t/TA'_{t-1}$, and $NETEQ_{t-1}/TA'_{t-1}$ rank rank first, second, and third in importance in financing R&D. In Panel C (large/mature firms in the New Economy), the High-Low statistics for $CAPX_t/TA'_{t-1}$ suggest that NCF_t/TA'_{t-1}, NCF_{t-1}/TA'_{t-1}, and $NETDT_t/TA'_{t-1}$ rank first, second, and third in importance in financing capital expenditures, while the High-Low statistics for $R\&D_t/TA'_{t-1}$ suggest that $NETEQ_t/TA'_{t-1}$, $NETEQ_{t-1}/TA'_{t-1}$, and NCF_t/TA'_{t-1} rank first, second, and third in importance in financing R&D. Finally, In Panel D (small/young firms in the New Economy), the High-Low statistics for $CAPX_t/TA'_{t-1}$ suggest that NCF_t/TA'_{t-1}, $NETDT_t/TA'_{t-1}$, and $NETEQ_t/TA'_{t-1}$, rank first, second, and third in importance in financing capital expenditures, while the High-Low statistics for $R\&D_t/TA'_{t-1}$ suggest that $NETEQ_t/TA'_{t-1}$ $NETEQ_{t-1}/TA'_{t-1}$, and NCF_t/TA'_{t-1} rank first, second, and third in importance in financing R&D.

Two features of the above results are particularly important. First, considering all Economy, firm size/age, and investment type combinations, current internal cash flow appears to be the most important source of financing for investment except for the financing of R&D in the New Economy, where for both large/mature firms and small/young firms it ranks third in importance behind current net equity financing and lagged net equity financing. Thus, we can tentatively conclude that the growth in R&D financing over time has been largely financed with 'lumpy' external equity. Second, current net debt has been a consistently important supplemental source of financing for capital expenditures, but it has been consistently unimportant for financing R&D. These results are consistent with the Myers and Majluf's (1984) pecking order model and Almeida and Campello's (2007) tangibility argument, and also suggest that improvements in U.S. equity markets over time allowed for increases in R&D investment.

3.4 Analyses of cash balance dynamics

Next we test the hypothesis, proffered by several papers discussed in Section 1, that cash balance is a measure of financial constraint. We examine cash balance dynamics in two ways. First, we regress both lagged cash balances and changes in cash balances on various regressors and using various subsamples. Second, we examine variation in the average values and standard deviations of lagged cash balances, as well as the standard deviation of changes in cash balances, across the subsamples. The results will also inform us about the likely performance of lagged cash balance and other proposed determinants and measures of constraint that we will be testing in investment regressions in Sections 4 and 5.

3.4.1 Lagged cash balance regressions and statistics

Here we regress $CASH_{t-1}/TA'_{t-1}$ on the following variables, individually or in combination: $NEWECON_{t-1}$, a dummy variable with a value of 1 (0) for observations in the New (Old) Economy, representing general change in cash balances over time; $SMYG_{t-1}$, used to test whether small/young firms manifest greater financial constraint via greater cash balances; $PPENT_{t-1}/TA'_{t-1}$, used to directly (indirectly) test whether physical capital (R&D) intensity is an inverse (direct) measure of financial constraint; and NCF_{t-1}/TA'_{t-1}, $NETDT_{t-1}/TA'_{t-1}$, and $NETEQ_{t-1}/TA'_{t-1}$, used to assess individual firm's 'savings' rates out of net internal cash flow, net debt financing, and net equity financing, respectively. The results are shown in Table 4. Panel A shows results for the full sample and for subsamples formed by separate sorts by $SMYG_{t-1}$, Economy, and ranges of $PPENT_{t-1}/TA'_{t-1}$. Panel B shows results for subsamples formed by combination sorts of these three variables. For each data set we also show the average value and standard deviation of $CASH_{t-1}/TA'_{t-1}$, which we discuss after discussing all regression results.

The first seven rows in Panel A employ full sample data. In the first six rows each regressor is used alone, while in the seventh row all regressors are included. In the first, second, and fourth rows respectively, the coefficients of $NEWECON_{t-1}$, $SMYG_{t-1}$, and NCF_{t-1}/TA'_{t-1} are all positive and highly significant, as expected. However, the adjusted R^2s are very low (0.021, 0.007, and 0.000, resp.), indicating that none of these variables explains much variation in lagged cash balances. In particular, the weakness of $SMYG_{t-1}$ suggests that firm size/age is a weak determinant of financial constraint. In sharp contrast, the results in the fourth row directly indicate that $PPENT_{t-1}/TA'_{t-1}$ is a strong *inverse* measure of constraint, and indirectly suggest that R&D intensity is a strong *direct* measure of constraint. The coefficient of $PPENT_{t-1}/TA'_{t-1}$ is negative, as expected, and highly significant, and the adjusted R^2 is substantial, 0.133.

The results for $NETDT_{t-1}/TA'_{t-1}$ and $NETEQ_{t-1}/TA'_{t-1}$ in the fifth and sixth rows, respectively, are consistent with Bolton, et al's (2009) model in which debt financing is contingent-continuous while external equity financing is lumpy. The coefficient of $NETDT_{t-1}/TA'_{t-1}$ is reliably negative, but its magnitude is small and the adjusted R^2 is very low, 0.002.[9] The coefficient of $NETEQ_{t-1}/TA'_{t-1}$ is reliably positive, its magnitude is large, and the adjusted R^2 is fairly substantial, 0.072. The value of the coefficient, 0.418, suggests that on average firms issuing equity in year t-1 retain 41.8% of the proceeds by year-end t-1. Recalling results in Table 3 that external equity is closely associated with R&D intensity, this result also links R&D intensity to constraint.

The results of using all regressors, shown in the seventh row, further indicate that $PPENT_{t-1}/TA'_{t-1}$ and $NETEQ_{t-1}/TA'_{t-1}$ are the dominant determinants of variation in $CASH_{t-1}/TA'_{t-1}$. The magnitudes of the coefficients of these two variables are similar to their corresponding magnitudes in regressions in which each is a sole regressor, while the magnitudes of the coefficients of $NEWECON_{t-1}$ and $SMYG_{t-1}$ shrink substantially relative to their corresponding sole-regressor magnitudes. Thus, it appears that both the increase in average cash balances observed over time and the higher cash balances observed for small/young firms have a common and important underlying determinant: R&D intensity (proxied here by both $PPENT_{t-1}/TA'_{t-1}$ and $NETEQ_{t-1}/TA'_{t-1}$).

Rows eight and nine show results of regressions using separate data for large/mature firms ($SMYG_{t-1}$=0) and small/young firms ($SMYG_{t-1}$=1), respectively, and in each all regressors are used except, of course, $SMYG_{t-1}$. The results for both firm size/age classes are very similar to each other and to the corresponding full-sample results, in terms of both coefficient values and adjusted R^2s, with the exception

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[9] The negative sign of this coefficient likely reflects a spurious relationship: As capital expenditures increase, average debt issuance increases, but average cash balance decreases, all as shown in Table 3.

that the coefficient of NCF_{t-1}/TA'_{t-1} is insignificant using data for the small/young firms. This exception relates to evidence in Table 3 indicating that our small/young firms generally are observed just emerging toward profitability, so they generally do not have the opportunity to hoard cash from year t-1 operations.

The next two rows show results for the Old and New Economy subsamples, respectively, and in each all regressors are used except, of course, $NEWECON_{t-1}$. The adjusted R^2 is substantially higher for the New Economy subsample (0.214) than the Old (0.094), and the magnitudes of the coefficients of both $PPENT_{t-1}/TA'_{t-1}$ and $NETEQ_{t-1}/TA'_{t-1}$ are substantially higher in the New Economy vs. the Old (-0.250 vs. -0.128 and 0.393 vs. 0.267, resp.). Interpreting these variables as inverse and direct proxies for R&D intensity, respectively, the results suggest that R&D intensity is associated with greater constraint in the New Economy than the Old. As such, the results pose a conundrum: How could R&D investment have increased over time if it became associated with greater financial constraint? The conundrum can be resolved if, simultaneously, advances in equity markets allowed more *highly-speculative* R&D-intensive firms (i.e., R&D-intensive firms that are younger, smaller, and/or less profitable) to emerge in the New Economy. Evidence in Table 3 is consistent with this argument: For both large/mature firms and small/young firms, the average profitability of R&D-intensive firms (measured by either NCF_{t-1}/TA'_{t-1} or NCF_t/TA'_{t-1}) fell substantially from the Old Economy to the New. Moreover, as noted earlier in the Old Economy (New Economy) current internal cash flow (current net external equity) appears to be the most important source of R&D financing.

The final five rows of Panel A show results by ranges of $PPENT_{t-1}/TA'_{t-1}$; thus we control for a variable that has emerged thus far as an important (inverse) measure of constraint. In three respects, the results simply further attest to the importance of $PPENT_{t-1}/TA'_{t-1}$ in explaining variation in lagged cash balance. First, all adjusted R^2s are much lower than for prior regressions where $PPENT_{t-1}/TA'_{t-1}$ is a regressor. Second, the adjusted R^2s decrease sharply with $PPENT_{t-1}/TA'_{t-1}$, from 0.091 for $PPENT_{t-1}/TA'_{t-1}<0.10$ to only 0.026 for $PPENT_{t-1}/TA'_{t-1}\geq 0.40$. Third, the magnitudes of the coefficients of $NEWECON_{t-1}$, $SMYG_{t-1}$, NCF_{t-1}/TA'_{t-1}, and $NETEQ_{t-1}/TA'_{t-1}$ all decrease sharply with $PPENT_{t-1}/TA'_{t-1}$. Separately, the coefficient of $NETDT_{t-1}/TA'_{t-1}$ is very small in all five regressions, and is insignificant in four of the five, consistent with Bolton et al's (2009) argument that debt financing is contingent-continuous.

We now turn to results of the combination sorts in Panel B. The results are similar to those in Panel A in three major respects. First, because $PPENT_{t-1}/TA'_{t-1}$ is controlled in all Panel B regressions, all adjusted R^2s are much lower than for those Panel A regressions where $PPENT_{t-1}/TA'_{t-1}$ is a regressor. Second, the coefficient of $NETEQ_{t-1}/TA'_{t-1}$ decreases sharply with $PPENT_{t-1}/TA'_{t-1}$ for all Economy and firm size/age combinations, while the coefficient of $NETDT_{t-1}/TA'_{t-1}$ is generally small and insignificant. Third, for large/mature firms in both Economies, the coefficient of NCF_{t-1}/TA'_{t-1} is always reliably positive, though it decreases with $PPENT_{t-1}/TA'_{t-1}$, while for small/young firms in both Economies, the coefficient of NCF_{t-1}/TA'_{t-1} is never highly reliable. Thus, in year t-1 small/young firms do not generally manage to save out of year t-1 net cash flow in either the Old or New Economies.

The results indicate that large/mature firms hoard cash in year t-1 from both net internal cash flow and net external equity, while small/young firms hoard only from the latter. Moreover, Table 3 shows that for small/young firms, average net external equity in both years t-1 and t is greater in the New Economy (0.054 and 0.056, resp.) than the Old (0.035 and 0.033, resp.). Thus, overall the results in Tables 3 and 4 suggest that in the Old Economy small/young firms are more constrained in obtaining external equity finance, so they must generally wait (in terms of investing) until they have internal profits in year t-1, while in the New Economy small/young firms are less constrained (i.e., they can invest at an earlier stage of development using external equity financing).

Finally, we examine patterns in the average values and standard deviations of $CASH_{t-1}/TA'_{t-1}$ across the various subsamples in both panels. Before doing so, however, we comment on the comparability of a standard deviation of $CASH_{t-1}/TA'_{t-1}$ calculated using panel data, as we have here, to the measure of *cash flow volatility* used in other theoretical and empirical research (i.e., the volatility of a given firm's internal cash flow over time). The two measures would compare very closely if, for panel data consisting of firms that are homogeneous in cash flow volatility, firms do not manage cash balances via offsetting external finance activity (which is, of course, impossible because cash balance may become negative at times).

With offsetting external financing activity, cash balance volatility would be much lower than cash flow volatility. For instance, a firm with an unlimited contingent-continuous line of credit could completely offset variation in internal cash flow via the line, so that cash balance volatility is zero even though cash flow volatility may be substantial. Alternatively, cash balance volatility will be muted relative to cash flow volatility for firms that are constrained in the Fazarri et al (1988) sense; i.e., the firm will invest only to the extent that contemporaneous internal cash flow allows.

However, note that both of the above scenarios, being narrowly defined, suggest that such firms would have no need to carry a positive cash balance. Thus, the usefulness of a cash balance must emerge from deviations around the confines of each scenario. Regarding deviations from the line-of-credit scenario, Bolton et al's (2009) model allows for a possible cap on the line of credit, and if the firm needs more cash after reaching the cap, it will either rely on lagged cash balance or issue lumpy equity, depending on the value of certain parameters. In either case, both positive cash balance and cash balance volatility are implied. Deviations from the Fazarri et al scenario emerge in periods when the constrained firm's internal cash flow *exceeds* its cash requirement for investment. After all, being constrained does not mean that the firm would use all available internal cash flow for contemporaneous investment. Instead, in such years the constrained firm would rationally hoard cash and draw down the balance in a future year in which desired investment exceeds current internal cash flow. Thus again, both positive cash balance and cash balance volatility are implied. These arguments lead us to conclude that both cash balance and cash balance volatility are valid measures of constraint, and that they would be positively related to each other.

Returning to Table 4, it is clear from inspection that average values and standard deviations of $CASH_{t-1}/TA'_{t-1}$ are positively related across the various subsamples. Both are higher in the New Economy (0.139 and 0.155, resp.) than the Old (0.094 and 0.105, resp.), and both are higher for small/young firms (0.150 and 0.165, resp.) than large/mature firms (0.119 and 0.137, resp.). However, all sorts by PP&E ranges in the table indicate that this variable, and by extension R&D intensity, is an important determinant of cross-sectional variation in both the average value and standard deviation of $CASH_{t-1}/TA'_{t-1}$, as both are strongly inversely related to PP&E. Referring to extremes, the statistics are 0.067 and 0.065, respectively, for large/mature firms with the highest PP&E intensity in the Old Economy, and 0.249 and 0.195, respectively, for small/young firms with the lowest PP&E intensity in the New Economy. These results can be seen as consistent with Almeida, et al (2004) and Bolton, et al (2009), though both studies refer to cash flow volatility rather than cash balance volatility.

3.4.2 Regressions of change in cash balance

Next, we regress year t *change* in cash balance, defined as $chgCASH_t=(CASH_t-CASH_{t-1})/TA'_{t-1}$, on $CASH_{t-1}/TA'_{t-1}$, NCF_t/TA'_{t-1}, $NETDT_t/TA'_{t-1}$, and $NETEQ_t/TA'_{t-1}$. Theory provides several predictions about the coefficients and explanatory power of these variables. The first prediction, shared by many of the theoretical models and hypotheses discussed in Section 1, is that for unconstrained firms *none* of these variables should have much power to explain variation in $chgCASH_t$, because unconstrained firms have near infinite flexibility to manage their cash balance over time (e.g., via a line of credit).

For constrained firms, predictions are as follows. For $CASH_{t-1}/TA'_{t-1}$, the qualitative prediction is that the coefficient will be negative because constrained firms' lagged cash balances often will either (a) include a temporary component intended for use in year t, or (b) be relatively deficient and will be replenished in year t via either internal cash flow or external financing (likely lumpy external equity). It is less clear, however, how the *magnitude* of the coefficient would vary with the degree of constraint because the magnitude represents the average *fraction* of $CASH_{t-1}/TA'_{t-1}$ that is drawn or replenished in year t.[10]

Regarding the coefficient of NCF_t/TA'_{t-1}, as noted earlier Fazarri et al's (1988) constraint argument tells us nothing about cash balances. However, Hubbard's (1998) argument that R&D entails very high adjustment costs, combined with arguments (and evidence thus far) that constraint increases with R&D intensity, suggest that the coefficient of NCF_t/TA'_{t-1} will be positive and will tend to increase with R&D intensity (because R&D-intensive firms will smooth the use of volatile internal cash flow to finance R&D steadily over time). In addition, both Almeida, et al (2004) and Bolton et al (2009) argue that constrained

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[10]Consequently, perhaps a better gauge of the extent to which a given type of firm uses lagged cash balance for year t investment (or any other purpose) is the product of average $CASH_{t-1}/TA'_{t-1}$ and the coefficient of $CASH_{t-1}/TA'_{t-1}$.

firms will tend to save cash from current cash flow, suggesting that the coefficient of NCF_t/TA'_{t-1} will be positive and will increase with the degree of constraint.

Regarding the coefficients of $NETDT_t/TA'_{t-1}$ and $NETEQ_t/TA'_{t-1}$, we refer again to Bolton et al (2009). In their model, debt financing is generally used by unconstrained firms and is contingent-continuous, so the coefficient of $NETDT_t/TA'_{t-1}$ should be negligible. In contrast, external equity financing is associated with constrained firms and is lumpy, so the coefficient of $NETEQ_t/TA'_{t-1}$ should be positive. Again though, its magnitude depends on how issuing firms allocate equity proceeds over time.

The results are displayed in Table 5. Similar to the arrangement in Table 4, Panel A shows results for the full sample and subsamples formed by individual sorts of $SMYG_{t-1}$, Economy, and ranges of $PPENT_{t-1}/TA'_{t-1}$, while Panel B shows results for combination sorts of these three variables. Also, for all datasets we show the average value and standard deviation of $chgCASH_t$. Using arguments similar to those we made to conclude that the standard deviation of lagged cash balance is a valid measure of constraint, we surmise that the standard deviation of $chgCASH_t$ is also a valid measure of constraint.

The results in Panel A are largely consistent with the predictions discussed above. Note initially that across the various subsamples the standard deviation of $chgCASH_t$ and the regression adjusted R^2 vary in tandem: Both are higher for small/young firms vs. large/mature firms; both are higher in the New vs. Old Economy; and both are strongly inversely related to PP&E intensity.

The coefficient of $CASH_{t-1}/TA'_{t-1}$ is negative and highly significant in every regression, as expected. Its magnitude is fairly stable across the various subsamples. Thus, the evidence in Table 4 that average $CASH_{t-1}/TA'_{t-1}$ varies across these subsamples in constraint-consistent fashion, combined with the stability of the coefficient of $CASH_{t-1}/TA'_{t-1}$ here, suggests that the importance of lagged cash balance as a year t source of funds increases with constraint. The coefficient of NCF_t/TA'_{t-1} is positive and highly significant in every regression, and varies across the subsamples in constraint-consistent fashion (e.g., it varies positively with the volatility of $chgCASH_t$). Finally, the coefficients of both $NETDT_t/TA'_{t-1}$ and $NETEQ_t/TA'_{t-1}$ are reliably positive in every regression. However, the coefficient of $NETEQ_t/TA'_{t-1}$ is consistently several times larger than the coefficient of $NETDT_t/TA'_{t-1}$, consistent with theory.

Qualitatively, though, these coefficients display similar behavior, both being larger for small/young firms and in the New Economy, and inversely related to PP&E intensity. Thus, both debt and external equity financing appear to involve a partial 'saving' component linked to constraint, though much more so for external equity than for debt.

The results in Panel B are largely as expected given the results in Panel A. To illustrate, consider the results for two 'extreme' subsamples: (a) large/mature firms in the Old Economy with the highest PP&E intensities; and (b) small/young firms in the New Economy with the lowest PP&E intensities. We expect subsample (a) ((b)) to reflect the lowest (highest) degree of constraint. Five aspects of the results are consistent with this expectation. First, among all subsamples the standard deviation of $chgCASH_t$ is lowest (highest) for subsample (a) ((b)). Second, among all subsamples the coefficient of NCF_t/TA'_{t-1} is third-lowest (highest) for subsample (a) ((b)). Third, among all subsamples the coefficient of $NETDT_t/TA'_{t-1}$ is second-lowest (second-highest) for subsample (a) ((b)). Fourth, among all subsamples the coefficient of $NETEQ_t/TA'_{t-1}$ is second-lowest (highest) for subsample (a) ((b)). Fifth and finally, among all subsamples the adjusted R^2 is lowest (highest) for subsample (a) ((b)).

4. Determinants of Corporate Investment: Propensities, Tobin's Q, and Financial Constraint

In this section, we test the efficacy of alternative regression models to explain variation in capital expenditure and R&D investment. Initially, we test the two modified 'q' models developed in Section 1 against each other and the basic 'q' model, excluding financial constraint variables. We then test our main propensity regression model, both excluding and including constraint variables, against various OLS/GLM alternatives used to represent the extant literature. Based on the results in Table 1, in all propensity regressions of capital expenditure (R&D) investment, we weigh regressors using $PPENT_{t-1}/TA'_{t-1}$ ($R\&DCAP_{t-1}/TA'_{t-1}$). We denote a propensity weight as 'pw_t'. Thus, we can denote an un-weighted OLS/GLM regression using pw_t=1.000.

4.1 Preliminary tests of two modified 'q' models of investment

Our preliminary analysis involves tests of the two modified 'q' models developed in Section 1, as well as the basic 'q' model, so constraint variables are excluded. Tests of the basic 'q' model simply involve OLS regression of a focal investment measure on Q_{t-1}. Tests of the first modified 'q' model, given in eq.'s (9) and (12) for capital expenditure and R&D investment, respectively (sans the second terms in each), involve propensity regression. The second modified 'q' model, also tested using OLS regression, is given in eq.'s (11) and (13) for capital expenditure and R&D investment, respectively. The results are displayed in Table 6 Panels A and B for capital expenditure and R&D investment, respectively. In each panel, we initially use full-sample data, and then repeat using subsamples for the Old and New Economy.

The First row of Panel A displays results of testing the basic 'q' model on capital expenditures using full-sample data. The coefficient of Q_{t-1} is positive and highly significant; however, we obtain the familiar paltry result in terms of explanatory power, as the adjusted R^2 is only 0.009. The second row shows the results of testing our second modified 'q' model, which simply involves adding the opposing investment measure, in this case $R\&D_t/TA'_{t-1}$, to the basic 'q' model as a second regressor. The coefficient of $R\&D_t/TA'_{t-1}$ is negative, as expected, and highly significant. In addition: (a) The size of the coefficient of Q_{t-1} increases markedly to 0.012 from 0.007 in the basic 'q' model regression; and (b) the adjusted R^2 also increases markedly to 0.049 from 0.009. Thus, the results provide a basic indication of the importance of accounting for alternative investment types in testing 'q' theory.

The next four rows show results of propensity regressions. In the first, the propensity weight itself ($pw_t=PPENT_{t-1}/TA'_{t-1}$) is the sole regressor. Thus, the results are identical to those shown in the first row of Table 1 Panel A (where we are investigating determinants of *ex ante* propensities to make capital expenditure investment), and are brought forward here to facilitate comparison. The coefficient of pw_t is reliably positive, and the adjusted R^2, 0.264, far exceeds the adjusted R^2s of the previous two regressions. On one hand, the results make a strong statement regarding the importance of accounting for individual firm's *ex ante* propensities to engage in capital expenditure investment. On the other hand, the results do not bode well for 'q' theory simply because a variable other than Q has substantial explanatory power.

However, our first modified 'q' model specifies that capital expenditure investment is a function of the *product* of a firm's ex ante propensity to make capital expenditure investment and Q. Thus, in the fourth regression, a propensity regression, the regressor is pw_t*Q_{t-1}. The coefficient is positive and highly significant, and the adjusted R^2, 0.273, is slightly higher than that of the previous regression. *Per se*, the results provide strong support for our first modified 'q' model, and thus for 'q' theory. However, and depending on one's perspective, assessing the relative importance of the individual terms in pw_t*Q_{t-1} is an important issue.

To address this issue, the fifth regression includes both pw_t and pw_t*Q_{t-1} as regressors. If pw_t has independent explanatory power, then: (a) the coefficient of pw_t will remain positive; (b) the coefficient of pw_t*Q_{t-1} will likely be smaller than its value in the fourth regression; and (c) the adjusted R^2 will be higher than in the fourth regression. If not, the coefficient of pw_t should be zero and the other results should resemble those in the fourth regression. The results are shown in the fifth row of Panel A. The coefficient of pw_t is reliably positive, the coefficient of pw_t*Q_{t-1} is smaller than in the fourth regression (though still highly significant), and the adjusted R^2, 0.315, is higher than in the fourth regression. Thus, we conclude that *ex ante* propensity has an independent effect on capital expenditure investment. Note, however, that the coefficient of pw_t in this regression, 0.107, is smaller by almost half relative to its value in the third regression, 0.189, suggesting that the inclusion of pw_t*Q_{t-1} substantially reduces the importance of pw_t. Nevertheless, in all our propensity regressions to follow, we will include both pw_t and pw_t*Q_{t-1} as regressors.

Finally, given that $R\&D_t/TA'_{t-1}$ was found to be a strong regressor in our tests of the second modified 'q' model, we add it to the fifth regression to form a sixth regression, even though our first modified 'q' model does not specify this variable. The results are displayed in the sixth row of Panel A. The coefficient of $R\&D_t/TA'_{t-1}$ is reliably *positive* in this regression, as opposed to negative as expected and as we found in the second regression. However, its magnitude here is less than $1/10^{th}$ its magnitude in the second regression. Moreover, the addition of $R\&D_t/TA'_{t-1}$ adds nothing to adjusted R^2 relative to the fifth regression. We interpret these results to indicate that the design of our first modified 'q' model assuages the need for an 'opposing investment' variable to account for an alternative investment type.

The results of using subsample data for the Old and New Economies, shown in the remainder of Panel A, are very similar to those for the full sample, so we do not discuss them separately.

The results in Panel B, for R&D investment, are qualitatively similar to those in Panel A. For the full sample, the first regression, testing the basic 'q' model, yields a reliably positive coefficient of Q_{t-1}. The adjusted R^2, 0.106, is low relative to later regressions in the Panel B, but is high relative to the corresponding regression in Panel A. In the second regression, the coefficient of the opposing investment measure, $CAPX_t/TA'_{t-1}$, is negative, as expected, and highly significant, and the addition of this variable boosts the adjusted R^2 to 0.142. In the third regression, results of which are identical to those shown in the first row of Table 1 Panel B, the coefficient of pw_t is reliably positive, and the adjusted R^2, 0.737, is very large. As noted earlier, we attribute this high explanatory power to Hubbard's (1998) argument that the adjustment costs of R&D are very high, so that R&D investment will tend to exhibit high persistence.

When pw_t*Q_{t-1} is the sole regressor, the coefficient is reliably positive, as expected. However, the adjusted R^2, 0.607, is somewhat *lower* than that of the previous regression. Nevertheless, when both pw_t and pw_t*Q_{t-1} are included in the regression, the adjusted R^2, 0.753, is slightly *higher* than when pw_t is the sole regressor, and the coefficient of pw_t, 0.289, is substantially lower than when pw_t is the sole regressor (0.389), indicating that pw_t*Q_{t-1} not only adds to explanatory power, but reduces the importance of pw_t. Thus, while the evidence is somewhat mixed, our first modified 'q' model as applied to R&D investment is supported. Finally, when we add $CAPX_t/TA'_{t-1}$ as a third regressor, the coefficient of $CAPX_t/TA'_{t-1}$ is small and the adjusted R^2 is not increased, suggesting again that the design of our first modified 'q' model obviates the need for the opposing-investment variable.

As in Panel A, the results of using separate data for the Old and New Economies, shown in the remainder of Panel B, are very similar to those for the full sample, so we do not discuss them separately.

4.2 Propensity regression vs. OLS/GLM alternatives

We now turn to tests of alternative investment regression models that include Q as well as constraint and external finance variables. We have two purposes for these tests. First, we wish to compare the efficacy of propensity regression to OLS/GLM regression alternatives used to represent the extant literature. Second, we wish to assess the robustness and explanatory power of individual regressors, and we do so by using alternative sets of regressors. For this analysis, we use full-sample data. Our main results are displayed in Table 7 Panels A and B for capital expenditure and R&D investment regressions, respectively.

The first set of regressions in Panel A are OLS/GLM regressions, denoted by pw_t=1.000. In the first regression Q_{t-1} is the sole regressor. The results are therefore identical to those in the first row of Table 6 Panel A, and are presented here to facilitate comparison. The second regression is formed by adding $CASH_{t-1}/TA'_{t-1}$ as a second regressor. The coefficient of $CASH_{t-1}/TA'_{t-1}$ is highly significant, and the adjusted R^2 increases somewhat to 0.027 from 0.009 in the first regression. However, the coefficient is *negative*, a result that is inconsistent with constraint theory which predicts that firms that are more constrained generally will have higher cash balances and will tend to drawdown cash balance for (year t) investment. To explain this result, recall earlier evidence that: (a) lagged cash balances are negatively related to PP&E; and (b) capital expenditures are positively related to PP&E. Thus, we interpret the negative coefficient of $CASH_{t-1}/TA'_{t-1}$ as due to this co-variation, rather than being inconsistent with constraint theory. Moreover, we contend that this result illustrates the faulty inferences that can result from failing to control for alternative investment types. Support for this contention is given in the propensity regression results later in the table, where the coefficient of $CASH_{t-1}/TA'_{t-1}$ is reliably *positive*.

Next, we add NCF_t/TA'_{t-1} as a third regressor. The coefficient is reliably positive, consistent with constraint theory (i.e., assuming that firms *in general* are constrained), and the adjusted R^2 increases to 0.093. Adding $NETDT_t/TA'_{t-1}$ more than doubles the adjusted R^2, to 0.190 from 0.093, and then adding $NETEQ_t/TA'_{t-1}$ increases the adjusted R^2 further to 0.216. Both coefficients are reliably positive. As discussed earlier, a contemporaneous external finance variable may play dual roles in an investment regression, as (a) a proxy for Tobin's Q if Q is measured with error, and (b) as a measure of constraint. The positive coefficients of both variables support both roles, while the observed reductions in the coefficient of Q_{t-1} as each variable is added support role (a).

In the literature, it is common to add fixed year and firm effects in an investment regression. The justification is that these effects account for unobserved factors.[11] While we recognize the potential importance of adding fixed year and firm effects, we have a qualm regarding their use in extant studies because results *without* the addition of the effects are not reported, so we cannot gauge the influence of adding them on either the coefficients of the variables explicitly included in the regression or the regression R^2. Here we have already estimated regressions without fixed effects, so as we now use GLM regression to add fixed year and firm effects, we can gauge their influence.

The addition of fixed year effects has very little effect on either the coefficients of the explicit regressors or the adjusted R^2 (which increases to 0.237 from 0.216). In sharp contrast, the addition of fixed firm effects nearly triples the adjusted R^2, to 0.640 from 0.216, and substantially alters the coefficients of several explicit regressors. Most notably, the coefficient of Q_{t-1} increases substantially from 0.002 to 0.008, and the coefficient of $CASH_{t-1}/TA'_{t-1}$ actually *reverses* in sign from negative and inconsistent with constraint theory to positive and consistent with constraint theory. These results attest to the importance of including fixed firm effects. However, we suspect that the reason why adding fixed firm effects 'works' in this regard is that they at least partially neutralize the confounding influence of R&D-intensive firms. Finally and unsurprisingly, the addition of both fixed year and firm effects are very similar to the results of adding only fixed firm effects.

Next, we turn to the results of propensity regressions of capital expenditures, displayed in the remaining rows of Panel A. The first propensity regression includes only pw_t and pw_t*Q_{t-1} as regressors, and is therefore identical to the propensity regression in the fifth row of Table 6 Panel A. The coefficient of pw_t*Q_{t-1} is reliably positive, and the adjusted R^2, 0.315, is very substantial. Thus, propensity regression produces much stronger support for q theory than we found with the corresponding OLS regression.

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[11] In their seminal analysis, Fazzari, et al (1988) justify their use of fixed year and firm effects as follows: "Fixed time effects are included to capture aggregate business-cycle influences. Fixed firm effects account for unobserved time-invariant links between investment and the explanatory variables." (p. 166) Other corporate investment studies that include fixed effects include Kaplan and Zingales (1997), Almeida and Campello (2007), Hennessy, Levy, and Whited (2007), Agca and Mozumdar (2008), and Brown and Petersen (2009).

Next, we successively add $pw_t*CASH_{t-1}/TA'_{t-1}$ and pw_t*NCFt/TA'_{t-1} as regressors. The coefficients of both $pw_t*CASH_{t-1}/TA'_{t-1}$ and pw_t*NCFt/TA'_{t-1} are reliably positive, consistent with constraint theory. Moreover, adding these variables successively increases the adjusted R^2 to 0.326 and then to 0.407. The positive coefficient of $pw_t*CASH_{t-1}/TA'_{t-1}$ also suggests that the propensity regression design alleviates the 'contamination' problem noted earlier for the OLS regressions.

Adding $NETDT_t/TA'_{t-1}$ increases the adjusted R^2 substantially to 0.504, whereas adding $NETEQ_t/TA'_{t-1}$ increases the adjusted R^2 by a smaller increment, to 0.537. The coefficients of both variables are reliably positive. The differential R^2 increments suggest that debt is more important than external equity as a source of funding for capital expenditures, consistent with Almeida and Campello's (2007) tangibility argument. Referring to the propensity regression that includes both variables, the coefficient of $NETDT_t/TA'_{t-1}$, 0.630, is substantially larger than the coefficient of $NETEQ_t/TA'_{t-1}$, 0.469, suggesting that generally the proportion of external financing proceeds used for capital expenditures is greater for debt than external equity. These results are consistent with Bolton et al's (2009) argument that debt finance is contingent-continuous while equity finance is lumpy and would involve a substantial 'saving' component.

The effects of adding fixed effects on adjusted R^2 as well as the coefficients of explicit regressors are much smaller for propensity regression than for OLS/GLM regression. Adding fixed effects increases adjusted R^2 to 0.701 from 0.537 (0.655 from 0.216) for propensity regression (OLS/GLM regression). In addition, adding fixed effects to propensity regression does not greatly affect the coefficient of $pw_t*CASH_{t-1}/TA'_{t-1}$, in contrast to their effect on this coefficient in OLS/GLM regression, where the sign of the coefficient is reversed, as noted earlier. Overall, we conclude that propensity regression is more effective in explaining variation in capital expenditures than OLS/GLM regression alternatives.

The sequence of results for R&D investment displayed in Panel B are qualitatively similar to those discussed in detail for capital expenditures above, so we do not repeat the discussion. Instead, we turn to a comparison of the coefficients of key regressors in the propensity regressions in Panels A vs. B. If R&D-intensive firms are inherently more constrained than physical capital-intensive firms as arguments and evidence thus far suggest, the difference should be reflected in these coefficients. For this comparison we focus on the results of the final propensity regression in each panel.

The coefficient of $pw_t*CASH_{t-1}/TA'_{t-1}$ is slightly larger in Panel A, 0.303, than in Panel B, 0.241. However, recalling that average lagged cash balance is several times larger for R&D-intensive firms than for physical capital-intensive firms, we conclude that lagged cash balance is generally a *more* important source of funding for R&D than for capital expenditures. As such, the results are consistent with constraint theory given that (a) R&D intensity is a *determinant* of constraint, and (b) lagged cash balance is a *measure* of constraint. Also, the coefficients of pw_t*NCF_t/TA'_{t-1}, $pw_t*NETDT_t/TA'_{t-1}$, and $pw_t*NETEQ_t/TA'_{t-1}$ are all larger in Panel A (0.545, 0.571, and 0.373, resp.) than in Panel B (0.450, 0.310, and 0.236, resp.). These results are also consistent with constraint theory: R&D-intensive firms will save more, and invest less, of current internal cash flow as well as proceeds of external finance.

Finally, Panels C and D show results of OLS/GLS regressions of capital expenditure and R&D investment that are in 'first-difference' form. We conduct first-difference regressions because several studies have used this approach as either a substitute for or complement to adding fixed effects to deal with the missing explanatory variables issue (e.g., Brown and Petersen, 2009; Brown, Fazzari, and Petersen, 2009). The first (second) regression in each panel excluded (includes) fixed effects. First-differencing appears to resolve the 'contamination' issue discussed earlier, as the coefficient of $CASH_{t-1}/TA'_{t-1}$ in the first Panel C regression is reliably positive. In addition, with one important exception (the coefficient of Q_{t-1} in the second Panel D regression), all coefficients are reliably positive as expected, and the adjusted R^2s are generally fairly substantial, though they are much lower than for many corresponding regressions in Panels A and B. Overall, we conclude that first-difference regression meets with some success, but is inferior to propensity regression.

For the final analysis in this section, we estimate propensity regressions of capital expenditure and R&D investment using data sorted by (a) firm size/age, (b) Economy, and (c) combinations of firm size/age and Economy. For all propensity regressions, we use the final specifications in Table 7 Panels A and B, each of which includes all explicit regressors as well as fixed year and firm effects. The results are displayed in Table 8 Panels A and B for capital expenditure and R&D investment, respectively.

The results in Panel A are perhaps most remarkable in terms of stability: Coefficients of all individual regressors, as well as the adjusted R^2, are broadly stable across subsamples. Beyond this, in three respects observed variation in coefficients is consistent with constraint theory. First, the coefficient of $pw_t*NETDT_t/TA'_{t-1}$, is always substantially greater than the coefficient of $pw_t*NETEQ_t/TA'_{t-1}$, consistent with Bolton et al (2009). Second, the coefficient of $pw_t*CASH_{t-1}/TA'_{t-1}$ is higher, while the coefficient of pw_t*NCF_t/TA'_{t-1} is lower, for small/young firms than large/mature firms. Third, the coefficient of $pw_t*CASH_{t-1}/TA'_{t-1}$ is higher, while the coefficient of pw_t*NCF_t/TA'_{t-1} is lower, in the New Economy than the Old. The second and third sets of results are consistent with constraint theory in that, as we documented earlier, cash balance volatility is higher for small/young firms than large/mature firms and also higher in the New Economy than the Old, and as volatility increases, firms save more out of current cash flow and consequently increase their tendency to finance investment with lagged cash balances. In this regard, the coefficients of $pw_t*NETDT_t/TA'_{t-1}$, and $pw_t*NETEQ_t/TA'_{t-1}$ provide mixed results, as the average coefficient of the former (latter) is lower (higher) for small/young firms than large/mature firms, and is lower (higher) in the New Economy than the Old.

The results in Panel B also exhibit considerable stability in terms of coefficient values and adjusted R^2s across subsamples. The most obvious difference between the results in Panels A and B is that the coefficients of all regressors are generally much lower in Panel B than in Panel A. This difference might be attributable to the greater persistence of R&D vs. capital expenditure investment noted earlier (see Table 6). Also, the coefficient of $pw_t*CASH_{t-1}/TA'_{t-1}$ is substantially higher, while the coefficient of pw_t*NCF_t/TA'_{t-1} is (slightly) lower, in the New Economy than the Old, consistent with constraint theory given that cash balance uncertainty is higher in the former. However, the coefficients of both $pw_t*NETDT_t/TA'_{t-1}$, and $pw_t*NETEQ_t/TA'_{t-1}$ are higher, rather than lower as expected, in the New Economy vs. the Old. Another puzzling result is that the coefficient of $pw_t*CASH_{t-1}/TA'_{t-1}$ is slightly lower, rather than higher as expected, for small/young firms than large/mature firms, even though the coefficients of both pw_t*NCF_t/TA'_{t-1} and pw_t*$NETDT_t/TA'_{t-1}$, are substantially lower, as expected, for small/young firms than large/mature firms.

5. Analyses by Industry

In this section, we analyze corporate investment by industry using the five industry classifications defined on Ken French's website: High-tech; Healthcare; Consumer; Manufacturing & Energy; and Other. Our analyses include: (a) graphical depictions of annual average values of PP&E, estimated R&D capital, capital expenditures, and R&D investment; (b) analyses of average values of investment and related variables; and (c) propensity regressions.

5.1 Annual average values of investment-related variables for each industry

Figures 2a, 2b, 2c, and 2d, respectively, show annual average values of $PPENT_t/TA'_t$, $R\&DCAP_t/TA'_t$ $CAPX_t/TA'_{t-1}$, and $R\&D_t/TA'_{t-1}$, respectively, by industry for the years 1974-2008. Figure 2a (2b) shows that average PP&E (estimated R&D capital) generally decreases (increases) over time for all five industries, though for both the trend is far steeper for the High-Tech and Healthcare industries. Correspondingly, Figure 2c (2d) shows that average $CAPX_t/TA'_{t-1}$ ($R\&D_t/TA'_{t-1}$) generally decreases (increases) over time for all five industries, though again the trends are far steeper for the High-Tech and Healthcare industries. Based on these results, we classify the industries into two groups. Group 1 includes High-Tech and Healthcare, and group 2 includes the Consumer, Manufacturing & Energy, and Other. Given theory and evidence presented thus far that R&D intensity is an important determinant of financial constraint, we expect the effects of constraint to be greater for industry group 1 than industry group 2, and for industry group 1 the effects should be greater in the New Economy than the Old.

5.2 Average values of investment and related variables by industry, Economy, and firm size/age

Next, we sort firms by industry and then cross-sort by Economy, $SMYG_{t-1}$, and combinations of Economy and $SMYG_{t-1}$. We then calculate average values of investment measures and related variables for each subsample. The results are displayed in Table 9. Panels A and B show results for industries in group 1 (High-Tech and Healthcare, resp.), and Panels C, D, and E show results for industries in group 2 (Consumer, Manufacturing & Energy, and Other, resp.).

Initially, we point out that the two industry groups differ not only in terms of their investment propensities, but also by each of two measures of growth. The first measure is Q_{t-1}, interpreted as a measure of *ex ante* growth expectations. In both Economies, average values of Q_{t-1} are substantially higher for industries in group 1 than group 2. The second growth measure is *ex post*; the percentage change in the number of firm-year observations from the Old Economy to the New (i.e, the values of 'N' shown in the table). The change is substantially higher for industries in group 1 (283.3% and 435.5% for High-Tech and Healthcare, resp.) than group 2 (74.8%, 43.5%, and 123.5% for Consumer, Manufacturing & Energy, and Other, resp.). Thus, by both measures R&D intensity is associated with higher growth.

Consistent with the results in Figures 2a-2d, average values of $CAPX_t/TA'_{t-1}$ and $PPENT_{t-1}/TA'_{t-1}$ ($R\&D_t/TA'_{t-1}$ and $R\&DCAP_{t-1}/TA'_{t-1}$) fall (rise) substantially from the Old to New Economy for industries in group 1, while the average values of these variables are relatively stable for industries in group 2. Also, variations in the average values of each of these variables across firm size/age classes for a given industry are very small relative to variations *across* industries for a given size/age class, and this is so in both the Old and New Economies. Thus, investment propensities vary strongly by industry and Economy, but little by firm size/age class for any given industry and Economy.

Variations in $CASH_{t-1}/TA'_{t-1}$ are parallel with variations in R&D intensity. In the Old Economy, average values of $CASH_{t-1}/TA'_{t-1}$ are generally only slightly higher for group 1 industries than group 2 industries, while in the New Economy, where R&D intensity is much greater for only the group 1 industries, average values of $CASH_{t-1}/TA'_{t-1}$ are roughly *twice* as high for group 1 industries as group 2 industries. Moreover, while average $CASH_{t-1}/TA'_{t-1}$ is consistently slightly higher for small/young firms than large/mature firms for all paired comparisons in the table, by far the highest average values of $CASH_{t-1}/TA'_{t-1}$ occur for *both* small/young and large/mature firms in industry group 1 in the New Economy, coinciding with high R&D intensities. Interpreting cash balance as a *measure* of constraint, the results indicate that R&D intensity is a far more important *determinant* of constraint than is firm size/age.

For all industries, average values of NCF_t/TA'_{t-1} are generally lower in the New Economy than the Old, especially for small/young firms. However, it is not obvious that low internal cash flow deters investment as theory suggests. For instance, small/young firms in the New Economy Healthcare industry have the lowest average NCF_t/TA'_{t-1} (0.030) across all industry, $SMYG_{t-1}$, and Economy combinations, yet these firms had high average R&D investment (0.096) as well as substantial average capital expenditures (0.043). Consistent with constraint theory, though, these firms also had the highest average values of $CASH_{t-1}/TA'_{t-1}$ (0.242) and $NETEQ_t/TA'_{t-1}$ (0.108) across the stated combinations.

Average values of $NETDT_t/TA'_{t-1}$ are relatively small, and are also relatively stable, across all industry, $SMYG_{t-1}$, and Economy combinations. These results are somewhat surprising, especially the lack of higher average values of $NETDT_t/TA'_{t-1}$ for firms in industry group 2 where physical-capital intensity (and thus tangibility) is high. Indeed, for group 2 industries in general, average values of $NETDT_t/TA'_{t-1}$ are generally on a par with average values of $NETEQ_t/TA'_{t-1}$. In addition, for group 2 industries average internal cash flow (NCF_t/TA'_{t-1}) is generally sufficient to finance average $CAPX_t/TA'_{t-1}$, but where it falls somewhat short, for small/young firms in the New Economy, we see higher average values of *net external equity* rather than debt. These results appear to challenge both the pecking order model and the tangibility hypothesis as they would apply to external financing of capital expenditures.

However, the bigger story regarding external financing of investment, and one that is consistent with both the pecking order model and the tangibility hypothesis, is associated with external equity financing of R&D investment. Average $NETEQ_t/TA'_{t-1}$ never exceeds 0.050 for industries in group 2, while average $NETEQ_t/TA'_{t-1}$ exceeds this threshold for small/young firms in both group 1 industries in both Economies, and also for large/seasoned firms in Healthcare in the New Economy.

Overall, the results in Table 9 indicate that much of the dynamics in investment, cash balances, and external finance documented in Section 4 is driven by firms in the R&D-intensive High-Tech and Healthcare industries, especially in the New Economy.

5.3 Propensity regressions by industry

For our final analysis, we estimate propensity regressions of capital expenditure and R&D investment by industry using data for all years and separately for the Old and New Economies. We use the same propensity regression design that we used for Table 8, which includes fixed effects. The results are displayed in Table 10. Panels A and B shows results for capital expenditure and R&D investment, respectively. To facilitate interpretation, we also calculate average values of regression coefficients across industries for each sample period. These are shown in italics.

Broadly, the results in each panel are fairly stable across sample periods and industries in terms of both slope coefficients and adjusted R^2s, attesting to the robustness of the propensity regression design. More closely, one of the key results from Table 8, a substantial increase in the coefficient of lagged cash balance ($CASH_{t-1}/TA'_{t-1}$) from the Old to New Economy, holds here as well, as the average coefficient of $CASH_{t-1}/TA'_{t-1}$ increases to 0.301 from 0.238 in Panel A, and to 0.217 from 0.025 in Panel B. Combining these results with evidence in Table 9 of an increase in average $CASH_{t-1}/TA'_{t-1}$ from the Old to New Economy for all industries, the results suggest that the increase over time in the tendency of firms to finance investment using lagged cash balance is a broad phenomenon, though the increase is likely greater for firms in the R&D-intensive High-Tech and Healthcare industries given that their average lagged cash balances increase more dramatically over time.

Also, our conclusion in Section 4, that the tendency of firms to finance investment using current internal cash flow decreases over time, is generally supported here for capital expenditure investment, but is not generally supported here for R&D investment. The average coefficient of NCF_{t-1}/TA'_{t-1} decreases to 0.479 from 0.571 in Panel A, but increases to 0.437 from 0.402 in Panel B.

Finally, constraint theory suggests that the coefficients of external finance variables should be lower in the New Economy than the Old. However, in only one of four cases is the average coefficient lower in the New Economy, for $pw_t*NETDT_t/TA'_{t-1}$ in Panel A. For $pw_t*NETEQ_t/TA'_{t-1}$ in Panel A, and both $pw_t*NETDT_t/TA'_{t-1}$ and $pw_t*NETEQ_t/TA'_{t-1}$ in Panel B, the average coefficient is higher in the New Economy than the Old. On the other hand, for nearly every industry and sample period combination, the coefficient of $pw_t*NETDT_t/TA'_{t-1}$ is higher than the coefficient of $pw_t*NETEQ_t/TA'_{t-1}$, as expected.

6. Summary

This paper is motivated by the dramatic shift over time in the investment propensities of U.S. firms away from capital expenditures and toward R&D, emphasizing the need to account for alternative investment types in analyses of determinants of corporate investment, a need that has largely been ignored in the extant literature. We: (a) develop modified 'q' models of investment that incorporate individual firm's propensities to engage in alternative types of investment; (b) conclude from a review of the financial constraint literature that R&D intensity (lagged cash balance) is a potentially important determinant (measure) of constraint, and (c) develop hypotheses about how constraint may affect the coefficients of lagged cash, current internal cash flow, and external finance variables in investment regressions. Empirically, we initially document that investment propensities of U.S. firms have shifted dramatically over the years 1974-2008 away from capital expenditures and toward R&D. Additional empirical analysis yields four important findings. First, two practices in numerous prior empirical studies, of scaling capital expenditure investment by PP&E and using samples of 'manufacturing' firms for capital expenditure regressions without adjusting for R&D as an alternative investment type, can lead to severe biases. Second, our analysis of cash dynamics indicates that R&D intensity (lagged cash balance) is an important determinant (measure) of constraint, and constrained firms tend to hoard cash from internal cash flow and external equity issues, but not from debt issues. Third, propensity regression provides stronger support for both 'q' and constraint theory than OLS/GLM regression alternatives. Fourth, propensity regression is robust to subsample analysis by firm size/age, Economy, R&D intensity, and industry.

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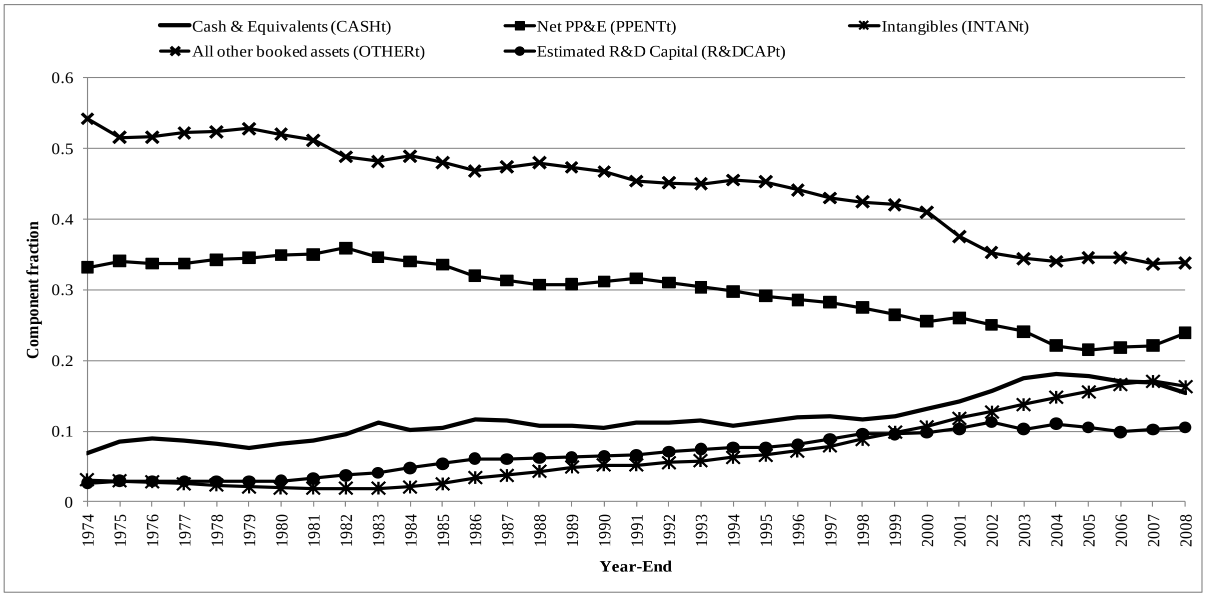

Figure 1a

Annual average values of components of augmented total assets

Shown are annual (1974-2008) average values of the following components of augmented total assets ($TA'_t = TA_t + R\&DCAP_t$): Cash&Equiv. ($CASH_t/TA'_t$) net PP&E ($PPENT_t/TA'_t$), intangibles ($INTAN_t/TA'_t$), all other book assets ($OTHER_t = [TA_t - CASH_t - PPENT_t - INTAN_t]/TA'_{t-1}$), and estimated R&D capital ($R\&DCAP_t/TA'_t$).

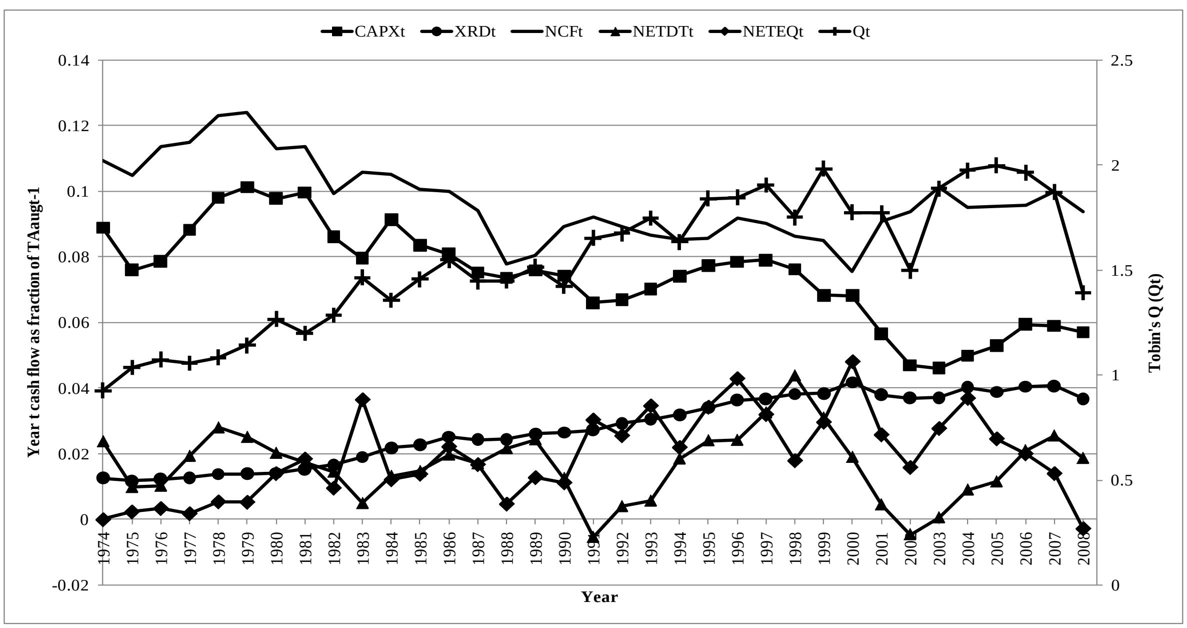

Figure 1b

Annual average values of investment measures, net cash flow, external financing, and Tobin's Q

Shown are annual (1974-2008) average values of capital expenditures ($CAPX_t/TA'_t$), R&D expenditures ($R\&D_t/TA'_t$), net cash flow (NCF_t/TA'_t), net debt financing ($NETDT_t/TA'_t$), net external equity financing ($NETEQ_t/TA'_t$), and Tobin's Q (Q_t).

Table 1
Determinants of *ex ante* propensities to make capital expenditure and R&D investment

Sample period	Intcpt.	$PPENT_{t-1}/TA'_{t-1}$	$R\&DCAP_{t-1}/TA'_{t-1}$	$INTAN_{t-1}/TA'_{t-1}$	LEV_{t-1}	NCF_{t-1}/TA'_{t-1}	Adj. R^2	N
Panel A: Dep. var.=$CAPX_t/TA'_{t-1}$								
All years	0.017 ***	0.189 ***					0.264	94,056
	0.074 ***		-0.132 ***	-0.126 ***	0.070 ***	0.075 ***	0.121	94,056
	0.022 ***	0.177 ***	-0.023 ***	-0.035 ***	-0.001	0.050 ***	0.276	94,056
Old Economy	0.022 ***	0.192 ***					0.210	29,720
	0.067 ***		-0.099 ***	-0.122 ***	0.113 ***	0.081 ***	0.077	29,720
	0.014 ***	0.184 ***	0.035 ***	-0.016 **	0.031 ***	0.061 ***	0.225	29,720
New Economy	0.016 ***	0.184 ***					0.278	64,336
	0.074 ***		-0.134 ***	-0.118 ***	0.056 ***	0.073 ***	0.129	64,336
	0.023 ***	0.174 ***	-0.027 ***	-0.029 ***	-0.012 ***	0.044 ***	0.290	64,336
Panel B: Dep. var.=$R\&D_t/TA'_{t-1}$								
All years	0.004 ***		0.370 ***				0.740	94,056
	0.066 ***	-0.090 ***		-0.069 ***	-0.034 ***	0.019 ***	0.203	94,056
	0.009 ***	-0.013 ***	0.357 ***	-0.010 ***	-0.005 ***	0.007 ***	0.744	94,056
Old Economy	0.001 ***		0.430 ***				0.783	29,720
	0.035 ***	-0.040 ***		-0.051 ***	-0.020 ***	0.020 ***	0.109	29,720
	0.003 ***	-0.003 ***	0.425 ***	-0.001	-0.004 ***	0.004 ***	0.784	29,720
New Economy	0.004 ***		0.364 ***				0.729	64,336
	0.077 ***	-0.105 ***		-0.090 ***	-0.034 ***	0.020 ***	0.237	64,336
	0.012 ***	-0.016 ***	0.347 ***	-0.013 ***	-0.006 ***	0.008 ***	0.733	64,336
Panel C: Dep. var.=$CAPX_t/PPENT_{t-1}$								
All years	0.368 ***	-0.275 ***					0.069	94,056
	0.290 ***		0.206 ***	0.047 ***	-0.146 ***	0.087 ***	0.036	94,056
	0.371 ***	-0.277 ***	0.035 ***	-0.097 ***	-0.035 ***	0.127 ***	0.083	94,056
Old Economy	0.344 ***	-0.201 ***					0.037	29,720
	0.259 ***		0.347 ***	0.049 **	-0.035 ***	0.142 ***	0.027	29,720
	0.319 ***	-0.208 ***	0.196 ***	-0.072 ***	0.058 ***	0.165 ***	0.058	29,720
New Economy	0.375 ***	-0.302 ***					0.081	64,336
	0.301 ***		0.179 ***	0.048 ***	-0.183 ***	0.061 ***	0.041	64,336
	0.391 ***	-0.307 ***	-0.009	-0.110 ***	-0.064 ***	0.110 ***	0.096	64,336
Panel D: Dep. var.=$R\&D_t/R\&DCAP_{t-1}$								
All years	0.420 ***		-0.007				0.000	48,339
	0.453 ***	-0.115 ***		-0.042 ***	-0.069 ***	0.044 ***	0.012	48,339
	0.488 ***	-0.171 ***	-0.137 ***	-0.078 **	-0.085 ***	0.044 ***	0.017	48,339
Old Economy	0.389 ***		0.410 ***				0.016	15,055
	0.477 ***	-0.107 ***		-0.041	-0.170 ***	0.022 **	0.017	15,055
	0.436 ***	-0.058 ***	0.309 ***	0.029	-0.148 ***	0.011	0.025	15,055
New Economy	0.428 ***		-0.054 ***				0.001	33,284
	0.448 ***	-0.137 ***		-0.037 ***	-0.038 ***	0.054 ***	0.012	33,284
	0.503 ***	-0.223 ***	-0.192 ***	-0.102 ***	-0.056 ***	0.050 ***	0.024	33,284

In each panel, the indicated year t investment measure is regressed on some or all of the following variables: $PPENT_{t-1}/TA'_{t-1}$, $R\&DCAP_{t-1}/TA'_{t-1}$, $INTAN_{t-1}/TA'_{t-1}$, LEV_{t-1}, and NCF_{t-1}/TA'_{t-1}, where $TA'_{t-1}=TA_{t-1}+R\&DCAP_{t-1}$. In each panel, regressions are estimated using data for all years (1974-2008), Old Economy years (1974-1987) and New Economy years (1988-2008). Significance indicators: *** (1%); **(5%); *(10%).

Table 2

Average values of corporate investment measures and related variables by Economy, 'industry', and ranges of physical capital intensity

	All	Economy		Ranges of x=($PPENT_{t-1}/TA'_{t-1}$):					
Variable:	Years	Old	New	x<0.10	0.10≤x<0.20	0.20≤x<0.30	0.30≤x<0.40	x≥0.40	Diff. (High-Low)
Panel A: All firms									
$CAPX_t/PPENT_{t-1}$	0.288	0.276	0.293	0.430	0.297	0.251	0.233	0.222	-0.208 ***
$R\&D_t/PPENT_{t-1}$	0.302	0.099	0.396	1.044	0.275	0.103	0.049	0.009	-1.035 ***
$CAPX_t/TA'_{t-1}$	0.072	0.087	0.066	0.027	0.047	0.064	0.082	0.131	0.104 ***
$R\&D_t/TA'_{t-1}$	0.029	0.017	0.035	0.065	0.038	0.025	0.016	0.004	-0.061 ***
Q_{t-1}	1.650	1.266	1.827	2.056	1.697	1.560	1.467	1.448	-0.607 ***
$CASH_{t-1}/TA'_{t-1}$	0.124	0.094	0.139	0.234	0.134	0.102	0.084	0.067	-0.167 ***
$PPENT_{t-1}/TA'_{t-1}$	0.292	0.338	0.271	0.054	0.150	0.248	0.346	0.601	0.547 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.070	0.037	0.085	0.159	0.088	0.057	0.038	0.010	-0.149 ***
LEV_{t-1}	0.177	0.186	0.173	0.096	0.138	0.164	0.196	0.272	0.176 ***
N'	94,056	29,720	64,336	19,390	20,004	17,619	12,511	24,532	
N' as %	100.0%	31.6%	68.4%	20.6%	21.3%	18.7%	13.3%	26.1%	
Panel B: 'Manufacturing' firms									
$CAPX_t/PPENT_{t-1}$	0.270	0.264	0.273	0.415	0.282	0.237	0.218	0.190	-0.226 ***
$R\&D_t/PPENT_{t-1}$	0.366	0.131	0.496	1.314	0.327	0.125	0.064	0.020	-1.293 ***
$CAPX_t/TA'_{t-1}$	0.059	0.074	0.051	0.027	0.045	0.060	0.076	0.099	0.072 ***
$R\&D_t/TA'_{t-1}$	0.039	0.023	0.048	0.085	0.046	0.030	0.021	0.010	-0.075 ***
Q_{t-1}	1.614	1.231	1.826	2.127	1.661	1.505	1.407	1.338	-0.789 ***
$CASH_{t-1}/TA'_{t-1}$	0.122	0.090	0.140	0.256	0.128	0.093	0.074	0.055	-0.200 ***
$PPENT_{t-1}/TA'_{t-1}$	0.252	0.297	0.228	0.056	0.151	0.248	0.346	0.530	0.475 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.093	0.051	0.116	0.208	0.106	0.070	0.050	0.023	-0.185 ***
LEV_{t-1}	0.155	0.163	0.150	0.082	0.135	0.160	0.184	0.228	0.146 ***
N'	53,259	18,974	34,285	9,781	13,253	12,625	8,504	9,096	
N' as %	100.0%	35.6%	64.4%	18.4%	24.9%	23.7%	16.0%	17.1%	
Panel C: Non-'Manufacturing' firms									
$CAPX_t/PPENT_{t-1}$	0.311	0.297	0.316	0.445	0.325	0.286	0.265	0.241	-0.203 ***
$R\&D_t/PPENT_{t-1}$	0.218	0.041	0.281	0.770	0.173	0.046	0.016	0.002	-0.768 ***
$CAPX_t/TA'_{t-1}$	0.090	0.111	0.082	0.026	0.053	0.074	0.095	0.149	0.123 ***
$R\&D_t/TA'_{t-1}$	0.017	0.006	0.021	0.045	0.023	0.011	0.005	0.001	-0.044 ***
Q_{t-1}	1.696	1.328	1.828	1.983	1.766	1.700	1.594	1.513	-0.469 ***
$CASH_{t-1}/TA'_{t-1}$	0.127	0.101	0.137	0.211	0.144	0.125	0.105	0.074	-0.138 ***
$PPENT_{t-1}/TA'_{t-1}$	0.344	0.409	0.321	0.051	0.148	0.248	0.348	0.643	0.591 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.039	0.012	0.049	0.109	0.051	0.025	0.013	0.003	-0.107 ***
LEV_{t-1}	0.206	0.225	0.199	0.110	0.145	0.173	0.221	0.298	0.188 ***
N'	40,797	10,746	30,051	9,609	6,751	4,994	4,007	15,436	
N' as %	100.0%	26.3%	73.7%	23.6%	16.5%	12.2%	9.8%	37.8%	

Average values of investment measures (alternatively scaled as indicated) and related variables are calculated for all firm-years and sorts by Economy (Old (1974-87) vs. New (1988-2008)) or indicated ranges of physical capital intensity ($PPENT_{t-1}/TA'_{t-1}$). Panel A shows results for all firms, while Panels B and C show results for 'manufacturing' and non-'manufacturing' firms, resp., where 'manufacturing' firms (the former defined as firms with SIC code values of 2000-3999). Significance indicators for differences: *** (1%); **(5%); *(10%).

Table 3
Average values of investment measures and related variables by Economy, firm size/age, and ranges of investment measures

		Ranges of $CAPX_t/TA'_{t-1}$						Ranges of $R\&D_t/TA'_{t-1}$:					
		0.000≤x	0.025≤x	0.050≤x	0.075≤x		Diff.	0.000≤x	0.025≤x	0.050≤x	0.075≤x		Diff.
Variable:	All	<0.025	<0.050	<0.075	<0.100	x≥0.100	(High-Low)	<0.025	<0.050	<0.075	<0.100	x≥0.100	(High-Low)
Panel A: Old Economy; Large/mature firms													
$CAPX_t/TA'_{t-1}$	0.086	0.014	0.038	0.062	0.087	0.180	0.166 ***	0.088	0.075	0.078	0.081	0.104	0.016 ***
$R\&D_t/TA'_{t-1}$	0.016	0.011	0.017	0.018	0.019	0.014	0.004 ***	0.004	0.036	0.061	0.085	0.131	0.128 ***
Q_{t-1}	1.225	1.101	1.122	1.173	1.238	1.406	0.306 ***	1.156	1.264	1.498	1.707	2.127	0.971 ***
$PPENT_{t-1}/TA'_{t-1}$	0.340	0.226	0.265	0.316	0.358	0.471	0.246 ***	0.365	0.278	0.236	0.221	0.202	-0.162 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.035	0.030	0.040	0.040	0.039	0.026	-0.004 ***	0.010	0.082	0.132	0.174	0.215	0.205 ***
$CASH_{t-1}/TA'_{t-1}$	0.090	0.108	0.087	0.083	0.084	0.089	-0.019 ***	0.088	0.082	0.101	0.109	0.129	0.041 ***
NCF_{t-1}/TA'_{t-1}	0.073	0.021	0.057	0.074	0.089	0.105	0.084 ***	0.061	0.091	0.124	0.143	0.151	0.089 ***
$NETDT_{t-1}/TA'_{t-1}$	0.013	0.003	0.007	0.012	0.013	0.025	0.022 ***	0.014	0.010	0.007	0.010	0.010	-0.004 ***
$NETEQ_{t-1}/TA'_{t-1}$	0.007	0.005	0.004	0.004	0.004	0.013	0.008 ***	0.005	0.007	0.010	0.025	0.047	0.042 ***
NCF_t/TA'_{t-1}	0.109	0.049	0.087	0.109	0.126	0.152	0.103 ***	0.097	0.129	0.157	0.179	0.223	0.126 ***
$NETDT_t/TA'_{t-1}$	0.016	-0.012	-0.001	0.006	0.015	0.053	0.065 ***	0.016	0.013	0.015	0.016	0.030	0.014 ***
$NETEQ_t/TA'_{t-1}$	0.008	0.005	0.003	0.004	0.009	0.018	0.013 ***	0.006	0.008	0.014	0.027	0.066	0.061 ***
N	25,873	3,977	6,023	5,105	3,386	7,382		20,163	2,986	1,411	687	626	
N as %	100.0%	15.4%	23.3%	19.7%	13.1%	28.5%		77.9%	11.5%	5.5%	2.7%	2.4%	
Panel B: Old Economy; Small/young firms													
$CAPX_t/TA'_{t-1}$	0.096	0.013	0.037	0.062	0.087	0.214	0.201 ***	0.103	0.079	0.081	0.072	0.080	-0.024 ***
$R\&D_t/TA'_{t-1}$	0.026	0.027	0.033	0.028	0.025	0.021	-0.005 ***	0.003	0.037	0.061	0.087	0.143	0.141 ***
Q_{t-1}	1.541	1.447	1.482	1.468	1.469	1.703	0.256 ***	1.375	1.632	1.745	1.968	2.376	1.002 ***
$PPENT_{t-1}/TA'_{t-1}$	0.324	0.213	0.263	0.298	0.365	0.443	0.231 ***	0.375	0.243	0.205	0.189	0.171	-0.204 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.056	0.071	0.074	0.054	0.048	0.035	-0.036 ***	0.010	0.092	0.137	0.176	0.250	0.240 ***
$CASH_{t-1}/TA'_{t-1}$	0.120	0.136	0.114	0.117	0.109	0.118	-0.018 ***	0.109	0.133	0.153	0.150	0.152	0.043 ***
NCF_{t-1}/TA'_{t-1}	0.003	-0.022	-0.003	0.003	0.017	0.020	0.042 ***	-0.002	0.023	0.003	0.040	-0.002	0.000 ***
$NETDT_{t-1}/TA'_{t-1}$	0.021	0.006	0.016	0.016	0.019	0.038	0.032 ***	0.024	0.023	0.016	0.006	0.009	-0.015 ***
$NETEQ_{t-1}/TA'_{t-1}$	0.035	0.026	0.033	0.029	0.030	0.048	0.022 ***	0.026	0.037	0.064	0.059	0.071	0.045 ***
NCF_t/TA'_{t-1}	0.100	0.035	0.082	0.108	0.115	0.149	0.114 ***	0.086	0.109	0.107	0.136	0.175	0.089 ***
$NETDT_t/TA'_{t-1}$	0.020	-0.011	0.002	0.006	0.018	0.063	0.074 ***	0.021	0.025	0.017	-0.001	0.027	0.006 ***
$NETEQ_t/TA'_{t-1}$	0.033	0.016	0.025	0.019	0.039	0.056	0.040 ***	0.027	0.032	0.030	0.043	0.086	0.059 ***
N	3,847	848	842	564	383	1,210		2,702	358	247	212	328	
N as %	100.0%	22.0%	21.9%	14.7%	10.0%	31.5%		70.2%	9.3%	6.4%	5.5%	8.5%	
Panel C: New Economy; Large/mature firms													
$CAPX_t/TA'_{t-1}$	0.066	0.013	0.036	0.061	0.087	0.192	0.179 ***	0.076	0.051	0.045	0.042	0.043	-0.033 ***
$R\&D_t/TA'_{t-1}$	0.033	0.045	0.034	0.029	0.025	0.017	-0.029 ***	0.003	0.036	0.062	0.087	0.159	0.156 ***
Q_{t-1}	1.836	1.718	1.760	1.846	1.917	2.099	0.381 ***	1.645	1.830	2.011	2.126	2.709	1.064 ***
$PPENT_{t-1}/TA'_{t-1}$	0.277	0.142	0.231	0.309	0.371	0.497	0.355 ***	0.340	0.215	0.163	0.134	0.101	-0.240 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.079	0.125	0.079	0.062	0.050	0.030	-0.095 ***	0.011	0.102	0.167	0.228	0.329	0.319 ***
$CASH_{t-1}/TA'_{t-1}$	0.134	0.176	0.122	0.110	0.109	0.112	-0.064 ***	0.099	0.130	0.182	0.211	0.268	0.168 ***
NCF_{t-1}/TA'_{t-1}	0.089	0.057	0.084	0.101	0.111	0.132	0.076 ***	0.075	0.103	0.119	0.132	0.119	0.044 ***
$NETDT_{t-1}/TA'_{t-1}$	0.010	0.006	0.007	0.010	0.011	0.022	0.016 ***	0.012	0.006	0.006	0.006	0.008	-0.004 ***
$NETEQ_{t-1}/TA'_{t-1}$	0.019	0.028	0.012	0.009	0.011	0.027	-0.001 ***	0.009	0.013	0.022	0.028	0.080	0.071 ***
NCF_t/TA'_{t-1}	0.096	0.063	0.091	0.105	0.116	0.143	0.081 ***	0.082	0.102	0.118	0.129	0.143	0.061 ***
$NETDT_t/TA'_{t-1}$	0.017	-0.002	0.007	0.017	0.025	0.058	0.060 ***	0.018	0.011	0.008	0.009	0.023	0.005 ***
$NETEQ_t/TA'_{t-1}$	0.018	0.020	0.012	0.009	0.009	0.035	0.015 ***	0.007	0.007	0.013	0.023	0.089	0.081 ***
N	52,235	16,165	13,613	8,211	4,802	9,444		34,489	5,100	3,718	3,081	5,847	
N as %	100.0%	30.9%	26.1%	15.7%	9.2%	18.1%		66.0%	9.8%	7.1%	5.9%	11.2%	
Panel D: New Economy; Small/young firms													
$CAPX_t/TA'_{t-1}$	0.065	0.012	0.036	0.061	0.086	0.214	0.202 ***	0.082	0.046	0.041	0.033	0.036	-0.046 ***
$R\&D_t/TA'_{t-1}$	0.045	0.061	0.046	0.040	0.034	0.018	-0.043 ***	0.002	0.037	0.062	0.088	0.168	0.166 ***
Q_{t-1}	1.787	1.705	1.707	1.863	1.844	1.994	0.288 ***	1.577	1.837	1.994	1.885	2.336	0.759 ***
$PPENT_{t-1}/TA'_{t-1}$	0.248	0.140	0.218	0.282	0.331	0.467	0.327 ***	0.331	0.182	0.134	0.110	0.085	-0.246 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.110	0.173	0.098	0.073	0.058	0.030	-0.143 ***	0.009	0.119	0.186	0.256	0.357	0.348 ***
$CASH_{t-1}/TA'_{t-1}$	0.159	0.195	0.144	0.131	0.133	0.129	-0.065 ***	0.105	0.179	0.226	0.234	0.279	0.174 ***
NCF_{t-1}/TA'_{t-1}	-0.042	-0.046	-0.039	-0.048	-0.048	-0.031	0.015 ***	-0.046	-0.037	-0.026	-0.020	-0.043	0.003 ***
$NETDT_{t-1}/TA'_{t-1}$	0.017	0.010	0.012	0.017	0.019	0.036	0.026 ***	0.023	0.007	0.010	0.007	0.007	-0.016 ***
$NETEQ_{t-1}/TA'_{t-1}$	0.054	0.057	0.045	0.049	0.048	0.065	0.007 ***	0.038	0.050	0.064	0.060	0.103	0.066 ***
NCF_t/TA'_{t-1}	0.060	0.031	0.060	0.068	0.084	0.109	0.078 ***	0.050	0.046	0.054	0.074	0.092	0.042 ***
$NETDT_t/TA'_{t-1}$	0.019	-0.002	0.007	0.017	0.033	0.074	0.076 ***	0.023	0.013	0.009	0.005	0.013	-0.011 ***
$NETEQ_t/TA'_{t-1}$	0.056	0.049	0.047	0.061	0.051	0.083	0.035 ***	0.040	0.040	0.054	0.053	0.116	0.076 ***
N	12,101	4,897	2,701	1,428	860	2,215		7,474	769	766	716	2,376	
N as %	100.0%	40.5%	22.3%	11.8%	7.1%	18.3%		61.8%	6.4%	6.3%	5.9%	19.6%	

Firms are sorted by Economy and firm size/age dummy ($SMYG_{t-1}$), and average values of indicated investment and related variables are calculated for all firms in a subsample and by indicated ranges of $CAPX_t/TA'_{t-1}$ and $R\&D_t/TA'_{t-1}$. Results displayed in Panels A, B, C, and D are for combinations of Old Economy and large/mature firms, Old Economy and small/young firms, New Economy and large/mature firms, and New Economy and small/young firms, resp. Old (New) Economy years are 1974-87 (1988-2008). Significance indicators for differences: *** (1%); **(5%); *(10%).

Table 4

Cross-sectional regressions of lagged cash balance

Sample period	$SMYG_{t-1}$	Range of $x=PPENT_{t-1}/TA'_{t-1}$	N	Dep. Var.: Mean	Dep. Var.: Std. dev.	Intcpt.	$NEWECON_{t-1}$	$SMYG_{t-1}$	$PPENT_{t-1}/TA'_{t-1}$	NCF_{t-1}/TA'_{t-1}	$NETDT_{t-1}/TA'_{t-1}$	$NETEQ_{t-1}/TA'_{t-1}$	Adj. R^2
Panel A: Results by individual sorts													
All years	Both	All	94,056	0.124	0.143	0.094 ***	0.045 ***						0.021
All years	Both	All	94,056	0.124	0.143	0.119 ***		0.031 ***					0.007
All years	Both	All	94,056	0.124	0.143	0.194 ***			-0.238 ***				0.133
All years	Both	All	94,056	0.124	0.143	0.123 ***				0.016 ***			0.000
All years	Both	All	94,056	0.124	0.143	0.125 ***					-0.069 ***		0.002
All years	Both	All	94,056	0.124	0.143	0.116 ***						0.418 ***	0.072
All years	Both	All	94,056	0.124	0.143	0.155 ***	0.023 ***	0.020 ***	-0.218 ***	0.096 ***	0.004	0.375 ***	0.202
All years	0	All	78,108	0.119	0.137	0.150 ***	0.023 ***		-0.213 ***	0.133 ***	0.018 ***	0.398 ***	0.202
All years	1	All	15,948	0.150	0.165	0.187 ***	0.015 ***		-0.238 ***	0.002	-0.046 ***	0.317 ***	0.201
Old Econ.	Both	All	29,720	0.094	0.105	0.128 ***		0.024 ***	-0.128 ***	0.053 ***	-0.001	0.267 ***	0.094
New Econ.	Both	All	64,336	0.139	0.155	0.184 ***		0.021 ***	-0.250 ***	0.120 ***	0.008	0.393 ***	0.214
All years	Both	x<0.10	19,390	0.234	0.192	0.161 ***	0.047 ***	0.016 ***		0.133 ***	0.001	0.405 ***	0.091
All years	Both	0.10≤x<0.20	20,004	0.134	0.139	0.101 ***	0.022 ***	0.020 ***		0.121 ***	-0.014	0.332 ***	0.060
All years	Both	0.20≤x<0.30	17,619	0.102	0.112	0.083 ***	0.013 ***	0.017 ***		0.104 ***	-0.016	0.290 ***	0.047
All years	Both	0.30≤x<0.40	12,511	0.084	0.096	0.070 ***	0.006 ***	0.015 ***		0.087 ***	-0.012	0.314 ***	0.056
All years	Both	x≥0.40	24,532	0.067	0.075	0.065 ***	-0.005 ***	0.005 ***		0.027 ***	-0.019 ***	0.167 ***	0.026
Panel B: Results by combination sorts													
Old Econ.	0	x<0.10	1,562	0.174	0.176	0.163 ***				0.112 ***	0.140 ***	0.343 ***	0.039
Old Econ.	0	0.10≤x<0.20	4,968	0.111	0.117	0.101 ***				0.119 ***	0.011 ***	0.261 ***	0.041
Old Econ.	0	0.20≤x<0.30	6,542	0.091	0.091	0.085 ***				0.086 ***	-0.052 ***	0.162 ***	0.025
Old Econ.	0	0.30≤x<0.40	4,776	0.077	0.079	0.071 ***				0.069 ***	-0.019	0.156 ***	0.021
Old Econ.	0	x≥0.40	8,025	0.067	0.065	0.065 ***				0.028 ***	-0.028 ***	0.056 ***	0.006
Old Econ.	1	x<0.10	546	0.201	0.204	0.178 ***				-0.028	0.064	0.357 ***	0.061
Old Econ.	1	0.10≤x<0.20	885	0.139	0.148	0.125 ***				-0.022	-0.006	0.350 ***	0.066
Old Econ.	1	0.20≤x<0.30	701	0.112	0.120	0.102 ***				0.022	-0.016	0.346 ***	0.057
Old Econ.	1	0.30≤x<0.40	553	0.104	0.115	0.095 ***				0.006	-0.017	0.413 ***	0.084
Old Econ.	1	x≥0.40	1,162	0.080	0.079	0.076 ***				0.012	-0.002	0.130 ***	0.021
New Econ.	0	x<0.10	12,840	0.237	0.191	0.199 ***				0.209 ***	0.035 *	0.456 ***	0.105
New Econ.	0	0.10≤x<0.20	11,714	0.139	0.141	0.117 ***				0.201 ***	-0.001	0.362 ***	0.067
New Econ.	0	0.20≤x<0.30	8,894	0.107	0.119	0.085 ***				0.210 ***	0.030 **	0.330 ***	0.060
New Econ.	0	0.30≤x<0.40	6,156	0.086	0.102	0.069 ***				0.160 ***	0.006	0.348 ***	0.066
New Econ.	0	x≥0.40	12,631	0.065	0.079	0.000 ***				0.048 ***	-0.014 **	0.194 ***	0.033
New Econ.	1	x<0.10	4,442	0.249	0.195	0.227 ***				-0.001	-0.158 ***	0.305 ***	0.065
New Econ.	1	0.10≤x<0.20	2,437	0.150	0.158	0.138 ***				-0.006	-0.084 ***	0.296 ***	0.053
New Econ.	1	0.20≤x<0.30	1,482	0.117	0.138	0.106 ***				-0.023	-0.080 **	0.299 ***	0.070
New Econ.	1	0.30≤x<0.40	1,026	0.094	0.112	0.083 ***				0.033 *	-0.019	0.335 ***	0.098
New Econ.	1	x≥0.40	2,714	0.068	0.082	0.063 ***				-0.003	-0.025 *	0.177 ***	0.049

Year-end t-1 cash balance ($CASH_{t-1}/TA'_{t-1}$) is regressed on the following variables, individually or in combinations: $NEWECON_{t-1}$, $SMYG_{t-1}$, $PPENT_{t-1}/TA'_{t-1}$, NCF_{t-1}/TA'_{t-1}, $NETDT_{t-1}/TA'_{t-1}$, and $NETEQ_{t-1}/TA'_{t-1}$. As indicated, results are for for all sample years (1974-2008), Old Economy years (1974-1987), or New Economy years (1988-2008) and for all firms, large/seasoned firms ($SMYG_{t-1}$=0), or small/young firms ($SMYG_{t-1}$=1), as well as for ranges of physical capital intensity ($PPENT_{t-1}/TA'_{t-1}$). Significance indicators: *** (1%); **(5%); *(10%).

Table 5

Regression analysis of change in cash

Sample period	$SMYG_{t-1}$	Range of x=$PPENT_{t-1}$/TA'_{t-1}	N	Dep. Var.: Mean	Dep. Var.: Std. dev.	Intcpt.	$CASH_{t-1}/TA'_{t-1}$	NCF_t/TA'_{t-1}	$NETDT_t/TA'_{t-1}$	$NETEQ_t/TA'_{t-1}$	Adj. R^2
Panel A: Results by individual sorts											
All years	Both	All	94,056	0.013	0.106	-0.017 ***	-0.104 ***	0.325 ***	0.089 ***	0.508 ***	0.308
All years	0	All	78,108	0.013	0.099	-0.017 ***	-0.089 ***	0.312 ***	0.085 ***	0.503 ***	0.286
All years	1	All	15,948	0.012	0.133	-0.019 ***	-0.148 ***	0.351 ***	0.104 ***	0.530 ***	0.374
Old Econ.	Both	All	29,720	0.013	0.083	-0.005 ***	-0.096 ***	0.202 ***	0.062 ***	0.366 ***	0.166
New Econ.	Both	All	64,336	0.013	0.115	-0.021 ***	-0.107 ***	0.368 ***	0.112 ***	0.544 ***	0.354
All years	Both	$x<0.10$	19,390	0.014	0.153	-0.020 ***	-0.133 ***	0.486 ***	0.226 ***	0.625 ***	0.434
All years	Both	$0.10\leq x<0.20$	20,004	0.014	0.108	-0.014 ***	-0.117 ***	0.351 ***	0.091 ***	0.523 ***	0.333
All years	Both	$0.20\leq x<0.30$	17,619	0.012	0.088	-0.012 ***	-0.117 ***	0.301 ***	0.078 ***	0.464 ***	0.259
All years	Both	$0.30\leq x<0.40$	12,511	0.011	0.082	-0.010 ***	-0.144 ***	0.274 ***	0.069 ***	0.432 ***	0.250
All years	Both	$x\geq 0.40$	24,532	0.012	0.078	-0.003 ***	-0.129 ***	0.152 ***	0.046 ***	0.344 ***	0.181
Panel B: Results by combination sorts											
Old Econ.	0	$x<0.10$	1,562	0.014	0.118	-0.005	-0.064 ***	0.315 ***	0.136 ***	0.346 ***	0.156
		$0.10\leq x<0.20$	4,968	0.014	0.089	-0.003	-0.102 ***	0.243 ***	0.048 ***	0.363 ***	0.169
		$0.20\leq x<0.30$	6,542	0.012	0.074	-0.001	-0.109 ***	0.190 ***	0.063 ***	0.349 ***	0.131
		$0.30\leq x<0.40$	4,776	0.013	0.070	-0.001	-0.125 ***	0.171 ***	0.067 ***	0.326 ***	0.139
		$x\geq 0.40$	8,025	0.012	0.064	-0.003 **	-0.106 ***	0.151 ***	0.041 ***	0.311 ***	0.128
	1	$x<0.10$	546	0.024	0.153	-0.008	-0.087 ***	0.354 ***	0.137 ***	0.413 ***	0.268
		$0.10\leq x<0.20$	885	0.009	0.122	-0.001	-0.185 ***	0.211 ***	0.085 ***	0.428 ***	0.255
		$0.20\leq x<0.30$	701	0.020	0.116	-0.006	-0.151 ***	0.213 ***	0.089 ***	0.555 ***	0.335
		$0.30\leq x<0.40$	553	0.014	0.110	-0.013 **	-0.191 ***	0.308 ***	0.115 ***	0.473 ***	0.343
		$x\geq 0.40$	1,162	0.015	0.097	0.006	-0.292 ***	0.194 ***	0.082 ***	0.309 ***	0.244
New Econ.	0	$x<0.10$	12,840	0.017	0.151	-0.021 ***	-0.128 ***	0.498 ***	0.251 ***	0.647 ***	0.445
		$0.10\leq x<0.20$	11,714	0.014	0.108	-0.017 ***	-0.113 ***	0.392 ***	0.118 ***	0.563 ***	0.370
		$0.20\leq x<0.30$	8,894	0.012	0.090	-0.016 ***	-0.094 ***	0.343 ***	0.085 ***	0.516 ***	0.304
		$0.30\leq x<0.40$	6,156	0.009	0.082	-0.013 ***	-0.139 ***	0.310 ***	0.081 ***	0.494 ***	0.303
		$x\geq 0.40$	12,631	0.011	0.078	-0.005 ***	-0.105 ***	0.149 ***	0.034 ***	0.339 ***	0.178
	1	$x<0.10$	4,442	0.005	0.166	-0.025 ***	-0.164 ***	0.501 ***	0.215 ***	0.652 ***	0.496
		$0.10\leq x<0.20$	2,437	0.016	0.137	-0.026 ***	-0.124 ***	0.408 ***	0.134 ***	0.590 ***	0.447
		$0.20\leq x<0.30$	1,482	0.010	0.119	-0.014	-0.214 ***	0.416 ***	0.161 ***	0.493 ***	0.384
		$0.30\leq x<0.40$	1,026	0.014	0.109	-0.013 ***	-0.172 ***	0.340 ***	0.077 ***	0.452 ***	0.289
		$x\geq 0.40$	2,714	0.016	0.103	0.000	-0.219 ***	0.141 ***	0.080 ***	0.391 ***	0.248

Year t change in cash balance ($chgCASH_t$=($CASH_t$-$CASH_{t-1}$)/TA'_{t-1}) is regressed on the following variables, individually or in combinations: $CASH_{t-1}/TA'_{t-1}$, NCF_t/TA'_{t-1}, $NETDT_t/TA'_{t-1}$, and $NETEQ_t/TA'_{t-1}$. As indicated, results are for for all sample years (1974-2008), Old Economy years (1974-1987), or New Economy years (1988-2008) and for all firms, large/seasoned firms ($SMYG_{t-1}$=0), or small/young firms ($SMYG_{t-1}$=1), as well as for ranges of physical capital intensity ($PPENT_{t-1}/TA'_{t-1}$). Significance indicators for regression coefficients: *** (1%); **(5%); *(10%).

Table 6

Preliminary OLS and propensity regressions of capital expenditure and R&D investment

Sample period	pw_t	Intcpt.	pw_t* 1.000	pw_t* Q_{t-1}	$R\&D_t/TA'_{t-1}$	Adj. R^2
Panel A: Dep. var.=$CAPX_t/TA'_{t-1}$						
All years	1.000	0.061 ***		0.007 ***		0.009
	1.000	0.062 ***		0.012 ***	-0.329 ***	0.049
	$PPENT_{t-1}/TA'_{t-1}$	0.017 ***	0.189 ***			0.264
	$PPENT_{t-1}/TA'_{t-1}$	0.029 ***		0.097 ***		0.273
	$PPENT_{t-1}/TA'_{t-1}$	0.015 ***	0.107 ***	0.059 ***		0.315
	$PPENT_{t-1}/TA'_{t-1}$	0.014 ***	0.110 ***	0.058 ***	0.028 ***	0.315
Old Economy	1.000	0.059 ***		0.022 ***		0.041
	1.000	0.059 ***		0.026 ***	-0.277 ***	0.051
	$PPENT_{t-1}/TA'_{t-1}$	0.022 ***	0.192 ***			0.211
	$PPENT_{t-1}/TA'_{t-1}$	0.040 ***		0.112 ***		0.242
	$PPENT_{t-1}/TA'_{t-1}$	0.022 ***	0.097 ***	0.076 ***		0.271
	$PPENT_{t-1}/TA'_{t-1}$	0.017 ***	0.107 ***	0.073 ***	0.147 ***	0.274
New Economy	1.000	0.052 ***		0.007 ***		0.012
	1.000	0.054 ***		0.012 ***	-0.310 ***	0.060
	$PPENT_{t-1}/TA'_{t-1}$	0.016 ***	0.184 ***			0.278
	$PPENT_{t-1}/TA'_{t-1}$	0.023 ***	***	0.094 ***		0.304
	$PPENT_{t-1}/TA'_{t-1}$	0.013 ***	0.093 ***	0.061 ***		0.337
	$PPENT_{t-1}/TA'_{t-1}$	0.012 ***	0.096 ***	0.060 ***	0.023 ***	0.338

Sample period	pw_t	Intcpt.	pw_t* 1.000	pw_t* Q_{t-1}	$CAPX_t/TA'_{t-1}$	Adj. R^2
Panel B: Dep. var.=$R\&D_t/TA'_{t-1}$						
All years	1.000	0.004 ***		0.016 ***		0.106
	1.000	0.011 ***		0.016 ***	-0.122 ***	0.142
	$R\&D_{t-1}/TA'_{t-1}$	0.004 ***	0.369 ***			0.737
	$R\&D_{t-1}/TA'_{t-1}$	0.012 ***		0.119 ***		0.607
	$R\&D_{t-1}/TA'_{t-1}$	0.004 ***	0.289 ***	0.034 ***		0.753
	$R\&D_{t-1}/TA'_{t-1}$	0.003 ***	0.292 ***	0.034 ***	0.013 ***	0.753
Old Economy	1.000	0.001 ***		0.012 ***		0.087
	1.000	0.004 ***		0.013 ***	-0.038 ***	0.096
	$R\&D_{t-1}/TA'_{t-1}$	0.001 ***	0.431 ***			0.782
	$R\&D_{t-1}/TA'_{t-1}$	0.008 ***		0.156 ***		0.571
	$R\&D_{t-1}/TA'_{t-1}$	0.001 ***	0.377 ***	0.028 ***		0.789
	$R\&D_{t-1}/TA'_{t-1}$	0.000	0.382 ***	0.027 ***	0.017 ***	0.791
New Economy	1.000	0.008 ***		0.015 ***		0.091
	1.000	0.016 ***		0.016	-0.155 ***	0.134
	$R\&D_{t-1}/TA'_{t-1}$	0.004 ***	0.362 ***			0.725
	$R\&D_{t-1}/TA'_{t-1}$	0.013 ***		0.116 ***		0.606
	$R\&D_{t-1}/TA'_{t-1}$	0.005 ***	0.277 ***	0.036 ***		0.744
	$R\&D_{t-1}/TA'_{t-1}$	0.004 ***	0.279 ***	0.036 ***	0.010 ***	0.744

Panel A (Panel B) shows results of OLS and propensity regressions of capital expenditure (R&D) investment. 'pw_t*' indicates regressors that are weighted by indicated propensity weight pw_t; OLS regression is indicated by pw_t=1.000. Data is alternately for all years (N=94,056), Old Economy years (1974-87; N=29,720), and New Economy years (1988-2008; N=64,336). Significance indicators: *** (1%); **(5%); *(10%).

Table 7

OLS/GLM and propensity regressions of capital expenditure and R&D investment on lagged Tobin's Q, financial constraint variables, and external financing variables

	Fixed effects:			pw_t*						OLS adj. R^2 or GLM R^2
pw_t	Year?	Firm?	Intcpt.	1.000	Q_{t-1}	$CASH_{t-1}/TA'_{t-1}$	NCF_t/TA'_{t-1}	$NETDT_t/TA'_{t-1}$	$NETEQ_t/TA'_{t-1}$	
Panel A: Dep. var.=$CAPX_t/TA'_{t-1}$										
1.000	No	No	0.061 ***		0.007 ***					0.009
1.000	No	No	0.065 ***		0.011 ***	-0.080 ***				0.027
1.000	No	No	0.051 ***		0.008 ***	-0.074 ***	0.183 ***			0.093
1.000	No	No	0.047 ***		0.006 ***	-0.063 ***	0.204 ***	0.251 ***		0.190
1.000	No	No	0.048 ***		0.002 ***	-0.063 ***	0.226 ***	0.259 ***	0.139 ***	0.216
1.000	Yes	No			0.004 ***	-0.052 ***	0.218 ***	0.253 ***	0.136 ***	0.237
1.000	No	Yes			0.008 ***	0.045 ***	0.162 ***	0.211 ***	0.124 ***	0.640
1.000	Yes	Yes			0.009 ***	0.043 ***	0.147 ***	0.201 ***	0.112 ***	0.655
$PPENT_{t-1}/TA'_{t-1}$	No	No	0.015 ***	0.106 ***	0.059 ***					0.315
$PPENT_{t-1}/TA'_{t-1}$	No	No	0.012 ***	0.103 ***	0.053 ***	0.296 ***				0.326
$PPENT_{t-1}/TA'_{t-1}$	No	No	0.014 ***	0.045 ***	0.042 ***	0.293 ***	0.623 ***			0.407
$PPENT_{t-1}/TA'_{t-1}$	No	No	0.017 ***	0.034 ***	0.032 ***	0.316 ***	0.648 ***	0.619 ***		0.504
$PPENT_{t-1}/TA'_{t-1}$	No	No	0.018 ***	0.034 ***	0.021 ***	0.320 ***	0.692 ***	0.630 ***	0.469 ***	0.537
$PPENT_{t-1}/TA'_{t-1}$	Yes	No		0.024 ***	0.026 ***	0.319 ***	0.683 ***	0.620 ***	0.467 ***	0.548
$PPENT_{t-1}/TA'_{t-1}$	No	Yes		-0.078 ***	0.033 ***	0.347 ***	0.582 ***	0.589 ***	0.393 ***	0.688
$PPENT_{t-1}/TA'_{t-1}$	Yes	Yes		-0.097 ***	0.036 ***	0.303 ***	0.545 ***	0.571 ***	0.373 ***	0.701
Panel B: Dep. var.=$R\&D_t/TA'_{t-1}$										
1.000	No	No	0.004 ***		0.016 ***					0.107
1.000	No	No	-0.001 ***		0.011 ***	0.102 ***				0.177
1.000	No	No	-0.006 ***		0.010 ***	0.104 ***	0.056 ***			0.192
1.000	No	No	-0.006 ***		0.010 ***	0.104 ***	0.056 ***	0.003 *		0.192
1.000	No	No	-0.005 ***		0.007 ***	0.105 ***	0.077 ***	0.010 ***	0.128 ***	0.247
1.000	Yes	No			0.006 ***	0.103 ***	0.082 ***	0.010 ***	0.130 ***	0.256
1.000	No	Yes			0.003 ***	0.005 ***	0.052 ***	0.020 ***	0.048 ***	0.859
1.000	Yes	Yes			0.002 ***	0.006 ***	0.053 ***	0.019 ***	0.047 ***	0.861
$R\&DCAP_{t-1}/TA'_{t-1}$	No	No	0.004 ***	0.292 ***	0.034 ***					0.756
$R\&DCAP_{t-1}/TA'_{t-1}$	No	No	0.004 ***	0.257 ***	0.029 ***	0.196 ***				0.762
$R\&DCAP_{t-1}/TA'_{t-1}$	No	No	0.004 ***	0.205 ***	0.032 ***	0.246 ***	0.434 ***			0.793
$R\&DCAP_{t-1}/TA'_{t-1}$	No	No	0.004 ***	0.203 ***	0.029 ***	0.255 ***	0.449 ***	0.294 ***		0.797
$R\&DCAP_{t-1}/TA'_{t-1}$	No	No	0.004 ***	0.196 ***	0.021 ***	0.262 ***	0.506 ***	0.331 ***	0.193 ***	0.803
$R\&DCAP_{t-1}/TA'_{t-1}$	Yes	No		0.195 ***	0.021 ***	0.275 ***	0.504 ***	0.329 ***	0.192 ***	0.805
$R\&DCAP_{t-1}/TA'_{t-1}$	No	Yes		0.001	0.017 ***	0.235 ***	0.454 ***	0.312 ***	0.238 ***	0.886
$R\&DCAP_{t-1}/TA'_{t-1}$	Yes	Yes		0.003	0.017 ***	0.241 ***	0.450 ***	0.310 ***	0.236 ***	0.887
					ΔQ_{t-1}	$\Delta CASH_{t-1}/TA'_{t-1}$	$\Delta NCF_t/TA'_{t-1}$	$\Delta NETDT_t/TA'_{t-1}$	$\Delta NETEQ_t/TA'_{t-1}$	
Panel C: Dep. var.=$\Delta CAPX_t/TA'_{t-1}$										
1.000	No	No	-0.003 ***		0.006 ***	0.108 ***	0.183 ***	0.166 ***	0.106 ***	0.230
1.000	Yes	Yes			0.006 ***	0.118 ***	0.172 ***	0.167 ***	0.111 ***	0.294
Panel D: Dep. var.=$\Delta R\&D_t/TA'_{t-1}$										
1.000	No	No	0.002 ***		0.001 ***	0.054 ***	0.020 ***	0.012 ***	0.020 ***	0.056
1.000	Yes	Yes			-0.002 ***	0.046 ***	0.024 ***	0.012 ***	0.019 ***	0.228

Panel A (Panel B) shows results of OLS/GLM and propensity regressions of capital expenditure investment (R&D investment) on lagged Tobin's Q (Q_{t-1}) and indicated financial constraint and external financing variables. Panel C (Panel D) shows results of OLS/GLM regressions using first differences for all explicit variables. "pwt*" indicates regressors that are weighted by indicated propensity weight pwt; OLS/GLS regression is indicated by pwt=1.000. The inclusion of fixed year and/or firm effects is indicated. Results are for all firms and years (1974-2008; N=94,056). Significance indicators: *** (1%); **(5%); *(10%).

Table 8
Propensity regressions of capital expenditure and R&D investment by Economy and firm size/age dummy

Sample period	$SMYG_{t-1}$	N	pw_t*: 1.000	Q_{t-1}	$CASH_{t-1}/TA'_{t-1}$	NCF_t/TA'_{t-1}	$NETDT_t/TA'_{t-1}$	$NETEQ_t/TA'_{t-1}$	GLM R^2
Panel A: Dep. var.=$CAPX_t/TA'_{t-1}$; pw_t =$PPENT_{t-1}/TA'_{t-1}$									
All years	Both	94,056	-0.097 ***	0.036 ***	0.303 ***	0.545 ***	0.571 ***	0.373 ***	0.701
All years	0	78,108	-0.091 ***	0.038 ***	0.282 ***	0.569 ***	0.570 ***	0.368 ***	0.715
All years	1	15,948	-0.258 ***	0.036 ***	0.296 ***	0.380 ***	0.536 ***	0.374 ***	0.805
Old Econ.	Both	29,720	-0.148 ***	0.039 ***	0.252 ***	0.611 ***	0.621 ***	0.329 ***	0.703
New Econ.	Both	64,336	-0.120 ***	0.038 ***	0.303 ***	0.484 ***	0.528 ***	0.363 ***	0.731
Old Econ.	0	25,873	-0.135 ***	0.043 ***	0.286 ***	0.663 ***	0.650 ***	0.322 ***	0.724
Old Econ.	1	3,847	-0.325 ***	0.023 ***	-0.006	0.305 ***	0.485 ***	0.375 ***	0.757
New Econ.	0	52,235	-0.115 ***	0.040 ***	0.267 ***	0.491 ***	0.509 ***	0.353 ***	0.743
New Econ.	1	12,101	-0.255 ***	0.037 ***	0.401 ***	0.420 ***	0.576 ***	0.396 ***	0.840
Panel B: Dep. var.=$R\&D_t/TA'_{t-1}$; pw_t =$R\&DCAP_{t-1}/TA'_{t-1}$									
All years	Both	94,056	0.003	0.017 ***	0.241 ***	0.450 ***	0.310 ***	0.236 ***	0.887
All years	0	78,108	0.015 ***	0.016 ***	0.231 ***	0.478 ***	0.327 ***	0.225 ***	0.894
All years	1	15,948	-0.116 ***	0.020 ***	0.206 ***	0.308 ***	0.223 ***	0.241 ***	0.942
Old Econ.	Both	29,720	0.038 ***	0.023 ***	0.037 ***	0.450 ***	0.208 ***	0.090 ***	0.925
New Econ.	Both	64,336	-0.018 ***	0.016 ***	0.251 ***	0.442 ***	0.322 ***	0.251 ***	0.886
Old Econ.	0	25,873	0.068 ***	0.023 ***	0.010	0.559 ***	0.241 ***	0.115 ***	0.936
Old Econ.	1	3,847	-0.078 ***	0.031 ***	0.037	0.324 ***	0.167 ***	0.084 ***	0.944
New Econ.	0	52,235	-0.009 ***	0.015 ***	0.238 ***	0.464 ***	0.332 ***	0.238 ***	0.893
New Econ.	1	12,101	-0.122 ***	0.019 ***	0.216 ***	0.303 ***	0.229 ***	0.252 ***	0.943

Propensity regressions of capital expenditure investment (Panel A) and R&D investment (Panel B) on lagged Tobin's Q (Q_{t-1}) and indicated financial constraint and external financing variables. Fixed year and firm effects are included. Results are for indicated combinations of sample period (where Old and New Economy years are 1974-87 and 1988-2008, resp.) and small/young firm dummy variable ($SMYG_{t-1}$). Significance indicators: *** (1%); **(5%); *(10%).

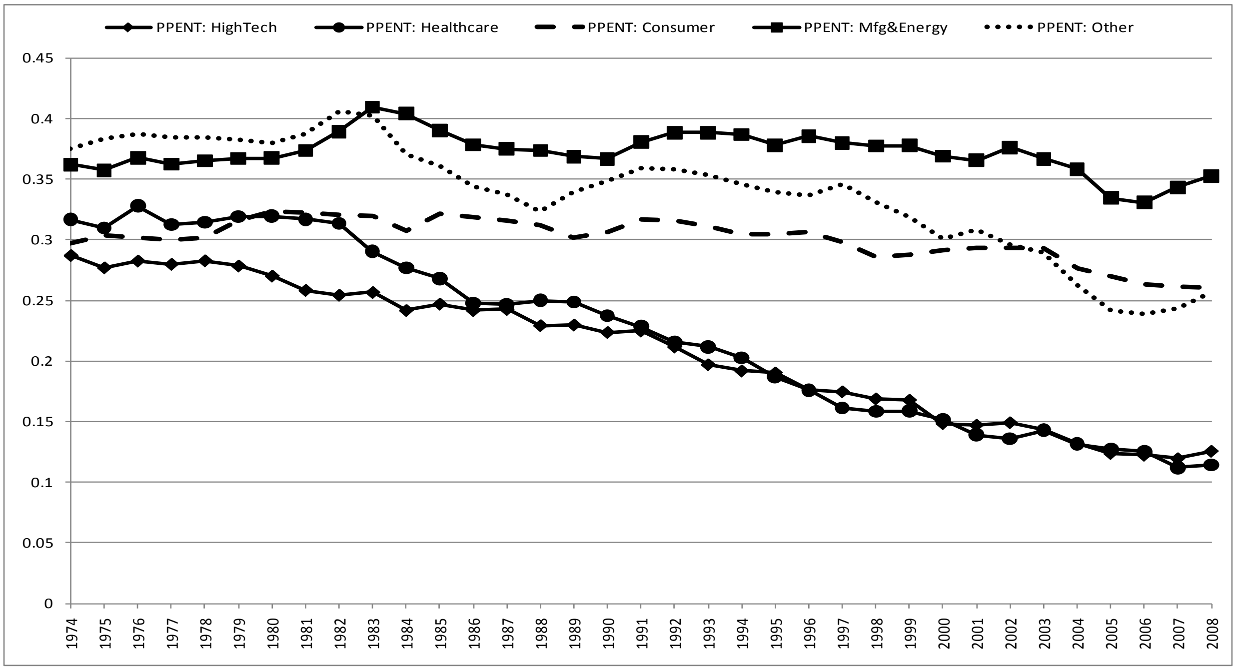

Figure 2a
Average PP&E by industry and year
Shown are average annual values of physical capital intensity ($PPENT_t/TA'_t$) by industry (High-tech; Healthcare; Consumer; Mfg. & Energy; and Other).

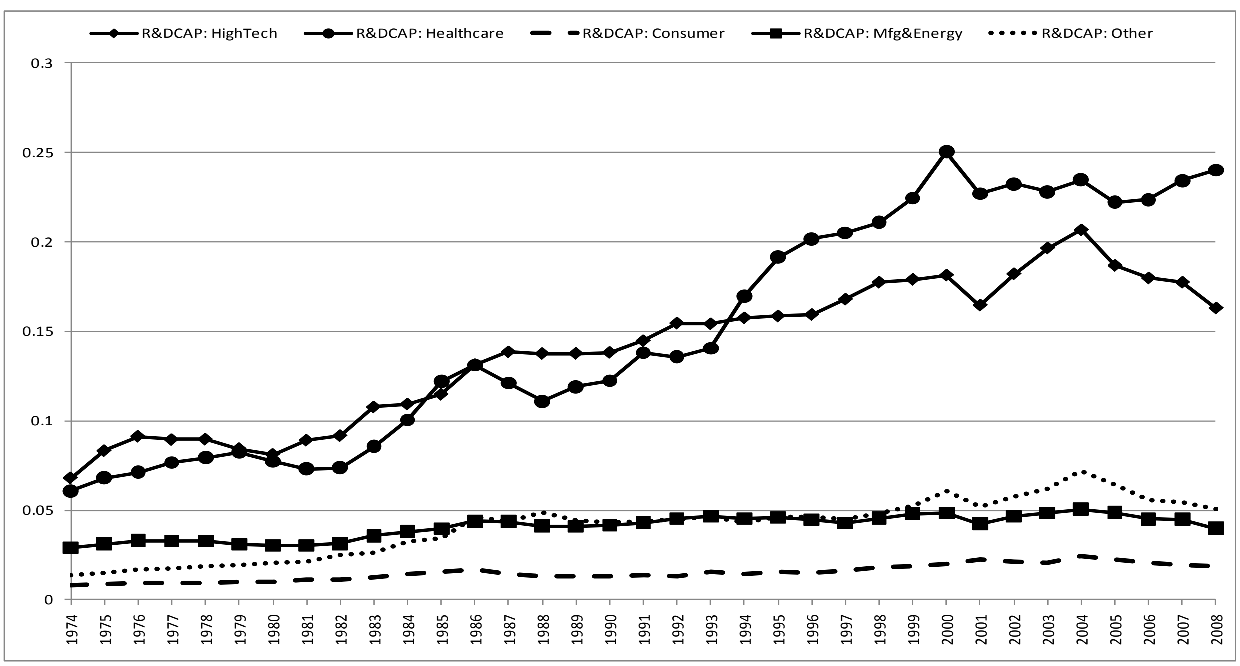

Figure 2b
Average estimated R&D capital by industry and year
Shown are average annual values of estimated intellectual-property capital intensity ($R\&DCAP_t/TA'_t$) by industry (High-tech; Healthcare; Consumer; Mfg. & Energy; and Other).

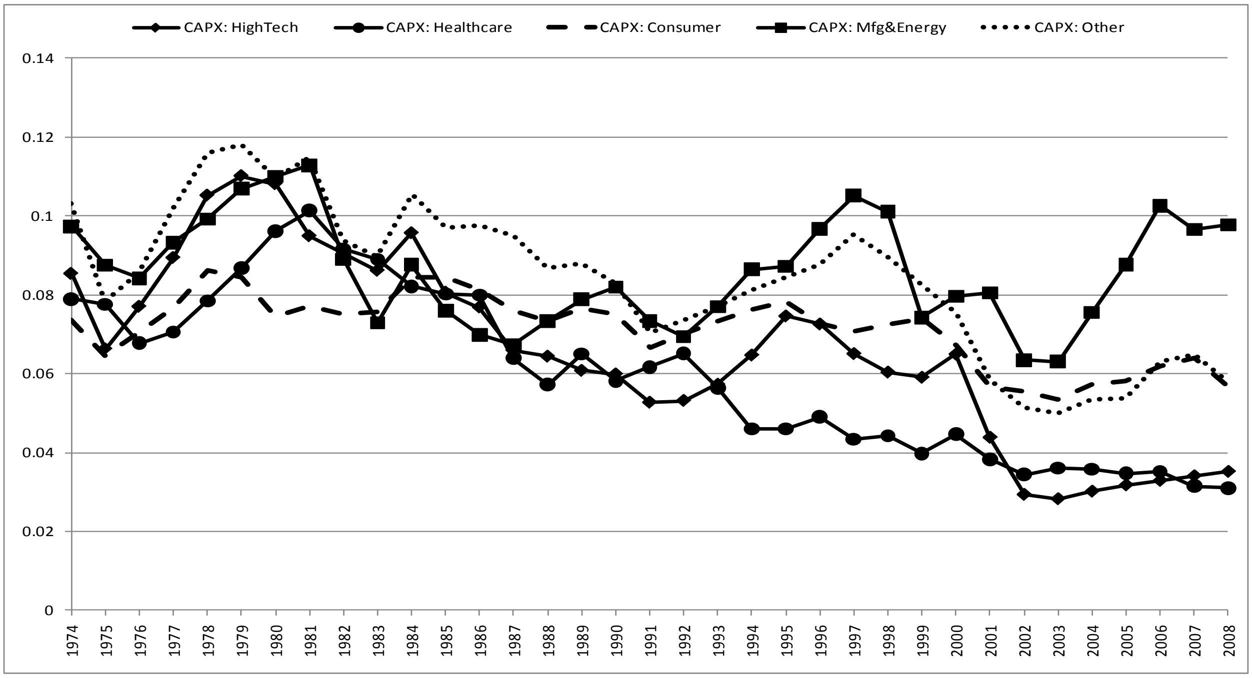

Figure 2c
Average capital expenditures by industry and year
Shown are average annual values of year t capital expenditures as a fraction of lagged augmented total assets ($CAPX_t/TA'_{t-1}$) by industry (High-tech; Healthcare; Consumer; Mfg. & Energy; and Other).

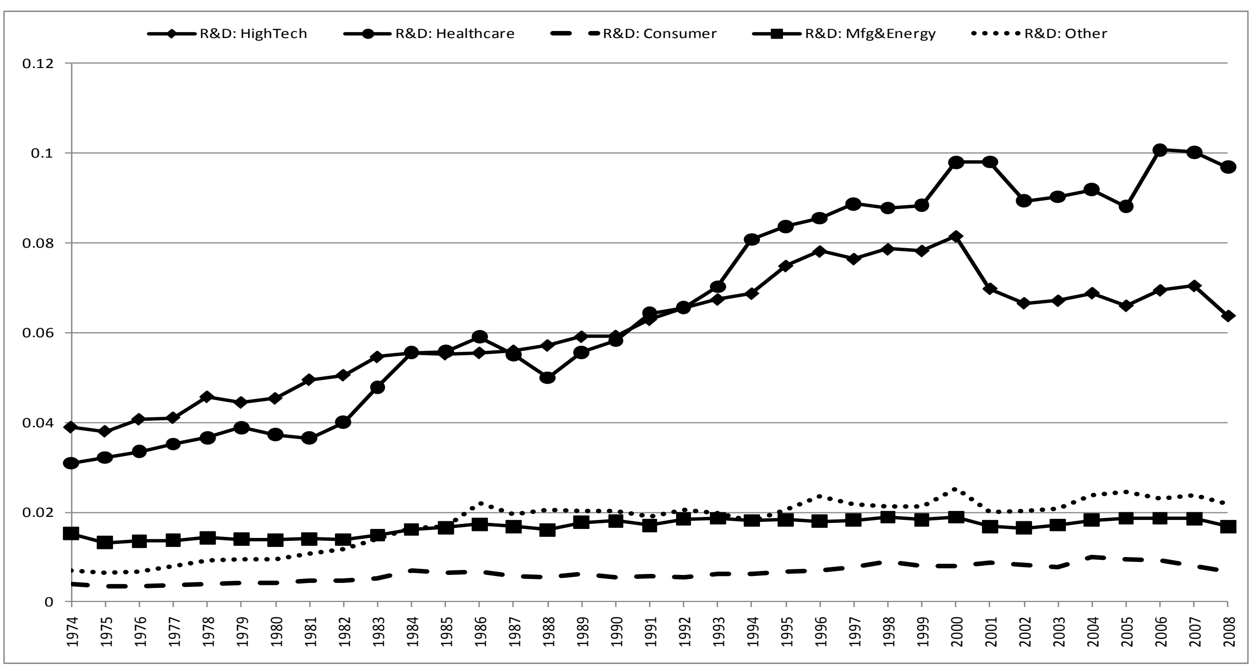

Figure 2d
Average R&D investment by industry and year
Shown are average annual values of year t R&D investment as a fraction of lagged augmented total assets ($R\&D_t/TA'_{t-1}$) by industry (High-tech; Healthcare; Consumer; Mfg. & Energy; and Other).

Table 9

Average values of investment measures and related variables by industry, Economy, and firm size/age

		Economy			$SMYG_{t-1}$			Old Economy			New Economy		
				Diff.			Diff.	$SMYG_{t-1}$		Diff.	$SMYG_{t-1}$		Diff.
Variable	All	Old	New	(New-Old)	0	1	(1 vs. 0)	0	1	(1 vs. 0)	0	1	(1 vs. 0)
Panel A: High-Tech industry													
$CAPX_t/TA'_{t-1}$	0.058	0.086	0.051	-0.035 ***	0.058	0.056	-0.002 *	0.086	0.085	-0.001	0.051	0.048	-0.003 **
$R\&D_t/TA'_{t-1}$	0.066	0.050	0.070	0.020 ***	0.062	0.079	0.016 ***	0.047	0.061	0.014 ***	0.066	0.084	0.017 ***
$PPENT_{t-1}/TA'_{t-1}$	0.186	0.259	0.166	-0.093 ***	0.192	0.163	-0.029 ***	0.268	0.230	-0.038 ***	0.172	0.145	-0.028 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.156	0.104	0.170	0.066 ***	0.148	0.188	0.041 ***	0.098	0.128	0.030 ***	0.161	0.205	0.044 ***
Q_{t-1}	1.894	1.497	1.997	0.501 ***	1.886	1.922	0.036	1.423	1.760	0.337 ***	2.006	1.966	-0.040
$CASH_{t-1}/TA'_{t-1}$	0.175	0.103	0.194	0.092 ***	0.169	0.199	0.030 ***	0.094	0.133	0.038 ***	0.188	0.217	0.029 ***
NCF_t/TA'_{t-1}	0.114	0.136	0.108	-0.027 ***	0.123	0.083	-0.040 ***	0.143	0.109	-0.034 ***	0.117	0.076	-0.041 ***
$NETDT_t/TA'_{t-1}$	0.016	0.020	0.015	-0.006 ***	0.016	0.014	-0.002	0.020	0.021	0.001	0.015	0.012	-0.003
$NETEQ_t/TA'_{t-1}$	0.035	0.031	0.036	0.005 **	0.028	0.062	0.034 ***	0.026	0.051	0.026 ***	0.028	0.065	0.036 ***
N	18,236	3,773	14,463		14,359	3,877		2,949	824		11,410	3,053	
Panel B: Healthcare industry													
$CAPX_t/TA'_{t-1}$	0.049	0.080	0.043	-0.037 ***	0.049	0.048	-0.001	0.081	0.078	-0.003	0.044	0.043	-0.001
$R\&D_t/TA'_{t-1}$	0.079	0.045	0.086	0.041 ***	0.076	0.089	0.013 ***	0.043	0.053	0.010 ***	0.083	0.096	0.013 ***
$PPENT_{t-1}/TA'_{t-1}$	0.183	0.291	0.163	-0.128 ***	0.188	0.167	-0.021 ***	0.300	0.259	-0.041 ***	0.167	0.151	-0.016 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.186	0.093	0.203	0.110 ***	0.178	0.212	0.034 ***	0.088	0.110	0.022 ***	0.195	0.230	0.035 ***
Q_{t-1}	2.310	1.835	2.399	0.564 ***	2.356	2.153	-0.203 ***	1.733	2.207	0.474 ***	2.474	2.144	-0.331 ***
$CASH_{t-1}/TA'_{t-1}$	0.206	0.120	0.222	0.102 ***	0.199	0.230	0.032 ***	0.107	0.166	0.059 ***	0.216	0.242	0.026 ***
NCF_t/TA'_{t-1}	0.085	0.128	0.077	-0.051 ***	0.098	0.041	-0.057 ***	0.134	0.105	-0.029 ***	0.091	0.030	-0.061 ***
$NETDT_t/TA'_{t-1}$	0.018	0.022	0.017	-0.004	0.018	0.016	-0.002	0.024	0.012	-0.012 *	0.017	0.017	0.000
$NETEQ_t/TA'_{t-1}$	0.065	0.028	0.072	0.044 ***	0.055	0.100	0.045 ***	0.020	0.056	0.036 ***	0.062	0.108	0.046 ***
N	8,287	1,304	6,983		6,420	1,867		1,023	281		5,397	1,586	
Panel C: Consumer industry													
$CAPX_t/TA'_{t-1}$	0.071	0.077	0.068	-0.010 ***	0.071	0.073	0.002	0.076	0.084	0.008 ***	0.067	0.069	0.002
$R\&D_t/TA'_{t-1}$	0.006	0.005	0.007	0.003 ***	0.006	0.009	0.003 ***	0.005	0.007	0.002 ***	0.007	0.010	0.003 ***
$PPENT_{t-1}/TA'_{t-1}$	0.300	0.312	0.294	-0.018 ***	0.303	0.283	-0.020 ***	0.313	0.297	-0.016 ***	0.297	0.279	-0.018 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.015	0.011	0.018	0.006 ***	0.014	0.021	0.006 ***	0.011	0.015	0.004 ***	0.017	0.023	0.006 ***
Q_{t-1}	1.471	1.136	1.662	0.527 ***	1.473	1.455	-0.018	1.127	1.210	0.083 ***	1.690	1.536	-0.154 ***
$CASH_{t-1}/TA'_{t-1}$	0.091	0.087	0.093	0.006 ***	0.090	0.093	0.003	0.086	0.095	0.009 ***	0.093	0.093	0.000
NCF_t/TA'_{t-1}	0.083	0.094	0.077	-0.017 ***	0.087	0.060	-0.027 ***	0.095	0.084	-0.011 ***	0.082	0.052	-0.030 ***
$NETDT_t/TA'_{t-1}$	0.016	0.014	0.017	0.003 **	0.015	0.018	0.003	0.014	0.016	0.002	0.016	0.019	0.002
$NETEQ_t/TA'_{t-1}$	0.006	0.005	0.007	0.002 **	0.002	0.029	0.027 ***	0.003	0.016	0.012 ***	0.001	0.033	0.032 ***
N	24,727	8,999	15,728		20,990	3,737		8,072	927		12,918	2,810	
Panel D: Manufacturing & Energy industry													
$CAPX_t/TA'_{t-1}$	0.086	0.090	0.084	-0.006 ***	0.084	0.102	0.018 ***	0.087	0.110	0.023 ***	0.082	0.098	0.016 ***
$R\&D_t/TA'_{t-1}$	0.017	0.015	0.018	0.003 ***	0.017	0.017	0.000	0.015	0.012	-0.003 ***	0.018	0.019	0.001 *
$PPENT_{t-1}/TA'_{t-1}$	0.373	0.376	0.371	-0.005 *	0.369	0.403	0.034 ***	0.371	0.422	0.051 ***	0.367	0.392	0.025 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.041	0.034	0.045	0.011 ***	0.041	0.039	-0.002 *	0.035	0.027	-0.009 ***	0.045	0.045	0.000
Q_{t-1}	1.415	1.182	1.578	0.397 ***	1.405	1.495	0.090 ***	1.156	1.416	0.260 ***	1.585	1.537	-0.048 **
$CASH_{t-1}/TA'_{t-1}$	0.086	0.082	0.089	0.007 ***	0.085	0.094	0.009 ***	0.079	0.102	0.023 ***	0.089	0.090	0.001
NCF_t/TA'_{t-1}	0.099	0.108	0.093	-0.016 ***	0.102	0.079	-0.022 ***	0.109	0.098	-0.011 ***	0.096	0.069	-0.027 ***
$NETDT_t/TA'_{t-1}$	0.017	0.016	0.018	0.003 *	0.016	0.025	0.009 ***	0.015	0.018	0.002	0.017	0.029	0.012 ***
$NETEQ_t/TA'_{t-1}$	0.011	0.007	0.014	0.007 ***	0.007	0.040	0.032 ***	0.005	0.027	0.022 ***	0.009	0.046	0.038 ***
N	23,735	9,749	13,986		20,973	2,762		8,783	966		12,190	1,796	
Panel E: Other													
$CAPX_t/TA'_{t-1}$	0.081	0.100	0.073	-0.027 ***	0.082	0.081	-0.001	0.099	0.109	0.011 ***	0.073	0.072	-0.001
$R\&D_t/TA'_{t-1}$	0.019	0.012	0.022	0.009 ***	0.017	0.026	0.010 ***	0.011	0.021	0.010 ***	0.020	0.028	0.008 ***
$PPENT_{t-1}/TA'_{t-1}$	0.331	0.376	0.310	-0.065 ***	0.337	0.305	-0.032 ***	0.379	0.355	-0.025 ***	0.316	0.290	-0.026 ***
$R\&DCAP_{t-1}/TA'_{t-1}$	0.044	0.026	0.052	0.026 ***	0.039	0.064	0.025 ***	0.023	0.045	0.022 ***	0.047	0.070	0.024 ***
Q_{t-1}	1.653	1.330	1.798	0.468 ***	1.628	1.758	0.129 ***	1.283	1.609	0.325 ***	1.797	1.802	0.005
$CASH_{t-1}/TA'_{t-1}$	0.132	0.113	0.140	0.027 ***	0.126	0.157	0.031 ***	0.109	0.140	0.031 ***	0.134	0.161	0.027 ***
NCF_t/TA'_{t-1}	0.093	0.108	0.087	-0.021 ***	0.098	0.072	-0.026 ***	0.108	0.109	0.002	0.094	0.061	-0.033 ***
$NETDT_t/TA'_{t-1}$	0.019	0.020	0.018	-0.001	0.018	0.022	0.004 **	0.018	0.030	0.012 ***	0.018	0.020	0.002
$NETEQ_t/TA'_{t-1}$	0.019	0.014	0.021	0.007 ***	0.013	0.045	0.032 ***	0.011	0.035	0.025 ***	0.014	0.048	0.034 ***
N	19,071	5,895	13,176		15,366	3,705		5,046	849		10,320	2,856	

Average values of investment measures and related variables by industry, Economy, and firm size/age dummy ($SMYG_{t-1}$). Significance indicators for differences: *** (1%); **(5%); *(10%).

Table 10
Propensity regressions of capital expenditure and R&D investment by industry and Economy

			pw_t*						
Industry	Sample period	N	1.000	Q_{t-1}	$CASH_{t-1}/TA'_{t-1}$	NCF_t/TA'_{t-1}	$NETDT_t/TA'_{t-1}$	$NETEQ_t/TA'_{t-1}$	GLM R^2
Panel A: Dep. var.=$CAPX_t/TA'_{t-1}$; $pw_t=PPENT_{t-1}/TA'_{t-1}$									
High-Tech	All years	18,236	-0.140 ***	0.045 ***	0.312 ***	0.574 ***	0.524 ***	0.420 ***	0.661
Healthcare	All years	8,287	-0.153 ***	0.036 ***	0.293 ***	0.486 ***	0.571 ***	0.319 ***	0.569
Consumer	All years	24,727	-0.101 ***	0.040 ***	0.305 ***	0.506 ***	0.577 ***	0.437 ***	0.685
Mfg. & Energy	All years	23,735	-0.070 ***	0.030 ***	0.291 ***	0.561 ***	0.523 ***	0.330 ***	0.736
Other	All years	19,071	-0.084 ***	0.030 ***	0.325 ***	0.538 ***	0.640 ***	0.373 ***	0.700
Avg. coeff.				*0.036*	*0.305*	*0.533*	*0.567*	*0.376*	
High-Tech	Old Econ.	3,773	-0.218 ***	0.066 ***	0.261 ***	0.675 ***	0.500 ***	0.283 ***	0.663
Healthcare	Old Econ.	1,304	-0.231 ***	0.062 ***	0.174 *	0.375 ***	0.514 ***	0.267 ***	0.634
Consumer	Old Econ.	8,999	-0.155 ***	0.052 ***	0.287 ***	0.574 ***	0.618 ***	0.331 ***	0.695
Mfg. & Energy	Old Econ.	9,749	-0.161 ***	0.030 ***	0.192 ***	0.619 ***	0.565 ***	0.361 ***	0.717
Other	Old Econ.	5,895	-0.101 ***	0.027 ***	0.275 ***	0.611 ***	0.734 ***	0.307 ***	0.722
Avg. coeff.				*0.047*	*0.238*	*0.571*	*0.586*	*0.310*	
High-Tech	New Econ.	14,463	-0.162 ***	0.043 ***	0.277 ***	0.496 ***	0.517 ***	0.438 ***	0.690
Healthcare	New Econ.	6,983	-0.184 ***	0.034 ***	0.271 ***	0.475 ***	0.565 ***	0.351 ***	0.555
Consumer	New Econ.	15,728	-0.123 ***	0.045 ***	0.272 ***	0.450 ***	0.543 ***	0.438 ***	0.716
Mfg. & Energy	New Econ.	13,986	-0.077 ***	0.030 ***	0.335 ***	0.516 ***	0.489 ***	0.307 ***	0.781
Other	New Econ.	13,176	-0.108 ***	0.032 ***	0.348 ***	0.460 ***	0.563 ***	0.365 ***	0.716
Avg. coeff.				*0.037*	*0.301*	*0.479*	*0.536*	*0.380*	
Panel B: Dep. var.=$R\&D_t/TA'_{t-1}$; $pw_t=R\&DCAP_{t-1}/TA'_{t-1}$									
High-Tech	All years	18,236	-0.009 **	0.021 ***	0.177 ***	0.440 ***	0.326 ***	0.275 ***	0.829
Healthcare	All years	8,287	-0.025 ***	0.013 ***	0.391 ***	0.417 ***	0.297 ***	0.232 ***	0.850
Consumer	All years	24,727	0.089 ***	0.016 ***	0.167 ***	0.262 ***	0.142 ***	0.166 ***	0.865
Mfg. & Energy	All years	23,735	0.094 ***	0.007 ***	0.216 ***	0.565 ***	0.389 ***	0.215 ***	0.869
Other	All years	19,071	0.026 ***	0.020 ***	0.129 ***	0.525 ***	0.291 ***	0.240 ***	0.892
Avg. coeff.				*0.015*	*0.216*	*0.442*	*0.289*	*0.226*	
High-Tech	Old Econ.	3,773	-0.009	0.032 ***	-0.048	0.551 ***	0.216 ***	0.188 ***	0.893
Healthcare	Old Econ.	1,304	0.052 **	0.031 ***	0.170 ***	0.328 ***	0.127 ***	-0.124 ***	0.920
Consumer	Old Econ.	8,999	0.096 ***	0.016 ***	-0.017	0.208 ***	0.109 ***	0.166 ***	0.910
Mfg. & Energy	Old Econ.	9,749	0.079 ***	0.031 ***	0.025	0.564 ***	0.189 ***	-0.077 ***	0.906
Other	Old Econ.	5,895	0.085 ***	0.007 ***	-0.004	0.360 ***	0.272 ***	0.259 ***	0.923
Avg. coeff.				*0.023*	*0.025*	*0.402*	*0.183*	*0.082*	
High-Tech	New Econ.	14,463	-0.022 ***	0.020 ***	0.191 ***	0.426 ***	0.340 ***	0.280 ***	0.828
Healthcare	New Econ.	6,983	-0.038 ***	0.011 ***	0.394 ***	0.420 ***	0.308 ***	0.247 ***	0.847
Consumer	New Econ.	15,728	0.057 ***	0.014 ***	0.171 ***	0.260 ***	0.148 ***	0.186 ***	0.867
Mfg. & Energy	New Econ.	13,986	0.058 ***	0.004 ***	0.213 ***	0.563 ***	0.440 ***	0.258 ***	0.871
Other	New Econ.	13,176	0.003	0.022 ***	0.116 ***	0.514 ***	0.291 ***	0.246 ***	0.896
Avg. coeff.				*0.014*	*0.217*	*0.437*	*0.305*	*0.244*	

Propensity regressions of capital expenditure investment (Panel A) and R&D investment (Panel B) on lagged Tobin's Q (Q_{t-1}) and indicated financial constraint and external financing variables, by industry and Economy. Fixed year and firm effects are included. Significance indicators: *** (1%); **(5%); *(10%).