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Why has the investment-cash flow sensitivity declined so sharply? Rising R&D and equity market developments

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ABSTRACT

The study of the investment-cash flow (ICF) sensitivity constitutes one of the largest literatures in corporate finance, yet little is known about changes in the ICF relationship over time, and the literature has largely ignored how rising R&D investment and developments in equity markets have impacted ICF sensitivity estimates. We show that for the time period 1970–2006, the ICF sensitivity: (i) largely disappears for physical investment, (ii) remains comparatively strong for R&D, and (iii) declines, but does not disappear, for total investment. We argue that these findings can largely be explained by the changing composition of investment and the rising importance of public equity as a source of funds, particularly for firms with persistent negative cash flows.

1. Introduction

The study of the investment-cash flow (ICF) sensitivity constitutes one of the largest empirical literatures in corporate finance. Many studies find that firms which are *a priori* more likely to confront binding financing constraints display a greater sensitivity of investment to cash flow. Although there is disagreement on how to interpret the findings in ICF studies, ICF regressions continue to be used extensively as a tool to study a variety of issues in corporate finance. But despite the literature's prominence, little is known about the stability of the ICF relationship over time and the R&D-cash flow relationship has been largely ignored. In particular, the literature has not explored how the rising importance of R&D or continued improvements in equity markets may have affected measures of the ICF sensitivity.

There are several reasons to suspect that the ICF sensitivity has declined significantly. Perhaps the most important reason is developments in US equity markets over the last three decades. One major improvement was the creation of the Nasdaq – launched in 1971 and repeatedly improved thereafter – which likely gave young firms access to a much more efficient stock exchange than was available to them for most of the 20th century. In the last few decades, there has been a sharp increase in the use of public equity finance by young firms, suggesting that stock issues may have become a closer substitute for internal finance. A second, closely related reason for a declining ICF sensitivity is the sharp increase in the fraction of publicly traded firms that report persistent negative cash flows. Since these firms often make very heavy use of public equity to expand investment when cash flow is particularly low, failure to account for external finance in ICF regressions can result in a downward omitted variable bias in the estimated cash flow coefficient. Third, there has been a sharp change in the composition of total investment: the absolute and relative importance of physical investment has declined substantially and R&D intensity has risen dramatically for the typical publicly traded manufacturing firm. Because almost all ICF studies focus on physical investment, the declining relative importance of physical investment can, by itself, lead to a decline in the conventionally measured ICF sensitivity.

This paper makes three main contributions. First, we provide a systematic documentation of what has happened to the ICF sensitivity over time. The only other studies to examine the ICF sensitivity over relatively long periods of time are Allayannis and Mozumdar (2004) and Agca and Mozumdar (2008), both of which show a substantial decline in the ICF sensitivity for *physical* investment over time. We expand on these studies by considering R&D

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and total investment in addition to physical investment. Comparatively few studies have examined the ICF sensitivity for R&D and no other studies have explored changes in the R&D-cash flow sensitivity over time. Second, we examine the role of external finance in ICF regressions by estimating dynamic investment models that include measures of stock and debt issues. We argue that these are potentially important omitted variables in most ICF studies, and their inclusion helps address some concerns that have been raised about interpreting ICF sensitivities. Finally, we explore *why* the estimated ICF sensitivity has changed over time, focusing on the impact of both capital market developments and the changing composition of investment.

We explore changes in the ICF sensitivity between 1970 and 2006 using Compustat data for manufacturing firms, divided into three subperiods: 1970–1981, 1982–1993 and 1994–2006. We also split firms into two categories, young and mature, where young firms have stock prices for fewer than ten years before the start of a given subperiod. We expect improvements in equity markets to have the greatest impact on young firms, since they are the most likely to be "equity-dependent." Our summary statistics show that, over time, there has been: (i) a very large decline in the physical investment share of total investment, (ii) a dramatic rise in the R&D-to-assets ratio, particularly for young firms, (iii) a very sharp rise in the proportion of negative cash flow observations, (iv) a substantial decline in the median cash flow ratio, particularly for young firms, and (v) a pronounced rise in the share of young firm finance accounted for by new stock issues.

We estimate the sensitivity of physical investment, R&D, and total investment (physical investment plus R&D) to cash flow with the standard OLS fixed effects model used in the ICF literature. Our main results, however, are based on dynamic investment regressions using GMM where cash flow and other financial variables are treated as endogenous. The other financial variables include both new stock issues and debt finance, variables that potentially matter a great deal for investment but are rarely included in ICF studies. A consistent pattern of results emerges from the OLS and GMM regressions. For *physical investment,* our OLS estimates show that, even after controlling for negative cash flows, there is a dramatic decline in the ICF sensitivity over time. Similarly, GMM regressions that control for negative cash flow and include measures of external finance show a decline in the ICF sensitivity of at least 70% between 1970–1981 and 1994–2006. We argue that much of this decline is due to the sharp fall in the physical investment share of total investment. For R&D investment, on the other hand, there is no decline in the ICF relationship over time in OLS regressions (that control for negative cash flow) or GMM regressions (that control for external finance). We will emphasize, however, that the cash flow coefficients for R&D, absent improvements in equity markets, should have *risen* a great deal because of the sharp rise in the R&D share of total investment that occurred during the period we study. Finally, the ICF pattern for *total investment* reflects a blend of the ICF pattern for physical and R&D investment and shows that the overall ICF sensitivity declined substantially over the time period of our study, but it did not disappear.

Our regression findings also shed light on the different roles of debt and stock issues as well as the rise in importance of the US stock market. First, in the physical investment regressions (where investment presumably has collateral value), debt coefficients are substantial but there is little or no evidence of stock effects. Second, for R&D (arguably the equity-dependent type of investment), stock issues play a more important role than debt, especially in the final period. Third, stock issues appear especially important for young firms, particularly young firms with negative cash flows (arguably the most equity-dependent type of firm). Fourth, in the R&D regressions, estimated coefficients on stock issues rise from near zero to large values by the final period for young firms, consistent with improvements in equity markets. Finally, our findings show that young firms with persistent negative cash flows rely heavily on stock issues to finance R&D and failure to account for this appears to cause a downward bias (e.g., negative cash flow coefficients) in the estimated R&D-cash flow sensitivity.

To summarize, the ICF sensitivity for physical investment has fallen dramatically, the ICF sensitivity for R&D remains comparatively strong, and the ICF sensitivity for total investment has fallen substantially. Absent improvements in equity markets, however, the ICF sensitivity of R&D should have increased a great deal, given the sharp change in the composition of investment. The bottom line is that the overall ICF sensitivity has declined noticeably in recent decades and improvements in equity markets were likely a significant contributing factor.

2. Overview of the investment-cash flow sensitivity

2.1. Background

Beginning with Fazzari et al. (FHP, 1988), the standard approach to measuring the ICF sensitivity has been to estimate a fixed effects regression of physical investment on cash flow and Tobin's Q (as a control for investment demand). The typical study separates firms into multiple groups based on the *a priori* likelihood that they face substantial financing constraints. Most studies find that firms which are *a priori* more likely to face binding financing constraints exhibit the greater sensitivity of investment to cash flow. Excellent surveys of the literature can be found in Schiantarelli (1996), Hubbard (1998), and Bond and Van Reenen (2007).[1]

A number of recent papers criticize conventional ICF regressions, particularly in studies that do not control for the potential endogeneity of cash flow or neglect the possibility of external finance. For example, Alti (2003) and Moyen (2004) calibrate models of firms that use debt as a substitute for internal finance. They run OLS regressions on simulated data from the models to show that ICF sensitivities can be generated even if firms do not face financing frictions. Alti (p. 721) writes that one problem in ICF regressions highlighted by his study is "relatively easy to handle; one can remove the effects of the surprise component of cash flow by using lagged instruments," something that we do in this paper. In Moyen (2004), unconstrained firms have substantial cash flow sensitivities because current period debt finance is correlated with contemporaneous cash flow and debt finance is not included in the regression. In this study, we control for external finance and instrument cash flow to eliminate the contemporaneous correlation between external finance and the cash flow regression variable. In addition, studies critical of ICF regressions have considered only physical investment (consistent with most of the ICF literature) and thus do not offer any explanation for differences in ICF sensitivities across different types of investment. Furthermore, we are aware of no critiques that can explain why ICF sensitivities have fallen sharply over time.

2.2. R&D investment

Compared to the large literature exploring the ICF sensitivity of physical investment, relatively few studies examine the sensitivity of R&D to cash flow and we are aware of no previous studies that

[1] ICF regressions continue to be used extensively as a tool for studying various issues in corporate finance. For example, they have been recently used to draw inferences about the efficiency of internal capital markets, the impact of managerial characteristics on corporate policies, the effect of agency problems on firm investment, and the behavior of financially distressed firms.