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What drives investment–cash flow sensitivity around the World? An asset tangibility Perspective☆

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ABSTRACT

Motivated by ongoing debates on investment–cash flow sensitivity (ICFS) and its documented decline and disappearance in the U.S., we investigate the determinants of ICFS. Using firm-level data across 41 countries for the 1993–2013 period, we document an important role of asset tangibility in explaining the patterns in ICFS. Asset tangibility affects ICFS through two channels: investment intensity and cash flow persistence. As the share of tangible capital, investment and cash flow persistence has fallen in developed economies, ICFS has declined. In contrast, as developing economies operate with more tangible capital, have higher investment rates and more persistent cash flows, their ICFS is more stable. The results support our explanation of ICFS as a reflection of capital (investment) intensity and income predictability, rather than a measure of financial constraints.

1. Introduction

The investment literature continues to debate the origins of investment–cash flow sensitivity (ICFS), at a time where recent evidence suggests it has declined over time and virtually disappeared in the United States (U.S). This decline and disappearance remains largely unexplained and poses a further challenge for our understanding of the sensitivity.

The purpose of our study is to understand the existence and downward trajectory of ICFS. To this end, we study how ICFS has evolved globally over time. There are two compelling reasons to choose an international setting. First, the existing research on ICFS relies largely on U.S. firms, with relatively few studies involving non-U.S. economies (Bond et al., 2003; Cleary, 2006; Islam and Mozumdar, 2007; Kadapakkam et al., 1998; Love, 2003). By extending the study of ICFS to international firms, we shed light on whether the decline and disappearance of ICFS is specific to U.S. firms or is part of a broader global pattern. The second reason is that using international data allows us to take advantage of a considerable cross-country variation in important firm characteristics, which should provide for sharper tests when analyzing the cross-sectional and time-series patterns in ICFS.

We propose an explanation of ICFS and its time series based on asset tangibility, where asset tangibility affects ICFS through *two* channels. The first channel is the interdependence between tangible capital and physical investment.[1] In macroeconomics, the

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[1] In our paper, we use tangible capital (assets, investment) and physical capital (assets, investment) interchangeably.

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share of tangible capital in total productive capital contains information about its marginal productivity. As the marginal productivity of capital relative to other productive factors varies across firms and over time, the rate of investment also varies. The main idea is that manufacturing (traditional) firms operating with a higher fraction of tangible productive capital invest more intensively. Over the last few decades, the U.S. economy has experienced a major transformation from traditional industries to high-tech and service-oriented industries. This transformation is accompanied by a shift in the nature of investment from tangible to intangible capital. In fact, most traditional firms are also engaged in research and development (R&D) and in changing their productive capital structures.[2] As intellectual and liquid capital has become more important in the U.S. economy, the role of tangible capital and investment has declined.[3] Similar patterns have occurred in other developed economies, whose productive capital structures and compositions of investment are somewhat similar to those of the U.S. We test the first hypothesis that a declining share of tangible capital assets and falling investment invariably translate into a decline in ICFS in most developed economies.

Developing economies are structurally different. Because their firms operate with more tangible capital and invest more intensively, their productive capital structures are more tangible. Over time, their levels of capital stock also decline due to technological progress and new product markets but at a slower pace. We test the second hypothesis that a high level of tangible capital stock and a stable rate of investment support ICFS in developing economies.

The second channel is based on the notion that cash flow explains investment because it predicts (contains information about) future cash flow and because investment is made in pursuit of future income. Riddick and Whited (2009) show that the marginal propensity to invest (vis-à-vis the marginal propensity to save) is higher when cash flow is more predictable. This result occurs because firms with more predictable income have a stronger incentive to transform liquid assets into more productive assets, that is, to invest. Compared with physical capital, intangible capital is associated with higher uncertainty. Given that intangible capital arises as an important component of production in the competitive environment of the "new economy" (Hansen et al., 2005), cash flow becomes less predictable. Over time, the declining share of tangible capital attenuates the persistence of cash flow in advanced economies. This loss of information eventually contributes to the decline in ICFS. In contrast, more tangible asset structures support the persistence of cash flow and ICFS in developing economies. These are our third and fourth hypotheses, respectively. Overall, given that asset tangibility affects both the rate of physical investment and the information content in cash flow, we expect asset tangibility, rather than the wedge between the costs of internal and external finance, to determine ICFS.

Using firm-level data across 41 countries for the 1993–2013 period, we document an important role of asset tangibility in explaining the patterns in ICFS across five sets of findings. The first evidence comes from descriptive statistics of firm characteristics. During the sample period, physical investment as a fraction of total assets fell by two-fifths of its value for U.S. firms, over a third for firms from other developed economies, and between a quarter and a third for firms from developing economies. The average fraction of tangible assets in total assets (productive assets) declined from 0.31 (0.74) in 1993 to 0.22 (0.57) in 2013 for U.S. firms, from 0.33 (0.91) to 0.27 (0.76) for firms from other developed economies, and from 0.42 (0.96) to 0.35 (0.90) for firms from developing economies.[4] It is therefore natural to expect a steady decline in ICFS in the U.S and other advanced economies (to a lesser degree) and a modest decline in ICFS in less developed economies.

The second set of results is the main evidence for this paper. There is substantial cross-country variation in ICFS. More telling, however, are the time-series patterns: sensitivity has nearly disappeared in the U.S. (fallen by two-thirds of its value), persistently declined in non-U.S. developed economies (fallen by half), and moderated in developing economies (fallen by a fifth). This finding regarding the global downward trajectory is interesting *per se* because we document that ICFS has declined beyond the U.S economy, although at different paces.

More importantly, we show that ICFS is low or absent if the cross-product term of cash flow and the fraction of tangible assets in total assets is included; that is, ICFS is dwarfed by the sensitivity of investment to the cross-product term of cash flow and tangible capital. In essence, ICFS is *investment–cash flow–tangible capital sensitivity* because the investment of a firm with low tangible capital is not systematically sensitive to cash flow. Only firms with high tangible capital have investments that vary with cash flows. Over time, the sum of ICFS and investment–cash flow–tangible capital sensitivity drops from 0.55 to 0.22 and from 0.54 to 0.35 in the U.S. and non-U.S. developed economies, respectively. In contrast, the aggregate sensitivity remains stable in developing economies.

We further document that non-cash flow financing, such as cash reserves, new equity and debt issues, cannot predict the time-series patterns of ICFS and investment–cash flow–tangible capital sensitivity. Although debt financing contributes to new investment, which is consistent with the pledgeability of the firm's assets, cash flow remains an important source of financing for capital-intensive firms.[5] Nevertheless, its importance has steadily declined in developed economies.

We verify our results using subsamples of firms along several dimensions. We define investment-intensive firms by the size of their investment outlay and estimate the cash flow sensitivities from a sample of firm-years for which the actual investment is strictly greater than depreciation. After eliminating those firm-years in which capital deteriorates, we find that firms from developed economies continue to experience a decline in tangibility and in the scale of their investment; thus, they tend to have diminishing sensitivities over time. In contrast, investment-intensive firms from less developed economies tend to have non-declining sensitivities.[6]

We examine a semi-balanced panel of firms that existed through the entire sample period. Although ICFS is still largely absent, investment–cash flow–tangible capital sensitivity is significantly positive. The aggregate cash flow sensitivity declines for firms from developed market economies and demonstrates no trend for firms from developing economies. This test reveals that the documented time-series patterns cannot be attributed to the changing firm composition.

[2] Brown et al. (2009) and Brown and Petersen (2009) argue that there has been a sharp change in the composition of investment: the importance of physical investment has declined substantially and R&D intensity has risen dramatically for U.S. firms. Pinkowitz et al. (2012) further document the tendency of U.S. firms to postpone investment and instead accumulate excess cash.

[3] Data from the U.S. economy in the post-war period imply that corporations indeed have formed large amounts of intangible capital (Hall 2001).

[4] Total productive assets are the sum of tangible and intangible assets.

[5] Because of the multitude of sources available to finance investment, the interpretation of ICFS or investment–cash flow–tangible capital sensitivity as a measure of the firm's degree of asset tangibility is not correct. Both sensitivities capture the effect of tangible capital through internal cash flow only, not through all financing channels.

[6] When we define capital-intensive firms by the size of their tangible capital assets and estimate their cash flow sensitivities, we obtain similar time-series patterns.

The third set of results addresses the concern that the phenomenon is due to the errors-in-variables problem. The alternative explanation is that ICFS, its time-series patterns and its relation to firm asset tangibility could be explained by the correction for poorly measured Tobin's q. To explore this possibility, we follow Erickson (2014), who developed the measurement error remedy (cumulant estimators) that is asymptotically equivalent to the high-order moment estimators in Erickson and Whited (2000, 2002). Although measurement error-consistent ICFS is negative and treated q is economically significant, the investment–cash flow–tangible capital sensitivity is also significant. Over the sample period, the sum of ICFS and investment–cash flow–tangible capital sensitivity fell from 0.35 to 0.15 in the U.S. and from 0.52 to 0.33 in non-U.S. developed economies. The aggregate cash flow sensitivity strengthened from 0.21 to 0.37 for firms from less developed economies. The cumulant-based estimates are generally similar to their least squares counterparts; thus, the proposed relation between asset tangibility and investment and its time-series dynamics is largely immune to measurement error.[7]

In the fourth set of results, we test the second channel and show that the degree of asset tangibility is the determinant of the information content in cash flow regarding investment opportunities. Cash flow persistence has substantially declined in the U.S. and other developed economies but improved in emerging market economies over time. When we estimate the persistence of the cross-product term of cash flow and tangible capital, we find that it exhibits greater magnitude and similar time-series patterns.

Minton and Schrand (1999) show that cash flow volatility is associated with depressed investment. It is therefore natural that more volatile (less predictable) cash flow negatively affects the strength of the sensitivity of investment to cash flow. On the other hand, a higher degree of tangibility should induce a greater persistence of cash flow and stability of investment. We find that cash flow volatility is indeed associated with lower, but still statistically significant, ICFS. However, when we incorporate the cross-product term of cash flow and tangible capital into the investment regression, the impact of cash flow volatility and the coefficient of standalone ICFS become largely insignificant. These results clearly show that tangibility is a strong predictor of ICFS.

Our final set of results provides empirical support for our explanation of ICFS as a reflection of a firm's capital (investment) intensity and income predictability, rather than an indication of financial constraints. Because physical assets can be pledged as collateral for obtaining external finance, the alternative interpretation of the relation between tangible capital and investment is financial constraints (Almeida and Campello, 2007). If this is the case, we should observe larger investment–cash flow–tangible capital sensitivity for firms classified as financially constrained. To test this possibility, we separate financially *more* constrained firms from *less* constrained firms. The results reveal that ICFS and investment–cash flow–tangible capital sensitivity are not consistently higher for financially constrained firms in all classification schemes. This evidence indicates that the explanatory power of asset tangibility does not derive from financing frictions.

The overall contribution of our study is important insight into the patterns of ICFS. We show that, among the potential explanations of ICFS and its time-series development, firm asset tangibility is an important determinant. We provide evidence supporting the explanation that the decline in ICFS is a result of slow capital formation and less predictable income flow in the developed world. To the best of our knowledge, this is new evidence because previous research does not provide a global analysis of the relation between changes in asset structure, the composition of investment and ICFS. Moreover, the paper provides new evidence on the persistence of cash flow and demonstrates its contribution to our understanding of ICFS. Our approach is not subject to the Kaplan and Zingales (1997) critique. In fact, our identification strategy supports the authors' argument that ICFS is not related to the degree of financial constraints and cannot be used to gauge the effect of financing frictions on investment. Finally, our approach carefully addresses the impact of biases stemming from unobservable variation in investment opportunities.

The rest of the paper is organized as follows. The following section briefly reviews the literature. We develop our hypotheses, discuss the research strategy, and explain the data in Section 3. In Section 4, we provide summary statistics. Section 5 presents the main evidence for the sensitivity of investment to (i) cash flow and (ii) to the combination of cash flow and tangible capital. In Section 6, we explore how asset tangibility determines the information content in cash flow regarding investment opportunities. We test the effect of financial constraints on the explanatory power of tangible capital in Section 7. The final section concludes.

2. Related literature

The neoclassic q theory states that what is relevant to a firm's investment decision is *marginal* q – the ratio of the market value of a marginal unit of capital to its replacement cost. The value indicates how an additional dollar of capital affects the present value of profit. Marginal q is a sufficient statistic for investment, and all other determinants, including cash flow, are irrelevant. However, marginal q is more difficult to measure than *average* q – the ratio of the total value of the firm to the replacement cost of its total capital (Tobin, 1969). The empirical problem is that average q is not necessarily sufficient to explain investment behavior. Instead, Fazzari (1988) found that investment is positively sensitive to cash flow, even after controlling for q, and interpreted this finding as evidence of financing frictions.[8] Let I and CF be physical investment and cash flow, respectively, scaled by physical assets K, and q be the market-to-book ratio. The investment–q (β_1) and investment–cash flow (β_2) sensitivities are as follows:

$$\frac{I_{i,t}}{K_{i,t-1}} = \beta_0 + \beta_1 q_{i,t-1} + \beta_2\left(\frac{CF_{i,t}}{K_{i,t-1}}\right) + \varepsilon_{i,t} \tag{1}$$

By ranking firms into high- and low-dividend groups, the authors found that β_2 is higher for low-dividend firms than for high-dividend firms, whereas β_1 is insignificant. In their empirical work, dividend payout was used as a proxy for financial constraints. As such, they argued that financial constraints affect firm investment, and that financially constrained firms have higher, and significant, ICFS.

The notion that financing frictions can affect firms' investment behavior is not controversial. There is, for instance, substantial evidence that there are costs associated with raising external capital and that the presence of internal resources can affect investment decisions (Lamont, 1997; Shin and Stulz, 1998). However, the debate centers on the following aspects: (i) whether the magnitude of ICFS provides an accurate measure of financial constraints, (ii) whether ICFS in fact measures the causal effect of cash flow on investment, and (iii) what has driven the sharp decline and disappearance of ICFS in the U.S over time.

[7] Additionally, we re-estimate ICFS and investment–cash flow–tangible capital sensitivity without q. Our main results continue to hold without the q proxy. We further show that the correlation between cash flow and (empirical and marginal) q cannot explain the time-series patterns of ICFS and investment–cash flow–tangible capital sensitivity.

[8] Given that the current cash flow is likely to be positively correlated with future profitability, a link between cash flow and investment could reflect the link between expected profitability and investment rather than the sensitivity of firm investment to cash flow. For this reason, q is used as a proxy for investment opportunities.

Kaplan and Zingales (1997) questioned the interpretation of ICFS as a measure of financial constraints. They studied the annual reports of those firms classified as financially constrained by Fazzari et al. (1988) and found that only a small fraction of low-dividend firms had experienced difficulties in accessing external finance. On the other hand, a large fraction of firms that appeared less constrained according to their classification actually exhibited greater ICFS. Thus, whether a large magnitude of ICFS is indicative of financial constraints is called into question. Fazzari et al. (2000) disputed both the theoretical model and the empirical classification scheme provided by Kaplan and Zingales (1997). However, the debate is not settled (see Kaplan and Zingales, 2000).

Other papers question the interpretation of ICFS as an indicator of financial constraints. For example, Kadapakkam et al., (1998) found that ICFS was generally highest (smallest) among the large (small) firms. Cleary (1999) developed a classification scheme based on firm characteristics and found that less creditworthy and more constrained firms have smaller ICFS. Gomes (2001) showed that ICFS is theoretically not sufficient for measuring financial constraints. Alti (2003) modeled the sensitivity in a frictionless financing environment. This author found that investment is sensitive to cash flow without financing frictions. Moyen (2004) considered a model with and a model without financial constraints. Their simulation results showed that ICFS is observed in both models. Cleary (2006) showed that firms with a stronger financial position and higher dividend payout are more investment–cash flow sensitive than firms with a weaker financial position and lower payout. Cleary et al., (2007) further showed that the relation between investment and cash flow is U-shaped: investment increases monotonically with large internal funds but decreases with low funds. Gatchev et al., (2010) indicated that ICFS does not acknowledge the multifaceted interdependence between financial and investment decisions and provides an incomplete and misleading view of true financial constraints. Despite the controversy regarding this interpretation, many studies continue to use ICFS (a partial list of papers includes Hoshi et al., 1991; Fazzari and Petersen, 1993; Bond et al., 2003; Love, 2003; Biddle and Hilary, 2006 and Beatty et al., 2010).

Although the debate on whether ICFS is indicative of financial constraints continues, the literature widely explores the question of why ICFS exists if it is not due to financial constraints and why q fails to explain real investment. The reason for the uncertainty is that the current cash flow may be correlated with future investment opportunities that cannot be adequately controlled for if empirical q is subject to measurement error. Erickson and Whited (2000, 2002) found that mismeasured q leads to an overstated relationship between investment and cash flow, even for financially constrained firms, and that q theory has good explanatory power once purged of measurement error. Alti (2003) also showed that q is a noisy proxy of near-term investment opportunities. Although the errors-in-variables problem has been broadly recognized in the literature, some studies argue that the variations in ICFS cannot be entirely explained by q measurement error (Chen and Chen, 2012; Lewellen and Lewellen, 2016).

Adding to the debate on the interpretation of ICFS is its sharp decline in the U.S. Whereas in the late 1960s the sensitivity remained at approximately 0.4, by the millennium, it had dropped to virtually zero. Allayannis and Mozumdar (2004) recorded a decline in ICFS over the 1977–1996 period, particularly for the most constrained firms. Agca and Mozumdar (2008) suggested that ICFS decreases with factors that reduce capital market imperfections. Ascioglu et al., (2008) suggested that investment expenditure decreases and ICFS increases with the probability of informed trading. Islam and Mozumdar (2007) found a negative relationship between cross-country financial development and the importance of internal capital for investment decisions. Brown and Petersen (2009) examined the changes in ICFS over the 1970–2006 period. They argued that the decline can be attributed to the changing composition of investment from physical investment to R&D and the rising importance of public equity. More recently, Chen and Chen (2012) made the interesting observation that ICFS has dramatically declined and disappeared during the 2007–2009 credit crunch. They showed that this trend cannot be explained by changes in sample composition, governance practices, market power, or the introduction of new financing and investment channels. Changes in the quality of q and information content in cash flow regarding growth options help us to understand, but do not completely explain, the time-series patterns in ICFS.

The rich, but inconclusive, literature motivates our interest in ICFS and its variation across firms and over time. We discuss our intuition and propose our hypotheses in the next section.

3. Predictions, research design, variable definitions and methodology

3.1. Hypotheses development

A natural question is why ICFS existed in the past but has disappeared in recent years. Our explanation of this phenomenon is based on asset tangibility, where asset tangibility may affect ICFS through *two* channels. The first channel is the interdependence between asset tangibility and investment intensity. The *tangibility* of a firm's assets refers to the share of tangible (physical) assets in total assets, whereas the *intensity* of its investment refers to the size of physical investment relative to assets.[9] In macroeconomics, the relative share of tangible capital contains information about its marginal productivity. As the productivity of tangible capital relative to other productive factors varies, the rate of investment also varies. At the firm level, the stock of tangible assets affects the rate of investment, which in turn affects the future stock of tangible assets. The main idea is that manufacturing (traditional) firms operating with a higher fraction of tangible capital invest more intensively. In contrast, hi-tech and service-oriented firms allocate their resources mostly to intangible capital, and their physical investment is low. The structure of productive capital is associated with the type of products. Manufacturing firms produce mostly capital-intensive final products, such as machinery or equipment, whereas "new economy" firms provide services and produce more intangible products, such as software or consumer electronics.

Over the last few decades, the U.S. economy has experienced a large structural transformation. In the early periods, capital-intensive firms prevailed in the economy. Their productive capital structures were heavily tilted towards physical assets, and their investment rates were high. The output was mainly produced from tangible capital. In the later periods, however, the importance of physical assets and investment has substantially declined. Research-intensive firms have emerged, and production technologies and product markets have dramatically changed. The "new economy" firms produce newer products that do not rely heavily on tangible capital. Even for traditional firms, the production does not rely on tangible capital as much as it did in the past. In fact, most manufacturing firms are now engaged in research and new product development. This transition is accompanied by a fundamental shift in the nature of investment from tangible

[9] We assume that all assets are "quasi-productive". This approach allows us to measure the share of tangible capital in the *total* asset structure. Scaling by total assets is justified because tangible capital can be substituted not only by intangible capital but also by cash reserves and inventories. Bates et al. (2009) show that U.S. firms hold vast cash reserves. Kashyap et al. (1994) refer to the importance of inventory holdings. Moreover, some firms do not report their R&D, and their intangible capital is underestimated by the accounting data.

to knowledge-based capital. In addition, U.S. firms hoard liquidity (cash) reserves, well above the historical average, and depress capital investment (Bates et al., 2009; Pinkowitz et al., 2012).[10] Other developed economies have experienced somewhat similar changes in production technologies, product markets and capital structures.

We hypothesize that ICFS reflects this long-lasting transition in the U.S. economic structure and that in other developed economies. We identify the effect of asset tangibility on investment and highlight its importance in predicting ICFS, sidestepping the wedge between the cost of internal and external funds.

H1: Declining asset tangibility and falling investment contribute to the decline in ICFS in developed economies.

Developing economies are structurally different. Their productive capital structures are more tangible because their firms operate with more tangible capital. Capital investment rates are generally higher. Over time, their levels of tangible capital stock also tend to decline due to productivity enhancement induced by R&D and new product markets but at a slower pace. Therefore, our second hypothesis is as follows:

H2: Higher asset tangibility and more stable investment support ICFS in developing economies.

The second channel is based on the notion that cash flow explains investment because it predicts future cash flow and because investment is made in pursuit of future income. High predictability of cash flow causes firms to invest more for future income growth (Riddick and Whited, 2009). Tangible and intangible capital are conceived as inputs in production and contribute to the future cash flow of the firm. The uncertainty associated with intangible capital is higher than that of physical capital; thus, intangible capital is expensed and written off from the firm's balance sheet. Because intangible capital has become an important component of production and the "new economy" environment in which firms operate is more competitive and complicated (Hansen, et al., 2005), cash flow has become less predictable over time. Because there is less information in the current cash flow regarding future cash flow, investment becomes less dependent on the current cash flow.

We hypothesize that ICFS reflects changes in cash flow persistence. Over time, the declining share of tangible capital attenuates the persistence of cash flow and contributes to the decline in ICFS in advanced economies. In contrast, more tangible asset structures improve the predictability of cash flow and support ICFS in developing economies. Therefore, our third and fourth testable hypotheses are as follows:

H3: Declining asset tangibility contributes to the decline in information content of cash flow in developed economies.

H4: Higher asset tangibility contributes to stable information content of cash flow in developing economies.

Under the proposed identification, asset tangibility affects the investment rate and the information content in cash flow. Investment varies with tangible capital because the share of tangible capital in total productive capital contains information about its marginal productivity. Investment varies with cash flow because cash flow provides information about marginal q with respect to capital productivity. As we confirm below, only high tangible capital firms have cash flow that explains investment beyond its simple correlation with q.

[10] According to the World Bank, at the macro level, the ratio of gross fixed capital formation to GDP in OECD countries has fallen from nearly 25% in the early 1970s to 22% in the early 2000s and 19% in 2013.

3.2. Research design

The implications of our hypotheses are formalized in the following model specifications:

$$I_{i,t} = \alpha_{c,j,t} + \beta_0 + \beta_1 q_{i,t-1} + \beta_2 \Psi_{i,t} + \varepsilon_{i,t} \tag{2}$$

$$\begin{aligned} I_{i,t} = \; & \alpha_{c,j,t} + \beta_0 + \beta_1 q_{i,t-1} + \beta_2 \Psi_{i,t} + \beta_3 \Psi_{i,t} Z_{i,t-1} \\ & + \beta_4 Z_{i,t-1} + \beta_5 I_{i,t-1} + \beta_6 X_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{3}$$

$$\begin{aligned} I_{i,t} = \; & \alpha_{c,j,t} + \beta_0 + \beta_1 q_{i,t-1} + \beta_2 q_{i,t-1} Z_{i,t-1} + \beta_3 \Psi_{i,t} \\ & + \beta_4 \Psi_{i,t} Z_{i,t-1} + \beta_5 I_{i,t-1} + \beta_6 I_{i,t-1} Z_{i,t-1} + \beta_7 X_{i,t} \\ & + \beta_8 X_{i,t} Z_{i,t-1} + \beta_9 Z_{i,t-1} + \varepsilon_{i,t} \end{aligned} \tag{4}$$

Model (2) corresponds to the standard ICFS in Fazzari et al. (1988), whereas Model (3) corresponds to a dynamic investment model with the cross-product term of cash flow and tangible capital and with alternative sources of financing.[11] To control for potential omitted variable bias, Model (4) additionally includes the cross-product term between tangible capital and all explanatory variables. We estimate regressions of these forms, where the ratio of a firm's physical investment to the beginning-of-period total assets is denoted by $I_{i,\,t}$. The ratio of a firm's cash flow to the beginning-of-period total assets is denoted by $\Psi_{i,\,t}$. The variable $Z_{i,t-1}$ is the share of tangible capital assets in total assets at the end of year *t* – *1*. This variable measures the extent to which a firm relies on tangible capital in production. Its interaction with cash flow serves to test our hypotheses and identifies the effect of tangibility on ICFS. The variable $I_{i,t-1}$ is the lagged investment. The variable $q_{i,t-1}$ is the market-to-book ratio at the end of year *t* – *1*. $X_{i,\,t}$ is a vector of non-cash flow sources of financing, such as the contemporaneous change in total debt, net equity issue, and cash reserves at the end of year *t* – *1*. $\alpha_{c,\,j,\,t}$ represents country, industry and time fixed-effects, respectively.

ICFS is obtained from the expression for $\frac{\partial I_{i,t}}{\partial \Psi_{i,t}}$. The investment–cash flow–tangible capital sensitivity is obtained from the expression for $\frac{\partial I_{i,t}}{\partial \Psi_{i,t} Z_{i,t-1}}$. Insignificant (significant) ICFS (investment–cash flow–tangible capital sensitivity) would indicate that tangible capital predicts investment. Under H_1, we expect to document declining investment–cash flow–tangible capital sensitivity for economically developed countries. The sum of ICFS and investment–cash flow–tangible capital sensitivity should also decline over time.[12] Under H_2, we expect to observe non-declining investment–cash flow–tangible capital sensitivity for economically developing countries. The sum of ICFS and investment–cash flow–tangible capital sensitivity should also remain stable over time.

We estimate the autoregression model of cash flow and the autoregression model of the combination of cash flow and tangible capital. This estimation examines the role of asset tangibility in explaining cash flow persistence.

$$\Psi_{i,t} = \alpha_{c,j,t} + \theta_0 + \theta_1 \Psi_{i,t-1} + \mu_{i,t} \tag{5}$$

$$\Psi_{i,t} Z_{i,t-1} = \alpha_{c,j,t} + \theta_0 + \theta_1 \Psi_{i,t-1} Z_{i,t-2} + \eta_{i,t} \tag{6}$$

[11] Fazzari et al. (1988) scale their regression variables by physical assets, while we scale our variables by total assets.

[12] Controlling for the tangibility of asset base, ICFS summarizes the portion of the relation between investment and cash flow that is not explained by the tangibility. Under our hypotheses, it is still possible that ICFS is statistically significant but not economically. Similarly, the decline in ICFS is not *solely* due to a decline in asset tangibility. It is also due to a decline in investment that is not explained by the tangibility. ICFS can decline over time, even after controlling for asset tangibility, but the rate of decline should be either statistically or economically insignificant.

As documented in Chen and Chen (2012), the autoregressive coefficient of cash flow and the explanatory power of Model (5) have declined over time. Under H_3 and H_4, the autoregressive coefficient θ_1 and its predictive power are expected to decline for advanced economy firms and to remain stable for developing economy firms. More importantly, if our hypotheses are correct, the persistence of the cross-product term (θ_1 in Model 6) should be significantly stronger than the persistence of standalone cash flow (θ_1 in Model 5). In other words, the degree of asset tangibility should have a pervasive impact on cash flow predictability.

3.3. Data and variable definitions

We focus on manufacturing firms (SIC codes from 2000 to 3990) from the Worldscope files over the 1993–2013 period. We estimate the investment regressions over consecutive seven-year periods (1993–1999, 2000–2006, and 2007–2013) and track how the estimated coefficients develop over time.

To mitigate the effects of outliers, we require firms to have total assets, physical assets and market capitalization of at least US$1 million. We also require firms to have at least three non-missing firm-year observations over the sample period. Moreover, we drop observations for years in which net income exceeds market capitalization. Unlike U.S.-based studies of ICFS, we do not exclude observations with sales (asset) growth rates greater than 100%, given the large proportion of young and fast-growing firms in our international sample. We consider sample firms with *strictly* positive cash flow. The rationale for examining profitable firms is to control for the distortionary effect of negative cash flow on ICFS (Allayannis and Mozumdar, 2004). In doing so, we rule out the possibility that the decline in ICFS is simply driven by an increase in the number of firm-years with negative income. Finally, all regression variables are trimmed at the 1% level.

For the purpose of our study, we divide firms into three subsamples: (i) U.S. firms, (ii) firms from 21 non-U.S. developed economies, and (iii) firms from 19 developing economies. The level of a country's economic and financial development is defined according to the Morgan Stanley Composite Index (MSCI) market classification.[13] This classification scheme should reflect the cross-country differences in the productive capital structures.

We also construct a semi-balanced panel sample of firms. The sample consists of firms that exist through the entire sample period. The number of firm-years in regressions may change over time because several important variables (not firms) are missing in some parts of the sample. Through this sample, we show how firm characteristics change over time, even for the same set of firms. Unfortunately, we cannot construct a strictly balanced panel because this restriction would dramatically reduce the number of firm-years, particularly for non-U.S. firms.

We measure (physical) investment as capital expenditures (WC04601). Cash flow is the sum of the income before extraordinary items (WC01551) and depreciation (WC01151). Both variables are scaled by the beginning-of-period total assets (WC02999). Tangible (physical) assets are defined as net property, plant, and equipment (WC02501). Tobin's q is the ratio of the market value of equity (WC08001) minus the book value of equity (WC03501) plus total assets to total assets. Non-cash flow sources of financing include the change in total debt (ΔWC03255), net equity issue (total equity issued, WC04251 minus common and preferred redeemed, WC04751), and cash reserves (WC02001).

[13] See http://www.msci.com/products/indices/market_classification.html. The MSCI classification is similar to the Dow Jones and the Standard and Poor's classifications.

3.4. Methodology

To ensure that our results are not driven by a few countries with the highest numbers of observations, our regression results from Models (2)–(6) are based on weighted least squares (WLS). The technique weighs each country equally such that firm-year observations receive more (less) weight in countries with fewer (more) firm-years. The standard errors are robust and clustered at the country level.

The problem is that the WLS estimates are likely to be biased. Because there is a positive correlation between mismeasured q and the cash flow regressor, the attenuation bias causes the coefficient on q to be biased downward and the coefficient on cash flow to be biased upward. To mitigate the measurement problem, we estimate the investment Models (2)–(4) by linear errors-in-variables regression with identification from high-order cumulant estimators. In this respect, we follow the recent work by Erickson et al., (2014), who developed the q measurement error remedy that is asymptotically equivalent to the moment estimators in Erickson and Whited (2000, 2002). The cumulant estimators are an advance beyond the moment estimators. Overidentified moment estimators require a numerical minimization procedure, but cumulants are linear and have a closed-form solution. Thus, using moments adds a level of complexity that is absent from high-order cumulants.[14] The goodness-of-fit measure of the regression, R^2 (*Rho*), and the R^2 of the measurement equation (*Tau*), which is an index of measurement quality, are also reported.

4. Descriptive statistics

Table 1 reports the descriptive statistics. Panel A reports the sample means and medians by country for the key variables used in this paper. The average fraction of tangible assets in total assets is 0.25 for U.S. firms, 0.31 for firms from other developed economies, and 0.41 for firms from developing economies. The average fraction of tangible assets in total productive assets, which is the sum of tangible and intangible assets, is 0.62 for U.S. firms, 0.76 for firms from other developed economies, and 0.92 for firms from developing economies.[15] Firms from advanced economies have asset structures which are less tilted to physical assets. Tobin's q varies across countries and is generally higher in the U.S. and other developed economies.

Panel B reports the sample means and medians by period for the full sample. The average fraction of tangible assets in total assets (in total productive assets) declined from 0.29 (0.69) in 1993–1999 to 0.21 (0.57) in 2007–2013 for U.S. firms, from 0.33 (0.90) to 0.28 (0.77) for firms from other developed economies, and from 0.42 (0.97) to 0.35 (0.91) for firms from developing economies. Although the rates of decline of the first ratio are similar for firms from non-U.S. developed economies and from developing economies, the latter firms still operate with much more tangible capital. Investment as a fraction of total assets declined from 0.07 to 0.04 for advanced economy firms and slightly declined from 0.08 to 0.07 for developing economy firms. The latter firms have higher rates of investment.

[14] The order number is an empirical choice. The minimum value is 3, which corresponds to a precisely identified Geary (1942) estimator. We use a starting value of 4. As a general rule, we aim to select the order that returns the highest possible magnitude of the q coefficient. Thus, we use order values ranging from 4 to 8.

[15] This measure is not perfect. Some firms do not report their R&D costs. Some firms do not capitalise their costs, and therefore, their intangible assets are underestimated by the accounting data. Still, the size of intangible assets provides useful information. If economic benefit is expected to flow to the entity as a result of incurring R&D costs, then these costs are treated as an asset rather than an expense (IAS, U.S. GAAP, U.K. GAAP).

Table 1
Descriptive statistics. The table reports the country-level means and medians for the key variables used in Models (2)–(6): physical investment ($I_{i,\,t}$), cash flow ($\Psi_{i,\,t}$), Tobin's measure ($q_{i,t-1}$), and beginning-of-period tangible capital ($Z_{i,t-1}$). The table also reports the ratio of tangible capital to the sum of tangible capital and intangible capital ($\Upsilon_{i,\,t}$). Investment, cash flow and tangible capital are deflated by the beginning-of-period total assets. The symbols correspond to the notation used in Models (2)–(6). US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. N is the number of firm-years.

Panel A. Cross-country statistics

			$I_{i,\,t}$		$\Psi_{i,\,t}$		$q_{i,t-1}$		$Z_{i,t-1}$		$\Upsilon_{i,\,t}$	
Country	Market	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
UNITED STATES	US	20,905	0.05	0.04	0.11	0.10	1.73	1.43	0.25	0.22	0.62	0.65
AUSTRALIA	DME	1651	0.05	0.04	0.11	0.10	1.45	1.26	0.31	0.31	0.68	0.76
AUSTRIA	DME	785	0.07	0.06	0.10	0.10	1.23	1.14	0.34	0.36	0.84	0.92
BELGIUM	DME	674	0.07	0.05	0.11	0.10	1.41	1.16	0.28	0.26	0.73	0.82
CANADA	DME	2298	0.06	0.04	0.11	0.10	1.47	1.22	0.35	0.33	0.72	0.84
DENMARK	DME	1049	0.07	0.05	0.11	0.10	1.41	1.18	0.34	0.33	0.83	0.97
FINLAND	DME	1114	0.07	0.05	0.12	0.10	1.50	1.25	0.32	0.31	0.73	0.82
FRANCE	DME	4311	0.05	0.04	0.10	0.09	1.38	1.17	0.21	0.19	0.66	0.72
GERMANY	DME	4752	0.07	0.05	0.11	0.10	1.40	1.23	0.28	0.27	0.77	0.86
HONG KONG	DME	3322	0.06	0.04	0.11	0.10	1.19	0.98	0.30	0.28	0.89	0.99
IRELAND	DME	460	0.05	0.04	0.11	0.11	1.68	1.50	0.31	0.32	0.60	0.63
ISRAEL	DME	1054	0.04	0.03	0.10	0.08	1.36	1.14	0.24	0.22	0.77	0.88
ITALY	DME	1621	0.05	0.04	0.08	0.07	1.28	1.11	0.25	0.24	0.71	0.79
JAPAN	DME	22,317	0.04	0.03	0.07	0.06	1.10	1.00	0.32	0.31	0.95	0.98
NETHERLANDS	DME	1223	0.06	0.05	0.11	0.11	1.54	1.29	0.30	0.31	0.74	0.91
NEW ZEALAND	DME	231	0.06	0.05	0.11	0.10	1.51	1.27	0.38	0.36	0.78	0.93
NORWAY	DME	709	0.07	0.05	0.11	0.10	1.49	1.25	0.30	0.29	0.71	0.78
SINGAPORE	DME	2518	0.06	0.04	0.11	0.09	1.26	1.07	0.32	0.31	0.92	0.99
SPAIN	DME	849	0.06	0.05	0.11	0.10	1.38	1.18	0.38	0.39	0.82	0.94
SWEDEN	DME	1755	0.05	0.04	0.12	0.11	1.57	1.32	0.26	0.24	0.63	0.70
SWITZERLAND	DME	1832	0.05	0.04	0.11	0.10	1.59	1.28	0.31	0.30	0.74	0.82
UNITED KINGDOM	DME	6074	0.06	0.05	0.12	0.11	1.64	1.42	0.30	0.29	0.74	0.92
All		60,599	0.06	0.04	0.11	0.10	1.42	1.21	0.31	0.30	0.76	0.86
ARGENTINA	EME	388	0.07	0.05	0.12	0.11	1.15	1.05	0.45	0.45	0.96	0.99
BRAZIL	EME	1506	0.07	0.05	0.11	0.10	1.16	0.99	0.39	0.39	0.93	1.00
CHILE	EME	945	0.06	0.05	0.11	0.09	1.32	1.12	0.45	0.46	0.91	0.97
CHINA	EME	11,408	0.08	0.06	0.09	0.07	1.99	1.66	0.32	0.30	0.87	0.91
GREECE	EME	584	0.05	0.03	0.07	0.06	1.17	1.01	0.42	0.42	0.91	0.98
INDIA	EME	8943	0.08	0.06	0.11	0.09	1.35	1.03	0.38	0.38	0.96	1.00
INDONESIA	EME	1521	0.07	0.04	0.11	0.09	1.27	1.02	0.41	0.40	0.97	1.00
MALAYSIA	EME	4328	0.05	0.04	0.10	0.08	1.17	0.94	0.41	0.40	0.94	1.00
MEXICO	EME	905	0.06	0.05	0.11	0.11	1.28	1.09	0.53	0.56	0.86	0.94
PAKISTAN	EME	1385	0.06	0.04	0.12	0.11	1.23	1.03	0.46	0.46	0.99	1.00
PERU	EME	468	0.06	0.04	0.12	0.11	1.20	0.97	0.45	0.44	0.93	0.99
PHILIPPINES	EME	459	0.06	0.04	0.10	0.09	1.18	0.99	0.40	0.38	0.91	0.98
POLAND	EME	971	0.07	0.05	0.11	0.09	1.29	1.06	0.42	0.42	0.88	0.96
PORTUGAL	EME	325	0.06	0.04	0.09	0.08	1.14	1.04	0.41	0.39	0.86	0.97
SOUTH AFRICA	EME	1143	0.07	0.06	0.13	0.12	1.41	1.26	0.35	0.34	0.84	0.98
SOUTH KOREA	EME	8467	0.07	0.05	0.09	0.08	1.02	0.91	0.37	0.36	0.93	0.98
TAIWAN	EME	10,241	0.06	0.04	0.10	0.09	1.37	1.17	0.34	0.33	0.96	0.99
THAILAND	EME	2648	0.07	0.05	0.12	0.11	1.18	1.03	0.42	0.42	0.97	1.00
TURKEY	EME	1382	0.06	0.04	0.12	0.10	1.39	1.16	0.35	0.36	0.92	0.99
All		58,017	0.06	0.05	0.11	0.09	1.28	1.08	0.41	0.40	0.92	0.98

Panel B. Time-series statistics (full sample)

			$I_{i,\,t}$		$\Psi_{i,\,t}$		$q_{i,t-1}$		$Z_{i,t-1}$		$\Upsilon_{i,\,t}$	
Period	Market	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1993–1999	US	7295	0.07	0.06	0.12	0.12	1.77	1.47	0.29	0.26	0.69	0.74
2000–2006	US	7634	0.05	0.03	0.11	0.09	1.73	1.40	0.25	0.21	0.61	0.63
2007–2013	US	5976	0.04	0.03	0.11	0.10	1.67	1.42	0.21	0.17	0.57	0.57
1993–1999	DME	14,420	0.07	0.05	0.10	0.09	1.44	1.25	0.33	0.31	0.90	0.98
2000–2006	DME	22,310	0.05	0.04	0.09	0.08	1.31	1.10	0.31	0.31	0.83	0.96
2007–2013	DME	23,869	0.04	0.03	0.09	0.08	1.24	1.06	0.28	0.26	0.77	0.92
1993–1999	EME	5207	0.08	0.06	0.11	0.09	1.44	1.17	0.42	0.42	0.97	1.00
2000–2006	EME	16,862	0.07	0.05	0.11	0.09	1.29	1.07	0.40	0.39	0.95	0.99
2007–2013	EME	35,948	0.07	0.05	0.10	0.08	1.43	1.12	0.35	0.34	0.91	0.98

Panel C. Time-series statistics (semi-balanced panel)

			$I_{i,\,t}$		$\Psi_{i,\,t}$		$q_{i,t-1}$		$Z_{i,t-1}$		$\Upsilon_{i,\,t}$	
Period	Market	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1993–1999	US	3018	0.07	0.06	0.13	0.13	1.87	1.57	0.30	0.27	0.70	0.74
2000–2006	US	3273	0.05	0.04	0.11	0.10	1.76	1.48	0.26	0.23	0.60	0.62
2007–2013	US	3100	0.04	0.03	0.11	0.10	1.64	1.44	0.22	0.19	0.56	0.55
1993–1999	DME	7351	0.06	0.05	0.09	0.08	1.42	1.25	0.32	0.31	0.91	0.99
2000–2006	DME	11,267	0.05	0.04	0.08	0.07	1.22	1.06	0.32	0.32	0.87	0.97
2007–2013	DME	11,566	0.04	0.03	0.08	0.07	1.19	1.04	0.29	0.29	0.81	0.94
1993–1999	EME	2731	0.08	0.06	0.11	0.10	1.45	1.16	0.43	0.43	0.97	1.00
2000–2006	EME	3498	0.06	0.04	0.11	0.10	1.20	0.99	0.44	0.44	0.95	1.00
2007–2013	EME	3614	0.06	0.04	0.11	0.09	1.35	1.09	0.39	0.39	0.92	0.98

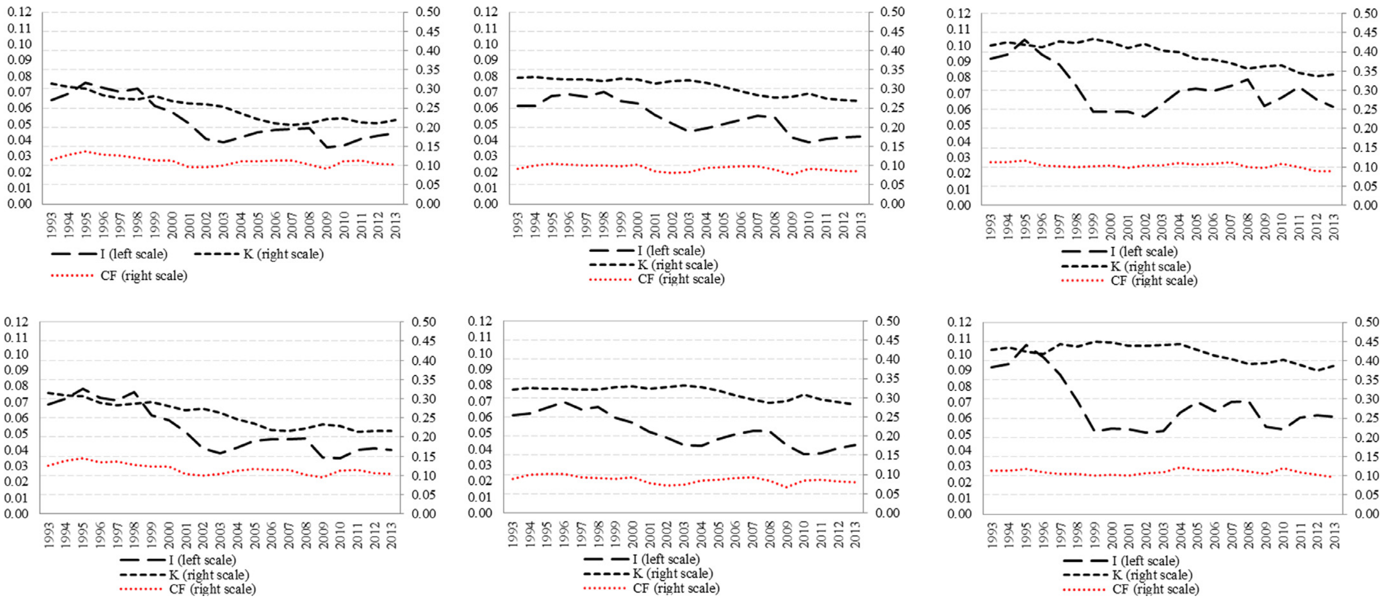

Fig. 1. Descriptive statistics (1). The figures plot physical investment, I ($I_{i,\,t}$) (long dash line), cash flow, CF ($\Psi_{i,\,t}$) (round dot line), and beginning-of-period tangible capital, K ($Z_{i,t-1}$) (square dot line). The variables are deflated by the beginning-of-period total assets. The left figures correspond to the U.S. full sample (upper) and semi-balanced panel (lower), respectively. The middle figures correspond to non-U.S. developed economies. The right figures correspond to developing economies.

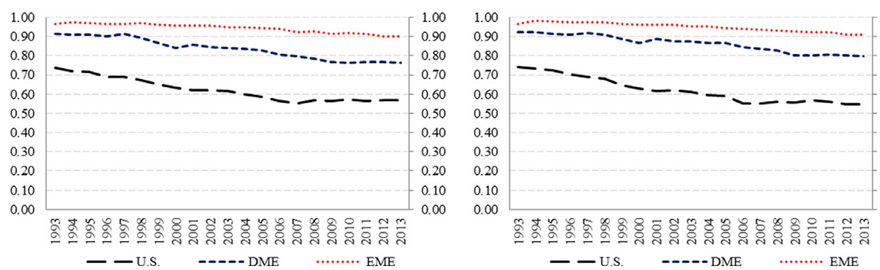

Fig. 2. Descriptive statistics (2). The figures plot the ratio of tangible capital to the sum of tangible capital and intangible capital ($\Upsilon_{i,\,t}$). The long dash line corresponds to the U.S. economy; square dot line – to non-U.S. developed economies (DME); round dot line – to developing economies (EME). The left figure corresponds to the full sample; the right figure – to semi-balanced panel.

Panel C contains the sample means and medians for the semi-balanced panel. Tangible capital and investment fell sharply in the U.S. The rate of investment also plunged in other economies, although at different paces, and with a more stable share of tangible assets. Although the firms in the restricted sample are the same, their characteristics have changed, and in particular, their asset structures and investment rates have changed. It is these changes, rather than the composition of the firms in the sample, that matter for the sensitivity of investment to cash flow.

The reported statistics are built based on seven-year subsample periods. The problem, however, is that we have only three periods. Using an alternative sampling approach, we report summary statistics for the key variables for each year in Figs. 1 and 2. The average fraction of tangible assets in total assets (in total productive assets) declined from 0.31 (0.74) in 1993 to 0.22 (0.57) in 2013 for U.S. firms, from 0.33 (0.91) to 0.27 (0.76) for other developed economy firms, and from 0.42 (0.96) to 0.35 (0.90) for developing economy firms. The physical investment as a fraction of total assets fell by two-fifths of its value for U.S. firms, by over a third for firms from other developed economies, and between a quarter and a third for firms from developing economies. The summary statistics indicate a global change in the productive capital structure, with a sharp fall in investment and tangible capital in the subsample of U.S. firms. It is therefore natural to expect a steady decline in ICFS in the U.S and other advanced economies (to a lesser degree) and a modest decline in ICFS in less developed economies.

5. Investment–cash flow sensitivity and asset tangibility

5.1. Baseline results

We report the WLS results returned from investment Models (2) and (3) in Panel A and Panel B of Table 2, respectively. The estimated coefficients on Tobin's q in all regressions are insignificant, at approximately 0.01, in sharp contrast to the theoretical value of 1 under the q theory model with constant returns to scale and no adjustment costs. Clearly, the empirical result is driven by the measurement error in q, which we address later in this study.

For investment Model (2), ICFS has dramatically declined in the U.S. In particular, the magnitude and statistical significance have declined from 0.25 (t = 14.5) in the first seven-year period to 0.11 (t = 7.96) in the last period. Similarly, ICFS has steadily declined in the subsample of non-U.S. advanced economies. Both the magnitude and significance have decreased from 0.34 (t = 12.2) in the first period to 0.14 (t = 7.28) in the final reporting period. Consistent with the literature, a strong response of investment to cash flow is evident only in the early parts of the sample. In contrast, ICFS is stable in the subsample of developing economies. We docu-

Table 2
Investment regressions The table reports coefficients estimated from the WLS regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). Cash flow has its cross-product term with tangible capital. The model specifications in Panel A and Panel B correspond to Models (2) and (3), respectively. US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Panel A. Investment Model (2)

Period	Market	$\Psi_{i,\,t}$	(t-stat)	$q_{i,t-1}$	(t-stat)	R^2	N
1993–99	US	0.25	(14.52)	0.00	(1.58)	16.1%	7295
2000–06	US	0.16	(12.59)	0.01	(6.75)	16.4%	7634
2007–13	US	0.11	(7.96)	0.00	(2.55)	10.7%	5976
1993–99	DME	0.34	(12.21)	0.00	(0.75)	18.1%	14,420
2000–06	DME	0.28	(12.21)	0.00	(0.39)	18.8%	22,310
2007–13	DME	0.14	(7.28)	0.00	(2.53)	14.9%	23,869
1993–99	EME	0.22	(6.51)	0.02	(3.94)	18.0%	5207
2000–06	EME	0.24	(11.70)	0.00	(0.89)	12.8%	16,862
2007–13	EME	0.21	(7.89)	0.01	(3.22)	13.5%	35,948

Panel B. Investment Model (3)

Period	Market	$\Psi_{i,\,t}$	(t-stat)	$(\Psi_{i,t} * Z_{i,t-1})$	(t-stat)	$I_{i,t-1}$	(t-stat)	$\Delta D_{i,\,t}$	(t-stat)	$E_{i,\,t}$	(t-stat)	$C_{i,t-1}$	(t-stat)	$q_{i,t-1}$	(t-stat)	R^2	$\Psi_{i,t} + (\Psi_{i,t} * Z_{i,t-1})$	(t-stat)
1993–99	US	0.02	(1.23)	0.55	(8.14)	0.41	(25.69)	0.09	(13.22)	0.05	(6.40)	0.02	(3.58)	0.00	(1.62)	48.8%	0.57	(10.78)
2000–06	US	0.01	(1.05)	0.40	(8.65)	0.41	(18.49)	0.06	(11.43)	0.05	(5.61)	0.00	(1.28)	0.00	(5.05)	47.5%	0.41	(10.68)
2007–13	US	0.02	(1.25)	0.24	(3.33)	0.44	(17.52)	0.05	(7.72)	0.04	(3.63)	0.01	(3.49)	0.00	(2.86)	45.1%	0.26	(4.22)
1993–99	DME	0.08	(2.80)	0.47	(7.63)	0.32	(12.54)	0.14	(7.05)	0.04	(2.47)	0.02	(2.90)	0.00	(0.41)	41.3%	0.55	(12.26)
2000–06	DME	0.05	(2.59)	0.46	(7.52)	0.35	(23.23)	0.11	(10.56)	0.03	(2.82)	0.01	(1.84)	0.00	(−0.16)	45.5%	0.51	(11.07)
2007–13	DME	−0.01	(−0.55)	0.43	(8.76)	0.39	(21.09)	0.09	(9.60)	0.04	(2.86)	0.01	(3.26)	0.00	(3.13)	45.7%	0.42	(9.53)
1993–99	EME	0.05	(0.96)	0.32	(2.62)	0.30	(12.83)	0.20	(13.83)	0.10	(3.82)	0.06	(4.02)	0.01	(3.20)	43.5%	0.36	(4.30)
2000–06	EME	0.07	(3.33)	0.29	(5.62)	0.35	(15.88)	0.18	(15.31)	0.11	(3.67)	0.01	(1.76)	0.00	(−0.80)	40.3%	0.37	(10.12)
2007–13	EME	0.01	(0.40)	0.42	(7.69)	0.37	(16.19)	0.17	(12.47)	0.08	(4.55)	0.02	(4.23)	0.00	(1.89)	44.5%	0.42	(9.42)

Note: For brevity, the coefficient estimates on tangible capital ($Z_{i,t-1}$) are not tabulated.

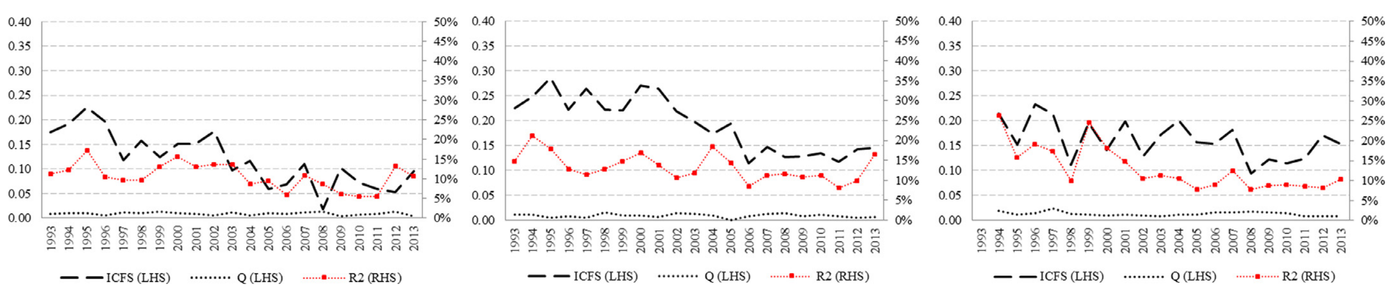

Fig. 3. Investment regressions by year. The figures plot coefficients estimated from the WLS regression of investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$) and Tobin's measure ($q_{i,t-1}$) from Model (2). The left figure corresponds to the U.S. economy. The middle figure corresponds to non-U.S. developed economies. The right figure corresponds to developing economies. One data point in 1993 for developing economy firms is missing due to the lack of sufficient observations. The R^2 is the adjusted R^2.

ment a magnitude of 0.22 (t = 6.51) in the first period and a magnitude of 0.21 (t = 7.89) in the last period.

Above, we divide the sample into seven-year periods, estimating the ICFS for each period. The disadvantage of such grouping is that with only three periods, we lack a more detailed picture of the time-series variation of ICFS. An alternative approach relies on cross-sectional estimations for each year. For this purpose, we first demean all variables by firm to remove fixed effects for the entire period and then estimate a cross-sectional regression of investment on cash flow and q for each year. We also include country and industry effects. The results are plotted in Fig. 3. Again, we observe a strong decline in ICFS for U.S. firms. In 1993, ICFS is nearly 0.2. In 2013, the figure is below 0.1. From 2005 onward, the sensitivity is never greater than 0.1. We also observe a declining ICFS for firms from non-U.S. advanced economies. ICFS is approximately 0.25 and below 0.15 in the early and later sample years, respectively. There is no clear pattern for firms from developing economies. ICFS varies between 0.1 and 0.25, although it is more stable in the earlier years. The only significant drop in ICFS occurred in 2008. The goodness-of-fit of the investment regressions follow the significance of ICFS. The q–investment sensitivity continues to be insignificant. This finding on the global downward trajectory is interesting *per se* because we document that ICFS has fallen beyond the U.S., although at different paces.

For investment Model (3) with the added cross-product term of cash flow and tangible capital, we observe two important results. First, ICFS is indistinguishable from zero, even for the early periods, after controlling for the cross-product term. ICFS is statistically significant in some estimations, but it is economically low (below 0.1). However, the cross-product term itself is significantly positive and economically meaningful in each of the periods. This result implies that ICFS is driven, to a very large extent, by the effect of asset tangibility. ICFS is in fact the *investment–cash flow–tangible capital sensitivity* because the investment of a firm with low tangible capital assets is not systematically sensitive to cash flow. Only firms with high tangible capital have cash flow that explains investment. They invest more when they have marginal cash flow, displaying a higher ICFS.

Second, over time, the sum of ICFS and investment–cash flow–tangible capital sensitivity declines from 0.57 (t = 10.8) to

Table 3
Investment regressions: alternative sources of financing. The table reports coefficients estimated from the WLS regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). Each explanatory variable has its cross-product term with tangible capital. The model specification corresponds to Model (4). US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Period	Market	$\Psi_{i,\,t}$	$(\Psi_{i,t} * Z_{i,t-1})$	$I_{i,t-1}$	$(\Delta D_{i,t} * Z_{i,t-1})$	$(E_{i,t} * Z_{i,t-1})$	$(C_{i,t-1} * Z_{i,t-1})$	$q_{i,t-1}$	R^2	N	$\Psi_{i,t} + (\Psi_{i,t} * Z_{i,t-1})$
1993–99	US	0.03	0.52	0.42	0.22	0.16	0.20	0.00	49.8%	7295	0.55
		(1.40)	(7.10)	(12.57)	(4.53)	(2.44)	(5.50)	(1.55)			(9.56)
2000–06	US	0.02	0.36	0.40	0.25	0.15	0.08	0.00	48.8%	7634	0.38
		(1.82)	(7.40)	(10.24)	(7.18)	(2.45)	(2.64)	(2.62)			(9.20)
2007–13	US	0.03	0.19	0.49	0.23	0.09	0.17	0.00	47.0%	5976	0.22
		(2.01)	(2.58)	(10.61)	(4.94)	(1.16)	(5.13)	(−0.38)			(3.49)
1993–99	DME	0.09	0.45	0.41	0.23	0.11	0.15	0.00	42.2%	14,420	0.54
		(2.48)	(5.07)	(8.40)	(3.14)	(1.33)	(2.81)	(0.19)			(8.37)
2000–06	DME	0.06	0.43	0.40	0.29	0.09	0.10	0.00	46.7%	22,310	0.49
		(3.31)	(7.00)	(8.66)	(4.57)	(1.34)	(3.18)	(−0.89)			(10.23)
2007–13	DME	0.01	0.34	0.42	0.34	0.19	0.13	0.00	47.6%	23,869	0.35
		(1.05)	(6.69)	(8.89)	(9.81)	(2.88)	(4.18)	(0.54)			(7.83)
1993–99	EME	0.10	0.18	0.39	0.41	0.29	0.22	0.00	45.8%	5207	0.27
		(1.99)	(1.79)	(8.13)	(5.36)	(2.99)	(3.73)	(−0.55)			(3.27)
2000–06	EME	0.09	0.25	0.40	0.32	0.17	0.10	0.00	41.4%	16,862	0.34
		(3.64)	(3.97)	(9.29)	(6.22)	(1.69)	(2.70)	(−1.33)			(7.83)
2007–13	EME	0.02	0.38	0.45	0.36	0.13	0.16	0.00	46.0%	35,948	0.40
		(1.07)	(6.26)	(13.69)	(6.30)	(1.97)	(7.10)	(0.77)			(8.06)

Note: For brevity, the table reports the main variables of interest.

0.26 (t = 4.22) in the U.S. and from 0.55 (t = 12.3) to 0.42 (t = 9.53) in non-U.S. developed economies. Individually, investment–cash flow–tangible capital sensitivity also declines in developed economies. This monotonic pattern supports H_1. The aggregate cash flow sensitivity is stable in developing economies. The value stands at 0.36 (t = 4.30) in the first period and at 0.42 (t = 9.42) in the last period. Investment–cash flow–tangible capital sensitivity is also non-declining. This pattern supports H_2. Overall, our results show that the declining ICFS documented in prior studies simply reflects the fact that the effect of asset tangibility on ICFS weakens over time.[16]

5.2. Alternative sources of financing

Alternative (non-cash flow) sources of financing may affect both investment and cash flow sensitivities. Bates et al., (2009) find that the average cash-to-assets ratio of U.S. industrial firms has doubled from 1980 to 2006. Thus, it is possible that firms finance their investment from their cash holdings rather than from cash flow. In this case, a higher level of cash holdings as internal funds will attenuate ICFS. Omission of the cash holdings in the model specification would bias the estimated coefficient of tangible capital. It is also possible that internal cash flow has become a less important source of financing compared with equity and debt financing.

Investment Model (4) controls for cash reserves, net equity issues, and the contemporaneous change in debt. The model further includes the cross-product term of tangible capital with each source of financing, lagged investment and Tobin's *q*. We now examine how this addition affects the coefficients on cash flow. The results are presented in Table 3.

Before we examine the main results, we briefly discuss our findings on firm financing characteristics. Debt finance contributes to new investment, which is consistent with the notion of asset pledgeability. In particular, the cross-product term between tangible capital and the change in debt is significant across countries and stable over time. Our results further indicate that cash reserves and net equity issues are less important in predicting investment.

None of the alternative channels of financing can predict ICFS and investment–cash flow–tangible capital sensitivity. Specifically, even though the cross-product terms of the firm financing characteristics are added into the regression model, the coefficients of the cross-product term of cash flow and tangible capital are still positive and significant. The value continues to steadily decline over time for developed economy firms. Conversely, it is strengthening for less developed firms. ICFS is economically low or insignificant in most estimations. Therefore, we conclude that internal cash flow remains an important source of financing for capital-intensive firms and that changes in alternative sources of financing cannot explain why ICFS changes over time.

5.3. Investment-intensive, capital-intensive, and semi-balanced panel firms

We verify our results using subsamples of firms along several dimensions. First, we define investment-intensive firms by the size of their investment and estimate the cash flow sensitivities from a sample of firm-years for which actual investment is greater than depreciation (Table 4). One could argue that the connection between asset tangibility and investment is driven by a simple mechanical relation that dictates that investment ought to replace depreciating assets. Of course, the level of investment is set to maintain the productive assets, and to test the argument that firms spend above necessary investments, we need a measure of the minimum required investment. We use depreciation as a proxy for the required investment outlay and define *net* investment as the difference between actual investment and depreciation. After eliminating those firm-years for which physical capital deteriorates (i.e., with negative net investment), we find that firms from developed economies continue to experience a decline in the tangibility and in the scale of their investment. Thus, they tend to have sensitivities with the significance declining over time. For instance, the sum of the sensitivities falls from 0.57 (t = 7.46) to 0.32 (t = 3.67) in the U.S subsample. Individually, investment–cash

[16] In untabulated results, we document a substantial cross-country variation in ICFS. Over the sample period, ICFS ranges from 0.05 (Philippines) to 0.44 (Austria). The presence of the product term of cash flow and tangible capital in the investment regression reduces the magnitude and significance of ICFS (the average coefficient is only 0.03). In contrast to ICFS, the coefficient on the product term itself (the investment–cash flow–tangible capital sensitivity) is on average 0.45.

Table 4
Investment regressions: investment-intensive firms. The table reports coefficients estimated from the WLS regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). Each explanatory variable has its cross-product term with tangible capital. The model specification corresponds to Model (4). The sample is restricted to firm-years with positive *net* investment (the difference between investment and depreciation). US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Period	Market	$\Psi_{i,\,t}$	$(\Psi_{i,t} * Z_{i,t-1})$	$I_{i,t-1}$	$(\Delta D_{i,t} * Z_{i,t-1})$	$(E_{i,t} * Z_{i,t-1})$	$(C_{i,t-1} * Z_{i,t-1})$	$q_{i,t-1}$	R^2	N	$\Psi_{i,t} + (\Psi_{i,t} * Z_{i,t-1})$
1993–99	US	0.04	0.53	0.36	0.22	0.20	0.32	0.00	46.9%	4331	0.57
		(1.22)	(5.30)	(8.68)	(3.26)	(2.84)	(6.52)	(1.16)			(7.46)
2000–06	US	0.03	0.32	0.33	0.28	0.06	0.17	0.00	46.5%	2804	0.35
		(1.53)	(4.04)	(6.18)	(4.52)	(0.65)	(2.86)	(0.41)			(5.35)
2007–13	US	0.01	0.31	0.31	0.10	0.09	0.28	0.00	43.9%	2346	0.32
		(0.61)	(2.92)	(5.31)	(0.97)	(1.02)	(5.08)	(0.58)			(3.76)
1993–99	DME	0.08	0.54	0.42	0.23	0.10	0.15	0.00	42.8%	8944	0.62
		(1.62)	(4.46)	(6.71)	(2.63)	(0.80)	(1.90)	(1.15)			(6.86)
2000–06	DME	0.06	0.47	0.36	0.29	0.07	0.16	0.00	47.5%	10,295	0.53
		(1.51)	(3.57)	(6.24)	(2.91)	(0.68)	(3.36)	(−0.88)			(5.61)
2007–13	DME	0.03	0.33	0.30	0.24	0.18	0.23	0.00	44.5%	10,582	0.36
		(1.23)	(4.37)	(4.95)	(4.31)	(2.19)	(4.60)	(0.46)			(6.11)
1993–99	EME	0.10	0.36	0.33	0.58	0.31	0.18	0.00	47.1%	3614	0.46
		(1.27)	(2.26)	(4.88)	(4.51)	(2.61)	(2.21)	(−1.05)			(4.53)
2000–06	EME	0.10	0.37	0.39	0.37	0.04	0.10	−0.01	42.6%	9606	0.47
		(2.73)	(4.69)	(8.00)	(4.85)	(0.20)	(1.83)	(−1.90)			(9.24)
2007–13	EME	−0.01	0.50	0.35	0.42	0.12	0.21	0.00	44.9%	22,575	0.49
		(−0.29)	(5.68)	(8.80)	(5.87)	(1.57)	(6.35)	(1.33)			(7.18)

Note: For brevity, the table reports the main variables of interest.

Table 5
Investment regressions: capital-intensive firms. The table reports coefficients estimated from the WLS regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). The sample is restricted to firm-years in the top quarter of the asset tangibility distribution in each country and year. Asset tangibility is defined as the ratio of tangible assets to total assets. US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Period	Market	$\Psi_{i,\,t}$	$I_{i,t-1}$	$\Delta D_{i,\,t}$	$E_{i,\,t}$	$C_{i,t-1}$	$q_{i,t-1}$	R^2	N
1993–99	US	0.28	0.40	0.14	0.09	0.05	0.00	49.3%	1827
		(10.29)	(16.92)	(8.71)	(3.15)	(1.91)	(0.00)		
2000–06	US	0.20	0.39	0.12	0.05	0.02	0.00	46.1%	1911
		(9.54)	(11.37)	(8.98)	(1.91)	(1.02)	(1.20)		
2007–13	US	0.11	0.43	0.10	0.07	0.03	0.00	41.2%	1496
		(5.21)	(11.98)	(6.40)	(2.11)	(1.88)	(1.78)		
1993–99	DME	0.36	0.32	0.17	0.03	0.04	0.00	47.1%	3658
		(13.21)	(11.71)	(8.30)	(1.72)	(2.71)	(−2.21)		
2000–06	DME	0.31	0.33	0.19	0.09	0.01	0.00	49.8%	5639
		(11.41)	(18.69)	(8.93)	(2.71)	(0.32)	(0.75)		
2007–13	DME	0.21	0.38	0.19	0.11	0.03	0.00	50.8%	6024
		(8.09)	(20.62)	(7.36)	(3.92)	(1.81)	(2.04)		
1993–99	EME	0.27	0.24	0.31	0.21	0.09	0.01	51.0%	1348
		(6.24)	(12.16)	(12.45)	(5.80)	(2.14)	(4.10)		
2000–06	EME	0.31	0.30	0.29	0.10	0.05	0.00	53.2%	4261
		(10.74)	(26.20)	(12.48)	(2.24)	(1.69)	(−1.14)		
2007–13	EME	0.32	0.28	0.30	0.15	0.05	0.00	50.7%	9040
		(11.51)	(10.94)	(8.32)	(4.92)	(2.80)	(1.04)		

flow–tangible capital sensitivity drops from 0.53 (t = 5.30) to 0.31 (t = 2.92). A similar trend is observed for non-U.S. developed economies. In contrast, as investment-intensive firms from developing economies operate with more tangible capital, they tend to have non-declining sensitivities. As reported, their aggregate cash flow sensitivity stands at 0.46 (t = 4.53) in 1993–1999 and 0.49 (t = 7.18) in 2007–2013.

Second, we rank firms based on their share of tangible assets in total assets in each country and year and assign to the capital intensive group those firms in the top quarter of the asset tangibility distribution. The purpose of this test is to rule out the possibility that our main results are driven by firms with low physical capital. Because we select capital-intensive firms for this test, we drop the cross-product term of tangible capital with explanatory variables from our model. The estimation results are presented in Table 5. ICFS dramatically falls from 0.28 (t = 10.3) to 0.11 (t = 5.21) in the U.S subsample. ICFS weakens from 0.36 (t = 13.2) to 0.21 (t = 8.09) for firms from other advanced economies. No evidence of decline in the sensitivity of investment to cash flow is found for less developed economies. Over the sample period, their ICFS improves from 0.27 (t = 6.24) to 0.32 (t = 11.5).

Third, we construct a semi-balanced panel of firms that exist through the 1993–2013 period. The number of firm-years varies across periods because several regression variables are missing in some parts of the sample. The purpose of this test is to rule out the possibility that ICFS and its relation to asset tangibility is driven by the composition of the firms in the sample. Specifically, it is possible that more "new economy" firms enter the sample and "old economy" firms play a less essential role. In descriptive statistics, we report that even for the unchanged firms in the panel, the rate of investment and the degree of asset tangibility decline on average.

Table 6
Investment regressions: semi-balanced panel. The table reports coefficients estimated from the WLS regression of physical investment ($I_{i,t}$) on cash flow ($\Psi_{i,t}$), beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,t}$), new equity issue ($E_{i,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). Each explanatory variable has its cross-product term with tangible capital. The model specification corresponds to Model (4). The sample includes firms that exist through the entire sample period. US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Period	Market	$\Psi_{i,t}$	$(\Psi_{i,t}*Z_{i,t-1})$	$I_{i,t-1}$	$(\Delta D_{i,t}*Z_{i,t-1})$	$(E_{i,t}*Z_{i,t-1})$	$(C_{i,t-1}*Z_{i,t-1})$	$q_{i,t-1}$	R^2	N	$\Psi_{i,t}+(\Psi_{i,t}*Z_{i,t-1})$
1993–99	US	0.00	0.68	0.49	0.24	0.14	0.17	0.00	53.5%	3018	0.67
		(−0.15)	(5.96)	(8.64)	(3.18)	(1.31)	(2.93)	(1.20)			(7.48)
2000–06	US	0.02	0.38	0.46	0.27	0.20	0.07	0.00	57.7%	3273	0.40
		(1.29)	(5.07)	(6.76)	(5.04)	(2.85)	(1.58)	(0.93)			(6.48)
2007–13	US	−0.02	0.48	0.50	0.10	0.15	0.09	0.00	60.3%	3100	0.45
		(−1.27)	(5.24)	(10.88)	(2.02)	(2.05)	(2.41)	(−0.40)			(5.94)
1993–99	DME	0.09	0.44	0.28	0.24	−0.06	0.18	0.00	44.9%	7351	0.53
		(1.50)	(3.29)	(4.84)	(2.93)	(−0.66)	(1.97)	(0.02)			(5.90)
2000–06	DME	0.06	0.39	0.53	0.35	0.00	0.14	0.00	49.2%	11,267	0.45
		(2.39)	(3.41)	(8.08)	(2.40)	(−0.05)	(1.54)	(−0.21)			(4.67)
2007–13	DME	0.01	0.30	0.61	0.36	0.16	0.06	0.00	59.7%	11,566	0.31
		(0.24)	(2.40)	(11.72)	(3.25)	(1.54)	(1.19)	(−0.38)			(3.28)
1993–99	EME	−0.06	0.46	0.26	0.36	0.24	0.11	0.00	46.5%	2731	0.40
		(−0.69)	(2.65)	(3.12)	(3.13)	(1.32)	(1.11)	(0.64)			(3.57)
2000–06	EME	0.11	0.19	0.37	0.23	0.44	0.17	−0.01	46.3%	3498	0.30
		(2.73)	(1.75)	(4.27)	(2.41)	(5.42)	(3.58)	(−1.51)			(4.44)
2007–13	EME	−0.02	0.53	0.54	0.38	−0.34	0.21	0.00	55.4%	3614	0.51
		(−0.64)	(5.67)	(11.39)	(4.15)	(−2.20)	(4.53)	(0.28)			(6.89)

Note: For brevity, the table reports the main variables of interest.

Table 6 reports the regression results. In general, for firms that exist through the entire sample period, the patterns are similar to those reported in Table 2, but they also show some differences across periods. ICFS is still largely non-existent. The investment–cash flow–tangible capital sensitivity is strong. The value declines in the subsamples of U.S. firms and firms from other developed economies, although not monotonically for the U.S. firms. The result for the subsample of firms from developing economies is less distinct. The coefficient on the sensitivity stands at 0.46 in 1993–1999, drops to 0.19 in 2000–2006 and improves to 0.53 in 2007–2013. The sudden drop in the second period is accompanied by relatively strong ICFS, making it difficult to explain. The aggregate cash flow sensitivity steadily declines in the subsamples of developed economy firms and varies within a certain range for firms from developing economies. The results returned from the full sample and semi-balanced panel are broadly consistent. This consistency indicates that the documented patterns cannot be attributed to the changing firm composition.

5.4. Measurement error in Tobin's q

We now address the concern that the phenomenon documented in the previous sections is due to the errors-in-variables problem. The alternative explanation is that ICFS, investment–cash flow–tangible capital sensitivity, and their time-series patterns could be explained by the correction for poorly measured q or by improved quality of q, or both. To explore this possibility and to address the attenuation bias in q, we use the cumulant estimators from Erickson et al., (2014). The cumulant-based estimation results of the investment Model (4) are reported in Table 7.

We find two important results. First, the measurement error-consistent ICFS is consistently negative. The treated q is positive. As discussed, we report the estimation results with the highest possible magnitude of the q coefficient. The magnitude of the treated q is several times stronger than the magnitude of the WLS (biased) q. Significantly, investment–cash flow–tangible capital sensitivity remains highly positive and statistically significant in all regressions performed.

Second, over the sample period, the sum of ICFS and investment–cash flow–tangible capital sensitivity falls from 0.35 (z-stat = 3.59) to 0.15 (z = 1.41) in the U.S. and from 0.52 (z = 7.09) to 0.33 (z = 5.01) in non-U.S. developed economies. Individually, investment–cash flow–tangible capital sensitivity also falls across developed economies. The aggregate cash flow sensitivity strengthens from 0.21 (z = 2.49) to 0.37 (z = 9.49) for firms from less developed economies. The patterns returned from the cumulant-based estimations are qualitatively similar to their WLS counterparts; therefore, we conclude that the proposed relation between investment and asset tangibility and its time-series patterns is immune to the measurement error.[17]

The measurement quality of q (*Tau* index) is stable or declining over time. It is never above 0.4. Low proxy quality is expected because measurement error typically stems from large conceptual gap between empirical (average) q and the underlying true (marginal) q. The measurement quality does not improve and thus cannot explain the decline in ICFS.

Additionally, we estimate Model (4) without the q variable. The results are presented in Table 8. The objective is to show how the sensitivities evolve over time without q. If the time series of the sensitivities are due to the improvement in the quality of q and not due to the changes in firm asset tangibility and investment activity, then we should observe a non-declining (or less declining) ICFS in regressions without q. Further investigation, however, shows that such an explanation is unlikely. ICFS continues to decline across the globe, whereas investment–cash flow–tangible capital sensitivity and the sum of sensitivities decline only for developed economy firms.

Finally, we examine whether the developments of ICFS and its connection to asset structure are due to the changes in correlation between cash flow and q. If the developments of the sensitivities are due to the correlation, then we should observe a declining correlation in the advanced economies and flat (or increasing) correlation in less developed economies. Fig. 4 plots the cross-sectional

[17] Although important for the ICFS literature, the q measurement concern is not problematic for reaching the conclusion drawn in our study. In particular, if q is a poor control for investment demand, it should be equally poor for firms with different asset structures and investment rates. Thus, the measurement error would not account for why economically motivated factors such as asset tangibility explain the existence of and variation in ICFS.

Table 7

Investment regressions: cumulant estimators. The table reports coefficients estimated from the errors-in-variables regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). Each explanatory variable has its cross-product term with tangible capital. The model specification corresponds to Model (4). The investment regressions are estimated with high-order cumulant estimators. US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The z-statistic is reported in parentheses. N is the number of firm-year observations. The R^2 is the R^2 of the regression. *Tau* measure is the R^2 of the measurement equation (i.e., index of measurement quality).

Period	Market	$\Psi_{i,\,t}$	$(\Psi_{i,t}*Z_{i,t-1})$	$I_{i,t-1}$	$(\Delta D_{i,t}*Z_{i,t-1})$	$(E_{i,t}*Z_{i,t-1})$	$(C_{i,t-1}*Z_{i,t-1})$	$q_{i,t-1}$	R^2	*Tau*	$\Psi_{i,t}+(\Psi_{i,t}*Z_{i,t-1})$
1993–99	US	−0.46	0.81	0.22	0.03	0.94	−0.29	0.06	49.0%	0.38	0.35
		(−3.12)	(4.46)	(4.84)	(0.21)	(2.75)	(−1.79)	(3.27)			(3.59)
2000–06	US	−0.30	0.45	0.19	0.00	0.35	−0.12	0.06	53.1%	0.36	0.14
		(−4.33)	(3.84)	(3.70)	(0.03)	(2.25)	(−1.20)	(5.97)			(1.46)
2007–13	US	−0.35	0.50	0.27	0.16	0.42	−0.08	0.06	48.9%	0.32	0.15
		(−3.19)	(2.98)	(4.38)	(0.96)	(1.34)	(−0.76)	(3.76)			(1.41)
1993–99	DME	−0.26	0.78	0.34	0.08	−0.09	−0.34	0.05	42.7%	0.29	0.52
		(−5.30)	(7.27)	(11.58)	(0.55)	(−0.61)	(−2.49)	(17.22)			(7.09)
2000–06	DME	−0.26	0.69	0.26	0.04	0.62	−0.17	0.05	46.9%	0.28	0.43
		(−8.10)	(9.65)	(10.49)	(0.38)	(3.58)	(−2.02)	(18.65)			(8.30)
2007–13	DME	−0.35	0.68	0.29	−0.12	0.44	−0.32	0.06	47.8%	0.33	0.33
		(−8.68)	(7.45)	(11.86)	(−1.13)	(2.48)	(−3.38)	(22.60)			(5.01)
1993–99	EME	−0.24	0.45	0.27	0.36	−0.06	−0.26	0.05	41.7%	0.27	0.21
		(−2.26)	(3.28)	(10.42)	(2.11)	(−0.17)	(−1.19)	(4.72)			(2.49)
2000–06	EME	−0.29	0.59	0.21	0.37	0.01	−0.26	0.09	42.7%	0.19	0.30
		(−3.11)	(4.93)	(9.50)	(2.98)	(0.04)	(−1.77)	(5.50)			(5.37)
2007–13	EME	−0.11	0.48	0.25	0.25	0.04	−0.30	0.05	45.3%	0.23	0.37
		(−3.08)	(8.16)	(17.88)	(3.08)	(0.34)	(−4.53)	(7.07)			(9.49)

Note: For brevity, the table reports the main variables of interest.

Table 8

Investment regressions without *q*. The table reports coefficients estimated from the WLS regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), and beginning-of-period cash reserves ($C_{i,t-1}$). Each explanatory variable has its cross-product term with tangible capital. The model specification corresponds to Model (4) (without Tobin's measure). US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Period	Market	$\Psi_{i,\,t}$	$(\Psi_{i,t}*Z_{i,t-1})$	$I_{i,t-1}$	$(\Delta D_{i,t}*Z_{i,t-1})$	$(E_{i,t}*Z_{i,t-1})$	$(C_{i,t-1}*Z_{i,t-1})$	R^2	N	$\Psi_{i,t}+(\Psi_{i,t}*Z_{i,t-1})$
1993–99	US	0.05	0.49	0.42	0.21	0.15	0.19	49.7%	7295	0.53
		(2.71)	(7.47)	(12.97)	(4.49)	(2.39)	(5.41)			(10.25)
2000–06	US	0.03	0.38	0.43	0.25	0.15	0.09	48.4%	7634	0.42
		(3.04)	(8.13)	(10.89)	(7.23)	(2.44)	(2.94)			(10.56)
2007–13	US	0.03	0.23	0.50	0.24	0.12	0.18	46.7%	5976	0.26
		(2.53)	(3.35)	(10.85)	(5.01)	(1.52)	(5.57)			(4.49)
1993–99	DME	0.09	0.45	0.41	0.23	0.11	0.15	42.2%	14,420	0.54
		(2.90)	(6.07)	(8.55)	(3.15)	(1.32)	(2.87)			(10.14)
2000–06	DME	0.05	0.45	0.40	0.29	0.10	0.10	46.7%	22,310	0.50
		(3.31)	(7.71)	(8.89)	(4.57)	(1.46)	(3.66)			(11.15)
2007–13	DME	0.02	0.39	0.42	0.34	0.20	0.14	47.3%	23,869	0.41
		(1.64)	(8.43)	(8.89)	(10.12)	(2.85)	(4.95)			(10.54)
1993–99	EME	0.08	0.30	0.40	0.43	0.29	0.26	45.2%	5207	0.38
		(1.79)	(2.98)	(8.16)	(5.46)	(2.82)	(4.40)			(5.42)
2000–06	EME	0.08	0.28	0.40	0.32	0.17	0.11	41.4%	16,862	0.35
		(3.07)	(4.93)	(9.28)	(6.34)	(1.72)	(2.98)			(9.70)
2007–13	EME	0.02	0.39	0.45	0.36	0.13	0.16	46.0%	35,948	0.41
		(1.42)	(6.73)	(13.82)	(6.42)	(1.99)	(6.88)			(8.63)

Note: For brevity, the table reports the main variables of interest.

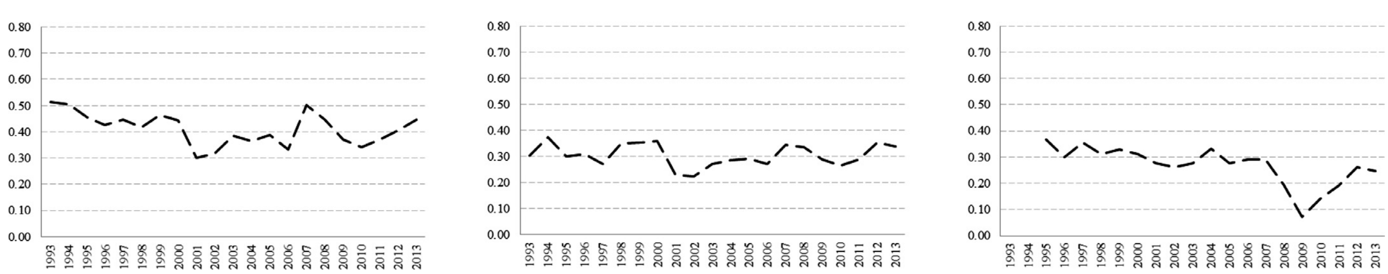

Fig. 4. Correlation between cash flow and Tobin's *q*. The figure plots the cross-sectional correlation between cash flow and Tobin's (empirical) *q* in each year between 1993 and 2013. The left figure corresponds to the U.S. economy. The middle figure corresponds to non-U.S. developed economies. The right figure corresponds to developing economies. Two data points in 1993 and 1994 years for developing economy firms are missing due to the lack of sufficient observations. The variables are demeaned by firm to remove fixed effects.

correlation between cash flow and q in each year between 1993 and 2013.[18] The correlation is U-shaped in the U.S. economy: it decreases monotonically from 0.5 down to 0.3 in the early period but increases above 0.4 in the later period. The correlation is somewhat similar, but generally lower, in other developed economies. In contrast, the correlation shows a sharp decline and subsequent recovery in developing economies. The correlation stands at 0.35 in the early period. The correlation is lowest in 2009 when it is 0.07. In 2013, it is 0.25. Interestingly, the correlation coefficients are highest in the U.S and lowest in the developing part of the world.[19] In conclusion, the correlation between cash flow and q cannot be the main driver of the time-series patterns of ICFS.

6. Cash flow persistence and asset tangibility

6.1. Cash flow persistence

According to q theory in general, investment varies with cash flow because cash flow provides information about marginal q. If the correlation between cash flow and q declines, ICFS can be lower. In the previous section, we show that the simple correlation between the two cannot completely explain the patterns in ICFS. Still, Chen and Chen (2012) show that the information content in cash flow regarding investment opportunities has declined for U.S firms. We now test whether the degree of asset tangibility is a determinant of the information content in cash flow. More specifically, we investigate whether the declining share of tangible capital can explain the declining predictability of cash flow.

Panel A and Panel B of Table 9 report the cash flow autoregressions from Models (5) and (6), respectively. The autoregressive coefficient and its explanatory power have substantially declined in the U.S. (from 0.35, t = 21.9 down to 0.21, t = 14.4) and non-U.S. developed economies (from 0.47, t = 12.4 down to 0.32, t = 11.3) but improved in emerging market economies (from 0.41, t = 8.80 up to 0.46, t = 17.8). When we estimate the predictability of the cross-product term of cash flow and tangible capital, we find that it exhibits greater magnitude, higher goodness-of-fit and similar time-series patterns. The patterns in cash flow persistence are broadly consistent with the patterns in cash flow sensitivities. As firms become less capital-intensive, tangibility plays a less essential role, and its shrinking importance attenuates the predictive power of the current cash flow. This loss of information eventually contributes to the decline in ICFS in advanced economies. In sharp contrast, due to the higher share of tangible capital in developing economies, the current cash flow is more predictable. Its information stability supports the magnitude of ICFS. These results are the basis for the argument that asset tangibility predicts investment, as well as the future value of cash flow.[20]

Table 9
Cash flow regressions. Panel A reports coefficients estimated from the WLS regression of cash flow ($\Psi_{i,t}$) on lagged cash flow ($\Psi_{i,t-1}$) from Model (5). Panel B reports coefficients estimated from the WLS regression of the cross-product term of cash flow and beginning-of-period tangible capital ($\Psi_{i,t} * Z_{i,t-1}$) on its lagged cross-product term ($\Psi_{i,t-1} * Z_{i,t-2}$) from Model (6). US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Panel A. Cash flow autoregressions

Period	Market	$\Psi_{i,t-1}$	(t-stat)	R^2	N
1993–99	US	0.35	(21.86)	26.4%	7295
2000–06	US	0.25	(19.34)	17.3%	7634
2007–13	US	0.21	(14.40)	14.0%	5976
1993–99	DME	0.47	(12.44)	42.0%	14,420
2000–06	DME	0.36	(14.16)	30.9%	22,310
2007–13	DME	0.32	(11.28)	26.5%	23,869
1993–99	EME	0.41	(8.80)	39.0%	5207
2000–06	EME	0.42	(10.11)	39.0%	16,862
2007–13	EME	0.46	(17.79)	40.2%	35,948

Panel B. Cash flow-tangible capital autoregressions

Period	Market	$\Psi_{i,t-1}*Z_{i,t-2}$	(t-stat)	R^2	N
1993–99	US	0.58	(28.14)	50.8%	7292
2000–06	US	0.46	(20.99)	40.9%	7628
2007–13	US	0.36	(9.54)	32.0%	5973
1993–99	DME	0.62	(24.89)	57.0%	14,413
2000–06	DME	0.57	(16.04)	55.1%	22,302
2007–13	DME	0.47	(8.28)	44.7%	23,863
1993–99	EME	0.49	(9.64)	43.4%	5201
2000–06	EME	0.46	(8.47)	41.7%	16,857
2007–13	EME	0.53	(19.27)	47.0%	35,941

6.2. Cash flow volatility

We now explore how cash flow volatility affects cash flow sensitivities in the investment regression. Minton and Schrand (1999) show that volatility is associated with depressed investment. It is therefore natural to expect that more volatile (and less predictable) cash flow negatively affects the strength of ICFS. However, based on the evidence presented in the previous section, a higher degree of tangibility should induce a greater persistence of cash flow and increased stability of investment. The cash flow volatility is defined as the standard deviation of the ratio of cash flow over total assets in each seven-year period.

We find that cash flow volatility is associated with lower, but still statistically significant, ICFS (Table 10). However, when we include the combination of cash flow and tangible capital into the investment regression, both the impact of volatility and the coefficients of ICFS become largely insignificant. Moreover, our original findings on the sensitivity of investment to the combination of cash flow and tangible capital continue to hold. The results clearly show that asset tangibility is a strong predictor of ICFS.

7. Financial constraints and asset tangibility

Thus far, we have documented that the most conspicuous characteristics of ICFS are driven by tangible capital. However, there is another potential channel – the credit multiplier originally proposed by Kiyotaki and Moore (1997) and manifested by Almeida and Campello (2007). The latter study examines the effect of asset pledgeability on corporate investment and documents that the ICFS of financially constrained firms increases with asset tangibility. The intuition is that tangible assets (pledged collateral) support more borrowing, which allows for further investment in tangible assets. The investment of unconstrained firms is not sensitive to the status of cash flow; therefore, the share of tangible capital is irrelevant to ICFS. To the extent that physical assets are more pledgeable and support more investment, our results are consistent with their study. However, we do not state that ICFS can be used to gauge the effect of financing frictions on investment.

[18] We omit two data points in 1993 and 1994 years due to the lack of sufficient observations for firms from developing economies. We also demean the variables by firm to remove fixed effects.

[19] The correlation between cash flow and marginal q exhibits similar patterns. The correlation of cash flow and marginal q is simply the correlation between cash flow and empirical q scaled by the square root of the *Tau* measure.

[20] In unreported results, we estimate cash flow persistence for capital-intensive firms using the cash flow autoregressive Model (5). The predictability of cash flow declines from 0.6 to 0.25 for U.S. firms and from 0.6 to 0.4 for other developed economy firms. Cash flow predictability remains stable and varies between 0.4 and 0.5 for capital-intensive firms from emerging economies.

Table 10
Investment regressions with cash flow volatility. The upper panel reports coefficients estimated from the WLS regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), cash flow volatility ($V_{i,\,t}$) and its cross-product term with cash flow ($\Psi_{i,\,t}{}^{*}V_{i,\,t}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). The lower panel reports coefficients estimated from the WLS regression of physical investment on cash flow, cash flow volatility, beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment, change in total debt, new equity issue, beginning-of-period cash reserves, and Tobin's measure. Each explanatory variable has its cross-product terms with cash flow volatility and with tangible capital. US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Period	Market	$\Psi_{i,\,t}$	(t-stat)	$(\Psi_{i,\,t}{}^{*}V_{i,\,t})$	(t-stat)	$(\Psi_{i,t} * Z_{i,t-1})$	(t-stat)	$\Psi_{i,t} + (\Psi_{i,t} * Z_{i,t-1})$	(t-stat)	R^2	N
1993–99	US	0.23	(13.97)	−0.50	(−3.73)					46.0%	7295
2000–06	US	0.13	(9.53)	−0.21	(−2.00)					44.9%	7546
2007–13	US	0.12	(9.60)	−0.40	(−4.98)					42.8%	5919
1993–99	DME	0.32	(12.39)	−0.93	(−2.95)					39.5%	14,420
2000–06	DME	0.25	(15.51)	−0.51	(−4.31)					42.8%	22,238
2007–13	DME	0.15	(7.29)	−0.50	(−3.76)					42.8%	23,754
1993–99	EME	0.15	(4.43)	−0.43	(−2.46)					42.7%	5207
2000–06	EME	0.24	(13.32)	−0.49	(−3.55)					39.6%	16,829
2007–13	EME	0.20	(6.01)	−0.52	(−1.85)					42.9%	35,904
1993–99	US	0.04	(1.64)	−0.13	(−0.94)	0.51	(6.77)	0.55	(9.57)	49.9%	7295
2000–06	US	0.02	(1.55)	−0.04	(−0.44)	0.37	(7.44)	0.39	(9.40)	49.2%	7546
2007–13	US	0.07	(3.27)	−0.34	(−3.65)	0.18	(2.55)	0.25	(4.37)	47.3%	5919
1993–99	DME	0.11	(2.88)	−0.28	(−0.99)	0.43	(4.50)	0.54	(7.37)	42.7%	14,420
2000–06	DME	0.08	(3.52)	−0.26	(−1.91)	0.41	(6.31)	0.49	(10.45)	46.8%	22,238
2007–13	DME	0.03	(1.31)	−0.18	(−1.40)	0.34	(6.63)	0.37	(7.67)	47.9%	23,754
1993–99	EME	0.09	(1.74)	−0.14	(−0.43)	0.17	(1.77)	0.26	(3.07)	45.8%	5207
2000–06	EME	0.13	(4.04)	−0.58	(−3.32)	0.27	(4.46)	0.40	(10.00)	41.8%	16,829
2007–13	EME	0.04	(1.53)	−0.26	(−1.04)	0.38	(6.63)	0.42	(7.20)	46.1%	35,904

Note: For brevity, the table reports the main variables of interest.

To explore the possibility that the credit multiplier overshadows the effect from two other channels, we examine the impact of asset tangibility on ICFS for financially more and less constrained firms. If the first channel (i.e., the intensity of physical investment) holds, the high tangible capital firms invest more from higher marginal cash flow, irrespective of their exposure to financing frictions. If the second channel (i.e., the information content in cash flow) holds, a marginal cash flow is more predictable for firms with higher tangible capital. Both channels yield a similar prediction with respect to the sign and significance of ICFS. However, there is no clear prediction of how a firm with high tangible capital should react when it faces costly external finance. According to the credit multiplier, the positive effect of tangibility on ICFS is evident only for financially constrained firms, and no such effect should be observed for unconstrained firms.

To empirically test the credit multiplier, we estimate the regression Model (4) for financially constrained and unconstrained firms separately. If the credit multiplier channel dominates, more constrained firms should have a higher investment–cash flow–tangible capital sensitivity, whereas unconstrained firms should have lower, or no, sensitivity. We adopt two popular classification schemes to differentiate our sample firms: firm size and dividend payout. Gilchrist and Himmelberg (1995) and Hennessy and Whited (2007) demonstrate that firm size is an accurate indicator of the cost of raising external funds. Size can be considered exogenous because it is not a choice variable for the manager in the short term. For the purpose of our study, the sample firms with total assets below the 30th percentile of the distribution for country *j* in year *t* are considered financially constrained. Firms with total assets above the 70th percentile of the distribution are considered unconstrained. Fazzari et al., (1988) also posit that financing frictions are more binding on non-dividend-paying firms. Consequently, non-dividend-paying firms are treated as financially constrained, and dividend-paying firms are treated as unconstrained in a particular year. For robustness check (unreported), we also use another popular scheme – the Whited–Wu Index. Whited and Wu (2006) developed an index to estimate the likelihood that a firm faces financial constraints. The index is a linear combination of six firm and industry-specific characteristics. Firms in the top (bottom) three deciles of the annual distribution are considered financially constrained (unconstrained). Firms are able to change their status over the sample period because they are ranked on an annual basis.[21]

The regression results are reported in Table 11. First, for both constrained and unconstrained firms, the presence of the cross-product term of cash flow and tangible capital continues to reduce the significance of the conventional ICFS. In most cases, the coefficient of cash flow becomes statistically or economically insignificant (below 0.1) after the product term has been included. This finding is similar to that observed previously, which means that how the investment of a firm is sensitive to the cash flow is determined, to a large extent, by the size of tangible capital it operates.

Second, irrespective of which criterion is used to differentiate financially more and less constrained firms, we find that the coefficients (i) on the combination of cash flow and tangible capital and (ii) on the aggregate cash flow sensitivity are not consistently different between the subsamples of firms. This finding suggests that tangibility is more likely to affect ICFS through the investment channel and the information content channel than through the credit multiplier channel. Our results do not necessarily reject the notion of the pledgeability of tangible assets but, rather, indicate that financial constraints are not important for reaching the conclusion drawn in this study.

Finally, and consistent with previous findings, the effect of tangible capital on ICFS declines in general for both financially constrained and unconstrained firms in developed economies. The effect does not diminish for firms in developing economies, irrespective of their exposure to financing frictions. This evidence indicates that the explanatory power of tangibility does not derive from financial constraints.

[21] We omit another broadly used scheme – the Kaplan–Zingales index (Kaplan and Zingales 1997) – because this measure is endogenously determined with the investment decision. We also do not consider bond or commercial paper ratings because too few firms in the international sample have such ratings.

Table 11
Investment regressions: constrained and unconstrained firms. The table reports coefficients estimated from the WLS regression of physical investment ($I_{i,\,t}$) on cash flow ($\Psi_{i,\,t}$), beginning-of-period tangible capital ($Z_{i,t-1}$), lagged investment ($I_{i,t-1}$), change in total debt ($\Delta D_{i,\,t}$), new equity issue ($E_{i,\,t}$), beginning-of-period cash reserves ($C_{i,t-1}$), and Tobin's measure ($q_{i,t-1}$). Each explanatory variable has its cross-product term with tangible capital. Firms are classified as the constrained (FC) and unconstrained (FUC) by dividend payout (Panel A) and firm size (Panel B). US denotes U.S. economy. DME denotes non-U.S. developed economy. EME denotes a developing economy. The t-statistic reported in parentheses adjusted for clustered standard errors at the country level. Country, industry and time fixed effects are included. N is the number of firm-year observations. The R^2 is the adjusted R^2.

Panel A. Dividend scheme

Period	Market	Status	$\Psi_{i,\,t}$	(t-stat)	$(\Psi_{i,t} * Z_{i,t-1})$	(t-stat)	R^2	$\Psi_{i,t} + (\Psi_{i,t} * Z_{i,t-1})$	(t-stat)
1993–99	US	FC	0.02	(0.66)	0.70	(6.93)	49.7%	0.71	(8.77)
2000–06	US	FC	0.01	(0.50)	0.43	(6.62)	47.4%	0.44	(7.71)
2007–13	US	FC	0.03	(2.09)	0.22	(3.34)	44.0%	0.25	(4.34)
1993–99	US	FUC	0.04	(1.53)	0.36	(3.77)	52.1%	0.41	(5.53)
2000–06	US	FUC	0.08	(3.67)	0.20	(2.57)	54.2%	0.28	(4.67)
2007–13	US	FUC	0.06	(1.81)	0.09	(0.61)	54.5%	0.15	(1.21)
1993–99	DME	FC	0.09	(2.15)	0.34	(2.45)	44.8%	0.43	(4.12)
2000–06	DME	FC	0.10	(2.80)	0.33	(2.83)	37.9%	0.43	(4.69)
2007–13	DME	FC	0.04	(2.28)	0.30	(3.82)	41.0%	0.35	(5.34)
1993–99	DME	FUC	0.10	(4.67)	0.50	(6.56)	47.7%	0.60	(8.96)
2000–06	DME	FUC	0.06	(2.84)	0.46	(7.97)	52.9%	0.52	(10.45)
2007–13	DME	FUC	0.04	(2.61)	0.36	(4.33)	51.1%	0.40	(5.20)
1993–99	EME	FC	0.18	(1.64)	0.15	(1.67)	44.9%	0.33	(2.46)
2000–06	EME	FC	0.09	(2.44)	0.33	(3.97)	43.3%	0.43	(6.76)
2007–13	EME	FC	0.06	(3.61)	0.44	(9.47)	42.2%	0.50	(13.46)
1993–99	EME	FUC	0.15	(2.44)	0.19	(1.84)	43.2%	0.33	(3.13)
2000–06	EME	FUC	0.06	(2.98)	0.40	(5.64)	44.8%	0.46	(8.61)
2007–13	EME	FUC	0.01	(0.37)	0.53	(8.68)	47.2%	0.54	(10.02)

Panel B. Firm size scheme

Status	$\Psi_{i,\,t}$	(t-stat)	$(\Psi_{i,t} * Z_{i,t-1})$	(t-stat)	R^2	$\Psi_{i,t} + (\Psi_{i,t} * Z_{i,t-1})$	(t-stat)
FC	0.02	(0.75)	0.49	(3.87)	42.2%	0.51	(4.96)
FC	0.01	(0.48)	0.47	(5.67)	38.1%	0.48	(6.64)
FC	0.01	(0.83)	0.25	(2.99)	33.1%	0.27	(3.59)
FUC	0.07	(2.17)	0.31	(2.83)	64.9%	0.38	(4.76)
FUC	0.04	(1.50)	0.30	(3.95)	68.6%	0.34	(5.74)
FUC	0.00	(0.13)	0.35	(3.07)	71.4%	0.35	(3.86)
FC	0.06	(1.64)	0.62	(5.55)	55.7%	0.68	(8.08)
FC	0.07	(2.39)	0.48	(5.17)	63.2%	0.55	(7.75)
FC	0.04	(2.82)	0.34	(4.55)	65.7%	0.38	(5.51)
FUC	0.07	(1.58)	0.45	(3.75)	55.7%	0.52	(5.50)
FUC	0.03	(1.07)	0.50	(5.05)	63.2%	0.53	(6.29)
FUC	0.06	(2.41)	0.27	(2.61)	65.7%	0.34	(3.77)
FC	0.16	(1.78)	0.24	(1.74)	34.6%	0.40	(2.91)
FC	0.04	(2.15)	0.43	(6.22)	36.9%	0.47	(7.95)
FC	0.03	(1.39)	0.44	(5.50)	34.7%	0.47	(7.16)
FUC	0.06	(0.72)	0.24	(1.79)	48.7%	0.31	(3.47)
FUC	0.09	(2.69)	0.33	(4.20)	52.7%	0.42	(7.69)
FUC	0.02	(0.73)	0.51	(10.38)	56.0%	0.53	(14.05)

Note: For brevity, the table reports the main variables of interest.

8. Conclusion

The literature on ICFS is rich but inconclusive. In particular, no published paper provides a plausible explanation for why this sensitivity has declined and virtually disappeared over time in the U.S. There is also little evidence from non-U.S. economies. In this study, we examine two channels that could potentially explain the existence and the time-series development of ICFS. First, we emphasize the importance of asset tangibility in predicting physical investment. The share of tangible capital in total productive capital contains information about its marginal productivity. The rate of investment varies with the productivity and with the productive capital structure. Our argument is that firms with high tangible capital spend more on investment. Second, we extend the notion that the current cash flow explains investment because it predicts future cash flow. The firms with more predictable cash flows exploit new growth opportunities and invest more. Our argument is that firms with high tangible capital have more predictable cash flows. Because asset tangibility predicts the intensity of physical investment and the persistence of cash flow, it contributes to ICFS.

Our empirical results confirm our prediction. We show that the global patterns in ICFS are explained well by the variation in tangible capital. Because developed economy firms use less tangible capital and adopt more intangible capital in production, the composition of their investments has changed, and the persistence of their cash flows has weakened. Their ICFS is virtually nonexistent, and investment–cash flow–tangible capital sensitivity has steadily declined over time. In contrast, because developing economy firms operate with more tangible capital, their physical investments are more stable and cash flows are more predictable. Their ICFS and investment–cash flow–tangible capital sensitivity are therefore non-diminishing.

Finally, we show that q measurement error is not the reason why ICFS exists. This error does not sufficiently explain the time series of this sensitivity or the relation between this sensitivity and asset tangibility. Furthermore, we provide evidence that the explanatory power of tangibility does not derive from financial constraints. The net results of this study support our explanation of ICFS as a reflection of capital (investment) intensity and income predictability, rather than an indication of financial constraints.

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