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Discussion of "Overinvestment of free cash flow"

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Abstract Richardson's paper is a useful addition to the literature on the relationship between cash flow and investment. His approach to estimating this relationship is a new twist on earlier approaches. Like most of this literature, Richardson finds evidence that firms' investment decisions are excessively sensitive to current cash flow, suggesting that violations of the Modigliani–Miller assumptions are empirically important. My view is that conceptual and implementation problems beset Richardson's attempt to identify the specific violation of the Modigliani–Miller assumptions, and his evidence on this second point is not convincing.

Keywords Investment · Cash flow · Modigliani-Miller theorem · Corporate governance

JEL Classification G31

Richardson's paper is a useful addition to the literature on the relationship between cash flow and investment. This literature, in my opinion, is framed by two classic works from the 1950s. The first work is *The Investment Decision*, a 1957 book by John Meyer and Ed Kuh. Meyer and Kuh collected a sample of data from 750 firms over the period between 1946 and 1950, and looked empirically at the determinants of investment. They conclude that the best explanation for their pattern of evidence is that managers are highly reluctant to tap external sources of finance, and are reluctant to change dividends. At least in the short run, investment is set as a residual and therefore moves closely with firms' internal resources.

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The second work may be more familiar: Modigliani and Miller's (1958) work 'The cost of capital, corporation finance, and the theory of investment.' Their result, applied to investment decisions, is familiar: in a world without financial imperfections, investment decisions are made by comparing the return promised by the investment to the relevant cost of capital. Controlling for investment opportunities, a firm's investment would, in a world without financial imperfections, be uncorrelated with its cash on hand or current profitability.

The Modigliani–Miller result has no implications for the *unconditional* correlation between cash flows and investment. If investment opportunities are positively correlated with current cash flows, then investment and cash flows will be correlated even if all of the Modigliani–Miller assumptions hold. Modigliani and Miller say that, in a world without financial imperfections, investment, controlling for investment opportunities, is uncorrelated with cash flows. Meyer and Kuh's empirical analysis highlight the variety of constraints that they perceived to be binding. Largely because of these constraints, in the short run, investment was set as a residual. This behavior necessarily induced a correlation between firms' investment and cash flows.

These two works frame the literature on investment that has emerged since the late 1950s. This literature spans across a number of different fields, and each field has its own tendencies in analyzing the determinants of investment.

In the public finance literature it is common to consider only two market imperfections: taxes and the transaction costs that are incurred when new capital is installed. The seminal work in this literature is Hall and Jorgenson (1967). They construct a tax-adjusted cost of capital, and estimate the sensitivity of investment behavior to this cost of capital. This type of analysis is useful for estimating the sensitivity of investment to the various levers available through tax policy, and this literature has recently been surveyed by Hassett and Hubbard (2002).

A large related literature in macroeconomics often starts from an assumption that information problems, rather than taxes, are the relevant imperfection. These information problems create barriers that keep firms from accessing external finance. In this situation, if investment opportunities exceed managers' wealth, the insiders' wealth (which is related to their incoming cash flow) will drive investment behavior.

This macroeconomics literature has also been relevant for policy. For example, monetary policy seems to have a much larger impact on investment than we would expect, given the sensitivity of investment to interest rates and the sensitivity of interest rates to monetary policy. This has led authors to investigate various additional channels through which monetary policy, by affecting the liquidity available to banks and firms, affects aggregate investment behavior. What these channels have in common is that, at their core, they reflect an investment-cash flow sensitivity that exists because information problems create a barrier to external finance. A review by Hubbard (1998) surveys much of relevant literature in macroeconomics.

A large literature in corporate finance, in which papers by Fama (1980) and Jensen (1986) are central, seeks to assess whether managerial agency problems affect firm investment. Typical work in this literature has sought to assess whether managers invest 'excessively' out of free cash flow. This 'excessive' sensitivity of investment to cash flow could be because of managerial opportunism, in the sense of trying to build empires, or managerial optimism, in the sense of being more optimistic about the chances of investments than their potential or actual investors are. Richardson's paper fits very neatly into this existing corporate finance literature, which is surveyed in Stein (2003).

In trying to assess whether the Modigliani–Miller conditions are violated in an economically meaningful way, a standard approach is to evaluate the empirical relationship between investment and cash flows. Because the mere existence of a correlation between investment and cash flows does not necessarily imply any violation of the M–M conditions, applied econometricians have devoted a great deal of energy to the search for ways to control for the investment 'opportunities' in a hypothetical M–M world.

Even if we find a departure between a firm's investment and the investment that would be appropriate in the Modigliani–Miller world, then we still need to figure out which set of the Modigliani–Miller assumptions are violated in meaningful ways. Are firms constrained because information problems inhibit access to external finance, leading to excessive sensitivity and aggregate underinvestment? Alternatively, do firms 'waste' any cash they have on hand on investment in negative NPV projects? Do taxes on corporate distributions create a wedge between the internal and external costs of capital that in turn induces an excessive sensitivity of investment to cash flows?

1. Richardson's approach

Richardson seeks to assess whether there is an excessive sensitivity of firm-level investment to firms' cash flows. Richardson also seeks to gather evidence on whether the departures from the Modigliani–Miller baseline are driven more by agency problems (the overinvestment of free cash flow) or by information problems impeding firms' access to external capital (underinvestment).

Richardson's approach is to construct a sample of 58,053 firm-year observations from the Compustat database, drawn from the 1988 to 2002 period. He constructs a measure of new investment, which is reported investment expenditure minus the investment needed to maintain current assets. His empirical proxy for the expenditure needed to maintain current assets is the firm's reported depreciation and amortization expense.

With new investment defined as capital expenditure less depreciation and amortization, the measure of excessive investment is constructed based on an econometric model of expected investment. Excessive investment is defined as the residual from this equation. The explanatory variables in this empirical model for investment include a V/P measure (similar to the reciprocal of Q),

leverage, lagged cash holdings, firm age, firm size, lagged stock returns, the previous period's new investment, and year and industry dummies.

Richardson's intention is for the fitted value from this equation to reflect mandated investment in positive NPV projects, and the residual to reflect (if positive) overinvestment and (if negative) underinvestment. An important problem with this approach is that Richardson's empirical measure of overinvestment is a residual from a regression model. As a residual, the measured overinvestment has a mean of zero. This means that Richardson's approach is incapable of discerning what he hopes to discern: whether overinvestment or underinvestment predominates in aggregate.

Richardson also constructs a measure of free cash flow. This measure is the cash flow from operations, plus research and development expenditure (viewed as discretionary) less the 'required' maintenance (again proxied by depreciation and amortization expenditure, viewed as not discretionary), less the 'expected' level of investment based on the equation mentioned above. Richardson applies the label 'free' cash flows to the resulting measure, which is cash flow less the assumed non-discretionary and mandated components of investment. The stated goal is to create a measure of the amount of cash flows that are not encumbered by the need to maintain the existing assets of the firm.

Among other things, this approach implies that cash spent to maintain assets that themselves were acquired as part of an earlier overinvestment binge should neither count as free cash flow nor be considered overinvestment.

With these empirical measures of free cash flow and excess investment, Richardson regresses one on the other, allowing for a kink in the fitted line around free cash flow of zero. The finding of a positive relationship between free cash flow and excess investment is presented as evidence that the Modigliani–Miller assumptions do not hold, and the finding that the relationship is steeper above the point where free cash flows equal zero than it is below that point is described by Richardson as evidence that the particular violation of the M–M theorem is a managerial tendency toward overinvestment.

2. Potential problems with Richardson's approach

The excess investment in Richardson's empirical model is the residual from a regression of new investment on a group of explanatory variables. Because the mean of the residuals is zero by construction, Richardson's empirical approach cannot be a test of whether overinvestment or underinvestment is more important in aggregate. His approach *assumes* that on average overinvestment, in the Modigliani–Miller sense of investment in negative NPV projects, is zero.

The set of explanatory variables is curious. Why include lagged cash holdings in the model for mandated investment? Can firms not overinvest out

of their *stock* of cash as well? Why include lagged investment? If firms overinvested last year, why include last-year's overinvestment in this year's model of expected investment?

On Richardson's efforts to distinguishing between overinvestment and underinvestment, it is my opinion that distinguishing between these hypotheses is quite difficult.[1] It seems likely to me that if agency-type problems at firms that are ex-post flush with cash lead to problematic overinvestment, then we should expect to see some ex-ante underinvestment because of rational forward-looking behavior by uninformed investors. I suspect that in a dynamic setting, the existence of overinvestment almost necessarily implies that underinvestment is also a problem.

Richardson tests the hypothesis that overinvestment is relevant by looking for a 'kink' in the relationship between excess cash flow and excess investment. Stein (2003) presents a simple model that is useful for thinking about Richardson's test. Stein's model nests capital constraints and managerial overinvestment, the two Modigliani–Miller imperfections that Richardson aims to distinguish between. In this model, a manager, with access to internal resources w, and with a production function $f(.)$, maximizes a utility function given by (1) below:

$$U = (1+\gamma)f(I)/(1+r) - (w+e) - \tau C(e) \tag{1}$$

The function $f(I)$ gives the gross return to investment, which is discounted at interest rate r. The parameter γ reflects managers' taste for overinvestment. Investment is funded out of internal resources w and external resources e, and external resources are raised at an excess cost captured by the parameter τ.

$$\text{Investment} = I = w + e \tag{2}$$

This setting nests the agency and information problems affecting managerial investment decisions. A manager optimizes utility by choosing investment such that $\mathrm{d}U/\mathrm{d}I = 0$. In this setting, if I is the optimized value of investment, then $\mathrm{d}^2I/\mathrm{d}w^2$ corresponds to the curvature of the relationship between cash on hand and investment. Richardson's test for a 'kink' in the relationship between cash flow and investment corresponds roughly to a test of the hypothesis that $\mathrm{d}^2I/\mathrm{d}w^2 > 0$, at least around the neighborhood w=0.

Richardson regards his test of the hypothesis that $\mathrm{d}^2I/\mathrm{d}w^2 > 0$ as a test of the hypothesis that agency problems are more important than information problems. This simple model suggests that such a test may not be appropriate. If γ=1 and τ=0, then agency problems are important and information problems negligible. In this setting, however, $\mathrm{d}^2I/\mathrm{d}w^2 = 0$. Without the imposition of additional information, Richardson's test for the existence of a kink in the relationship between cash flow and investment does not seem to offer hope of distinguishing which imperfection is more important.

[1] Hadlock (1998) makes a valiant effort to disentangle the impact of these imperfections using an empirical test based on managerial stock ownership.

In sum, there are a variety of problems with the approach that Richardson takes toward evaluating the relative importance of agency problems versus information problems in firms' investment decisions. First, zero overinvestment on average is an assumption of Richardson's approach, and not something being tested. Second, it is my belief that in a realistic dynamic model, ex-post overinvestment implies some ex-ante underinvestment. Finally, Stein's simple model suggests that a kinked relationship between investment and cash flows is not evidence for or against any particular deviation from the Modigliani–Miller assumptions. Richardson's approach seems incapable of demonstrating which capital market imperfection is empirically more important.

3. Richardson's approach, in context

This subsection turns away from assessing Richardson's goal of disentangling which imperfection is more relevant, and toward his more general goal of testing the hypothesis that some Modigliani–Miller assumption is violated. Richardson follows a long literature assessing the relationship between cash flows and investment, seeking to learn whether any departures from the Modigliani–Miller assumptions are empirically important. The framework that follows will outline how Richardson's paper fits into this existing empirical literature.

Life would be easy if the world were simple enough that the regression in Eq. (3) could allow us to reject the Modigliani–Miller assumptions.

$$\text{Investment} = \alpha_1 + \alpha_2 * \text{Cash Flow} + \varepsilon_\alpha \tag{3}$$

Meyer and Kuh basically run this regression, and find a correlation between profits (a proxy for cash flow) and investment. They suggest that this relationship was not an artifact of the data but reflected conscious, and conservative, managerial policy.

Estimating Eq. (3) and finding a positive coefficient on α_2 does not imply any violation of the Modigliani–Miller assumptions, though. Assume that a true description of the world is as follows in Eqs. (4) and (5):

$$\text{Investment} = \alpha_1 + \alpha_2 * \text{Cash Flow} + \alpha_3 * \text{Opportunities} + \varepsilon_a \tag{4}$$

$$\text{Cash Flow} = \beta_1 + \beta_2 * \text{Opportunities} + \beta_3 * \text{Other Things} + \varepsilon_b \tag{5}$$

The 'Other Things' that affect cash flow, but are uncorrelated with firms' investment opportunities might include required pension contributions or windfalls from legal decisions. Investment responds to investment opportunities, and cash flows are positively correlated with investment opportunities.

A researcher who estimates the Eq. (3) and finds a positive coefficient on α_2 has not proven the relevance of any imperfections, or the existence of any overinvestment or underinvestment. The positive coefficient on α_2 may merely

reflect the joint movement in investment and cash flow caused by their correlation with investment opportunities.

Both Richardson and most of the existing literature seek to deal with this identification problem. Efforts to find convincing empirical strategies for identifying the coefficient α_2 have led researchers down a variety of paths. Researchers commonly estimate Eq. (3) including variables that proxy for the investment opportunity set, an approach expressed in Eq. (6) below. With perfect proxies for investment opportunities, estimates of Eq. (6) would give consistent estimates of α_2. In this setting, with opportunity proxies that perfectly control for investment opportunities, an estimate of α_2 that departed from zero would imply some departure from the Modigliani–Miller model.

$$\text{Investment} = \alpha_1 + \alpha_2 * \text{Cash Flow} + \alpha_3 * \text{Opp Proxies} + \varepsilon_a \qquad (6)$$

The quality of the proxies for investment opportunities determines how useful this exercise is. With perfect proxies for investment opportunities, a finding of $\alpha_2>0$ would signal the existence of an imperfection. It would not, however, identify whether this imperfection is causing underinvestment at constrained firms, overinvestment at firms flush with cash, or both. Other imperfections could also lead the researcher, in this perfectly specified model, to find $\alpha_2>0$: both taxes and transactions costs can create wedges between internal and external finance.

Because of a widespread view that there are no perfect empirical proxies for the investment opportunity set, other papers have tried different strategies for identifying the coefficient α_2 in Eq. (3). Lamont (1997) looks at the impact of changing oil prices on investments at the non-oil subsidiaries of firms that also have substantial oil operations. For this small sample of firms, changing oil prices have a large impact on the amount of cash on hand, but have little impact on the NPV of investments at the firms' non-oil subsidiaries. A more recent paper by Rauh (2006) uses a much larger sample, and estimates Eq. (6) using the variation in firms' cash resources that is related to required contributions to pension plans. Because the schedule of required contributions is particularly complex and non-linear, and arguably unrelated to investment opportunities, using only the variation in cash flows that is related to these contributions gives hope that we are estimating the true value of α_2.

This approach, called an instrumental variables approach, amounts to the estimation of a restricted version of Eq. (6). The restriction is that only the variation in cash flows driven by correlation with the 'instrument' is used to estimate the relationship between cash flow and investment. This part of the variation in cash flows is assumed to be uncorrelated with investment opportunities. How well this approach works, in practice, depends critically on the amount of variation in cash flows actually induced by the instrument, and on the validity of the assumption that variation in the instrument is only correlated with investment through the impact of the instrument on firms' cash flows.

Scott Richardson's approach fits into this general framework, in the sense that he is also estimating a restricted version of model (6). He starts by creating a statistical model for estimating 'needed investment' versus 'overinvestment'.

$$\text{Needed Investment} = \gamma_1 + \gamma_2 * \text{Opp Proxies} + \varepsilon_g \tag{7}$$

$$\text{Overinvestment} = \text{Investment} - \text{Needed Investment} \tag{8}$$

$$\text{Free Cash Flow} = \text{Cash Flow} - \text{Needed Investment} \tag{9}$$

Richardson then uses these estimates of overinvestment and free cash flow in a regression model. Richardson then uses this statistical model of overinvestment in a regression similar to what we've seen in the past:

$$\text{Overinvestment} = \delta_1 + \delta_2 * \text{Free Cash Flow} + \varepsilon_d \tag{10}$$

This model is just a rearrangement of (6), with some additional restrictions. Equation (10′) substitutes Eqs. (7)–(9) into Eq. (10). Equation (10″) rearranges terms:

$$\begin{aligned}&\text{Investment} - (\gamma_1 + \gamma_2 * \text{Opportunities})\\ &= \delta_1 + \delta_2 * (\text{Cash Flow} - (\gamma_1 + \gamma_2 * \text{Opp Proxies}))\end{aligned} \tag{10′}$$

$$\begin{aligned}&\text{Investment} = (\delta_1 + \gamma_1 * (1 - \delta_2))\\ &+ \delta_2 * \text{Cash Flow} + \gamma_2 * (1 - \delta_2) * \text{Opp Proxies}\end{aligned} \tag{10″}$$

Richardson's analysis is therefore similar to the equations estimated in the earlier literature, which also runs regressions of investment on cash flow and proxies for investment opportunities. Like researchers who use IV approaches, Richardson places additional restrictions on the model. Richardson's approach, articulated as a restriction on Eq. (6), is new.

While earlier researchers have placed restrictions on the part of the variation in cash flows that they use in estimating (6), Richardson is placing a restriction on the estimated coefficients in his empirical regression. The restriction that he imposes is that the coefficients on the investment opportunity proxies and on cash flows are related to each other, as Eq. (10″) highlights.

A central challenge for Richardson would be to articulate why the restrictions he imposes on the coefficients in Eq. (10″) lead to a more robust estimate of the relationship between cash flows and investment. A natural alternative to Richardson's approach is to allow the investment opportunity proxies to have a coefficient that is estimated without restrictions. A priori, estimating Eq. (6) with no constraints on the coefficients on the opportunity proxies seems preferable to estimating Eq. (6) with restrictions placed on these coefficients. If our goal is to soak up the impact of the underlying investment opportunity set, then an approach that places restrictions on how we do this seems likely to be generically dominated by an unrestricted

approach. Another relevant comparison is between Richardson's work and instrumental variables approaches. Rauh is able to articulate a reason why the set of restrictions he imposes (focusing on a part of cash flows that are arguably unrelated to investment opportunities, and looking at the relationship between investment and this restricted set of cash flows) leads to a more robust estimate of α_2.

In order to have some basis for comparing Richardson's approach with naïve estimation of Eq. (6) and with estimation by instrumental variables approaches, I generated an artificial data set, in which the underlying parameters of interest are known, and assessed the performance of the different empirical approaches on these artificial data.

I started with normally distributed investment opportunities:

$$\text{Opportunities} \sim N(0,1) \tag{11}$$

Available empirical proxies for investment opportunities measure these opportunities with some error. There is a monotonic but non-linear relationship between the opportunities and the proxies, and an additional noise term:

$$\text{Opp Proxies} = \text{Opportunities} + \text{Opportunities} * (\text{Opportunities}\,0) + N(0,1) \tag{12}$$

Required pension payments are assumed to affect cash flows, but are uncorrelated with investment opportunities:

$$\text{Pension payments} \sim N(0,1) \tag{13}$$

Cash flows are correlated with both the opportunity set and with the pension payments (with an additional error term):

$$\text{Cash flow} = \text{Pension payments} + \text{Opportunities} + N(0,1) \tag{14}$$

Finally, investment is related to both the investment opportunity set and to the cash flow on hand. In other words, the 'excess sensitivity' parameter α_2 is equal to 1:

$$\text{Investment} = \text{Cash flow} + \text{Opportunities} + N(0,1) \tag{15}$$

A dataset consisting of 10,000 observations was generated 4000 separate times, and the different empirical approaches were applied to each of these 4000 separate datasets. Figure 1 presents the coefficients estimated using these different approaches on the artificially generated dataset.

The results of these simulations suggest that Richardson's approach is potentially dominated by estimation approaches that use instrumental variables to estimate α_2. These simulation results are tilted, however, toward favoring instrumental variable approaches. In these simulations, pension

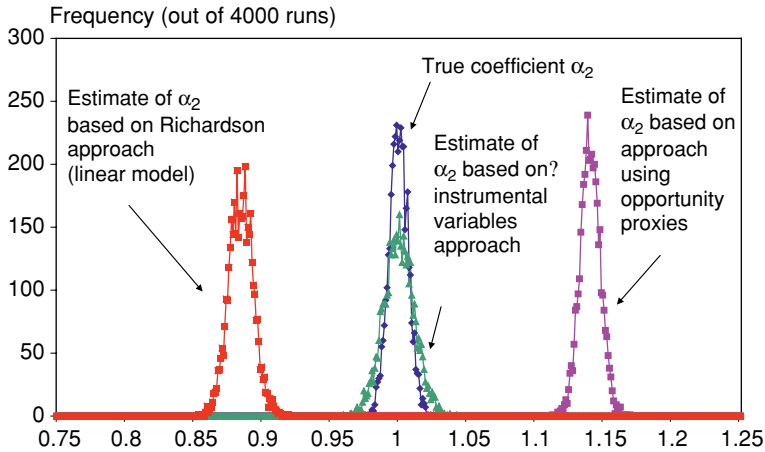

Fig. 1 Estimated α_2 coefficients based on artificial data Frequency (out of 400 runs)

funding requirements are a perfect instrument, in the sense that they are entirely uncorrelated with investment opportunities and induce a large amount of variation in cash flows. A researcher using real data must build a case that an instrument is valid, and almost any instrument can be challenged on a priori grounds. Nevertheless, my opinion is that the weaknesses in Richardson's specification of 'mandated' investment are likely to exceed potential weaknesses due to correlations between investment opportunities and the instruments used in the recent papers that have used IV approaches to look at the relationship between investment and cash flows.

The coefficients in Fig. 1 are based the estimation of a linear model of investment and cash flow; Fig. 2 below illustrates an additional complication of Richardson's approach. A non-linear relationship between the investment opportunity set and the investment opportunity proxies can lead to a spurious finding of a 'kinked' relationship between overinvestment and free cash flows. Figure 2 presents the estimated coefficients on the kink term (with a knot point at zero) based on the 4000 simulated datasets described above.

The previous section presented evidence that the finding of a kink in the relationship between free cash flows and investment is not evidence for or against any particular deviation from the Modigliani–Miller assumptions; the simulation presented here suggests that the very finding of a kink may itself be spurious, and reflect the limitations of Richardson's empirical proxies for the investment opportunity set.

4. Some smaller points

Richardson also documents evidence on the relationship between firms' governance structures and the relationship between free cash flows and investment. These results focus on 2002, a year for which Richardson has access to

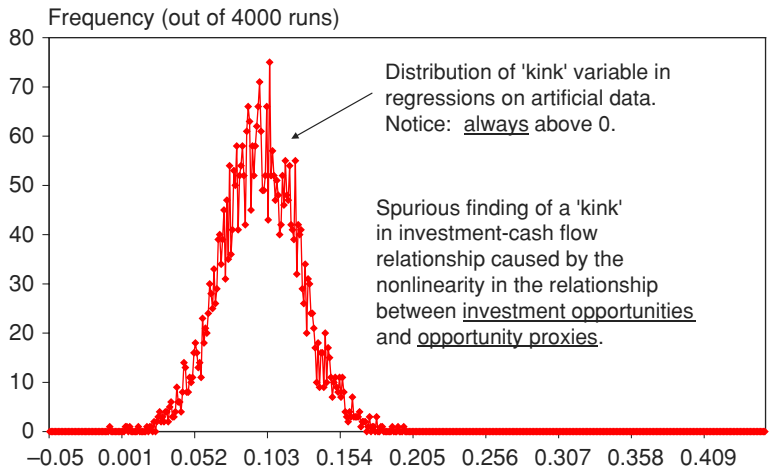

Fig. 2 Estimated coefficients on 'kink' term Frequency (out of 4000 runs)

disaggregated measures of corporate governance for a subsample of 815 firms. The results here are largely negative: the measures of corporate governance do not, in aggregate, have much impact on the amount of investment or on the relationship between investment and free cash flows. My view is that this analysis inherits some of the problems discussed above. In particular, the measure of overinvestment is investment relative to an empirical model of mandated investment. This empirical model includes current cash holdings and lagged investment. Average overinvestment of zero is an assumption of this approach, rather than something being tested; if all firms always invest in negative NPV projects, doing so year after year and out of both cash flows and stocks, then Richardson's approach would not pick this up.

5. Conclusion

Richardson adds a new framework for estimating the relationship between firm-level cash flows and investment. Similar to instrumental variables approaches, this approach involves restricted estimation of the relationship between cash flow and investment. While my sense is that the specific restricted approach that Richardson applies is likely to be dominated by both unrestricted approaches and by existing instrumental variables approaches, I do not claim to have proven that this is the case. No empirical approach to estimating the relationship between cash flow and investment is without flaws. I would encourage Richardson to articulate his approach more clearly in terms of the restrictions he is imposing, so that the costs and benefits of his approach relative to other approaches may be more easily weighed.

Like the bulk of the existing literature, Richardson's results confirm the empirical significance of some set of departures from the Modigliani–Miller

baseline. It appears that cash flows have an impact on investment activity, even when we control for firms' investment opportunities. I remain, however, very skeptical regarding Richardson's attempts to parse out the particular violation of the Modigliani–Miller assumptions that is empirically more important.

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