The Corporate Propensity to Save

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September 15, 2006

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Abstract

We develop a dynamic model of the firm with endogenous choices of external finance, distributions, cash, and real investment. The model predicts that firms facing costly external finance dissave out of cash flow, because they funnel cash flow into investment rather than cash after receiving good productivity news. Data from six countries support this prediction. OLS regressions replicate the result in the literature that the propensity to save out of cash flow is positive. However, after treating measurement error in Tobin's q, we find the opposite. Interestingly, costly external finance explains less of the saving propensity than the uncertainty a firm faces.

1. Introduction

How does costly external finance affect corporate decisions—both real and financial? Whatever the answer, it must incorporate the idea that one cannot understand real decisions without understanding how they interact with financial decisions, and vice versa. We apply this general principle to further our understanding of corporate cash policy, asking, in particular, how costly external finance affects corporate saving; i.e. the propensity for a firm to funnel its cash flow into cash holdings.

We develop a model that provides several surprising insights. Although we do not directly estimate this model, we follow Caggese (2006) and Whited (2006) by using what we call a quasi-structural approach. Specifically, we develop an infinite-horizon model of a firm that invests and saves in the face of uncertainty, taxation, and costly external finance. We then use a numerical solution to the model to generate an exact testable implication concerning the sign of the coefficient on cash flow in a linear regression of the change in cash levels (savings) on Tobin's q and cash flow. Under most model parameterizations our simulations produce a negative coefficient on cash flow, which becomes increasingly negative as external finance becomes more costly and as the degree of uncertainty the firm faces falls. We find strong support for this prediction using international firm-level data.

Although this prediction is, at first, counterintuitive, the intuition behind our model is straightforward. A firm makes joint investment, saving, and production decisions. It faces both convex and fixed costs of adjusting its physical capital stock, and it can only raise external finance at a premium. Because interest on any cash balances is taxed, the firm faces a dynamic trade-off between the tax penalty on saving and the reduction in expected future financing costs conferred by holding cash. Its optimal savings policy therefore depends not only on the cost of external finance, but also on its expected future financing needs, which,in turn, depend on its technology and especially on the nature of the uncertainty in income that it faces. This uncertainly in income turns out to be quite important for our results, and the intertemporal nature of the model allows us to understand the effects of the serial correlation and variance of income shocks on the saving decision, as well as the interaction between corporate saving and investment decisions.

For example, if the firm faces positively correlated income shocks over time, a positive shock to income means that its capital goods will be productive in the future, and it invests. It also knows that it will be unlikely to need external finance in the future. These two effects lead to a propensity to dissave out of cash flow. On the other hand, we find the opposite result if the firm faces highly negatively correlated income shocks. In this case, for example, if a firm experiences a positive shock, it knows that it will likely experience a negative shock in the future. It therefore expects the productivity of capital goods to decline, which leads to a decrease in investment. The firm also anticipates an income shortfall in the future, which may force the firm to find outside finance for any desired future investment projects. These two effects cause an increase in saving. On a priori grounds this second result is unlikely inasmuch as most firms have positively serially correlated cash flows.

The relationship between saving and cash flow becomes increasingly negative as the serial correlation of profit shocks and the cost of external finance increase. This second result occurs because our simulated firms with highly costly external finance hold higher *levels* of cash than firms with less costly external finance. Such firms therefore have more slack with which to respond to profit shocks, and they save or dissave more aggressively in large part to counteract these shocks. Although the levels and changes in cash for a firm are clearly related, a high level of cash does not imply a high sensitivity of the change in cash (saving) to cash flow; nor does a low level of cash imply a low sensitivity of saving to cash flow. This distinction would be impossible to uncover, for example, in a static, two-period model, because in such a setting the change in cash is indistinguishable from the level. A dynamic model such as ours is therefore key to understanding corporate saving behavior.

We test the prediction that the cash-flow coefficient is negative in a regression of corporate saving on Tobin's q, and cash flow, using firm-level data from six countries—Canada, France, Germany, Japan, the U.K., and the U.S. Our results are interesting. In support of the findings in Almeida, et al. (2004), our OLS regressions produce a positive coefficient on cash flow for all six countries. We again confirm their results when we find that this coefficient is higher for small firms than large firms. However, when we correct for the well-documented measurement error in q, following Erickson and Whited (2000, 2002), we find negative coefficients on cash flow in all six countries, and many are significant. The countries with the most negative cash-flow coefficients are those that face the least uncertainty, and firms typically categorized as facing finance constraints have cash-flow coefficients closer to zero than their unconstrained counterparts, because they have highly variable income shocks. Taken together, our simulations and empirical evidence suggest that income shocks are at least as important as financial constraints in determining corporate saving.

Our results may seem somewhat puzzling in light of the argument that measurement error in Tobin's q should not matter in a regression of the change in cash levels (rather than investment) on Tobin's q and cash flow. As explained in Almeida, et al. (2004), cash flow contains information about future investment opportunities, and it is this information that in part causes the significance of cash flow in an investment regression. Implicit in this argument is the idea that cash flow contains little information about future savings opportunities. If this argument is correct, then using a measurement-error consistent estimator should confer no advantage over OLS. As explained in Erickson and Whited (2000), however, measurement error in Tobin's q can bias any regression coefficient as long as the regressor in question is correlated with true, unobserved q. The information about future investment opportunities in cash flow leads naturally to a positive correlation between q and cash flow—a correlation that biases the cash-flow coefficient in the presence of a noisy measure of Tobin's q. We are able to avoid this issue by correcting for measurement error in q, and our results are accordingly different from those found previously.

Because one of the main contributions of our paper is a richer framework for investigating cash holdings, it is important to identify the advantages and disadvantages of our quasi-structural approach with respect to a purely structural approach. On one hand, estimation of a structural model, as in Hennessy and Whited (2005, 2006), is preferable because it provides a direct link between the underlying theory and any empirical results. On the other hand, structural estimation always faces the issue that any inference drawn could be fragile with respect to the choice of assumptions used to render the model estimable. A quasi-structural approach such as ours only provides an indirect link between theory and its tests. It is, however, more robust to problems with misspecification of the theoretical model, because the model is not estimated. Rather model simulations are used to derive the exact form of a regression. In other words, our approach provides insights into understanding how the world might work if our model closely mimics reality. It does not require that our model be exactly true with regard to our data moments of interest.

Our approach also has clear advantages over predictions that take the form of the sign of a partial derivative in a static model. These latter sorts of predictions by nature hold all other relevant variables constant, and they typically give little guidance concerning the specification of a regression or plausible reduced-form identification strategies. In contrast, our model provides an exact regression specification that accounts for several decisions that are made jointly. Because our empirical predictions take the form of linear projections, they do not, by definition, suffer from endogeneity concerns.

The model in this paper is most closely related to that in Whited (2006), in which a firm chooses investment and cash holdings in the face of costly external equity finance and fixed costs of capital adjustment. Our two extensions are the inclusion of a corporate income tax and convex adjustment costs, and we examine empirically the model's implications for saving rather than for investment, as in Whited (2006). Our model is also closely related to the one in Eisfeldt and Rampini (2006), which characterizes the business-cycle properties of aggregate liquidity. They calibrate a general-equilibrium model with a rich specification of uncertainty. Although many of the same economic mechanisms at work in their model also operate in ours, the focus of the two papers is quite different in that we are interested in directly testing the implications of the model at the firm level, instead of calibrating at the aggregate level. Another closely related paper is Gamba and Triantis (2006). Their model is quite general, allowing for cash holding, as well as separate debt and equity finance, though, unlike us, they omit physical adjustment costs. Their intent is to examine how costly external finance and technology affect the levels of corporate cash holding. Their main contribution is an explanation of how debt flotation costs can lead to simultaneous cash and debt holdings. Once again, however, this paper is entirely theoretical. Ours also has a different focus. Instead of concentrating on the debt versus cash decision, we study the effects of endogenous investment on saving, that is, the change in cash balances.

Our model is also related to those in recent theoretical and empirical papers that tackle other corporate finance questions in dynamic frameworks. For example, Gomes (2001) studies the sensitivity of investment to cash flow in a general equilibrium model. Cooley and Quadrini (2001) study entry and exit in an industry-equilibrium model in which firms can issue defaultable debt and face proportional costs of external equity. Their model is more general than ours because it allows external risky debt finance. They do not, however, model physical adjustment costs or allow firms to save. Moyen (2004) studies investment in a partial-equilibrium model of financially constrained and unconstrained firms. Her model also contains separate debt and equity finance but does not incorporate savings or adjustment costs. Cooper and Ejarque (2003) use a dynamic model to estimate investment-cash flow sensitivities. Hennessy and Whited (2005, 2006) also estimate dynamic models of corporate capital structure and the cost of external finance.

Our work is tangentially related to recent empirical work on the determinants of the level of corporate cash holdings, such as Kim Mauer, and Sherman (1998), Opler, Pinkowitz, Stulz, and Williamson (1999), Pinkowitz and Williamson (2001), Dittmar and Mahrt-Smitt (2005), and Faulkender and Wang (2006). Our paper is much more closely related to empirical work that specifically concentrates on saving, such as Almeida, Campello, and Weisbach (2004), who investigate the firms' tendencies to save in the face of external finance constraints; Khurana, Pereira, and Martin (2006), who replicate the results in Almeida, et al. (2004) on data from several different countries; Acharya, Almeida, and Campello (2006), who examine both the propensity to save and the propensity to issue debt, and Sufi (2006), who uses cash-cash flow sensitivities as an explicit metric for gauging the severity of external finance constraints. Our results stand in stark contrast to those in the second group of studies because of our use of a dynamic model and measurement-error consistent estimators.

The paper is organized as follows. Section 2 presents the model. Section 3 outlines the model simulation and describes the simulation results. Section 4 presents the estimation procedure and results, and Section 5 concludes. The details regarding the estimation procedure are in the Appendix, along with a Monte Carlo simulation to determine finite-sample performance of our estimators.

2. A Model of Cash Holding

To motivate our empirical work, we consider a discrete-time, infinite-horizon, partial-equilibrium model of investment and saving. First we describe the technology, taxation, and financial frictions. Then we move onto a description of the optimal financing policies.

2.1. Technology and Financing

A risk-neutral producer uses capital, k, to produce output. The producer's per period profit function is given by $\pi(k,z)$, in which $\pi(k,z)$ is continuous, $\pi(0,z)=0$, $\pi_z(k,z)>0$, $\pi_k(k,z)>0$, $\pi_{kk}(k,z)<0$, and $\lim_{k\to\infty}\pi_k(k,z)=0$. The profit function can be thought of as a reduced-form production function in which variable factors have already been maximized out of the problem. Concavity of $\pi(k,z)$ results from decreasing returns in production, a downward sloping demand curve, or both. The combination demand and productivity shock is denoted by z. It is observed by the producer before he makes his current period decisions, but not observed by the econometrician. The shock z takes values in $[\underline{z},\bar{z}]$ and follows a first-order Markov process with transition probability $q(z',z)$, in which a prime indicates a variable in the subsequent period, and in which $q(z',z)$ has the Feller property.

Without loss of generality, k lies in a compact set. As in Gomes (2001), define $\overline{k}$ as

$$\pi(\overline{k},\overline{z})-d\overline{k}\equiv 0, \tag{1}$$

in which d is the constant rate of depreciation, $0<d<1$. Concavity of π and $\lim_{k\to\infty}\pi_k(k,z)=0$ ensure that $\overline{k}$ is a well-defined quantity. Because $k>\overline{k}$ is not economically profitable, k lies in the interval $[0,\overline{k}]$. Because $\pi(k,z)$ is continuous and the state space is compact, it is bounded. Investment, I, is defined as

$$I \equiv k' - (1-d)k. \qquad (2)$$

We now discuss financing. In this model all external finance takes the form of equity. Although inappropriate for the study of capital structure, this simplification allows us to highlight the interaction between technology, finance constraints, and cash holdings. Further, the simple structure does not affect the qualitative outcome of the simulations that follow. The firm can hold cash balances, p, via a riskless one-period discount bond that earns an interest rate r. To ensure compactness of the choice set, we assume an arbitrarily high upper bound on corporate saving, $\bar{p}$. This upper bound is imposed without loss of generality, because our taxation assumptions ensure bounded saving.

The firm faces both real and financial frictions. First, the firm purchases and sells capital at a price of one. When it does so, it incurs adjustment costs according to

$$A(k, k') = ck\Phi_i + \frac{a}{2}\left(\frac{k'}{k} - (1-d)\right)^2 k. \qquad (3)$$

The functional form of (3) is sufficiently flexible that it encompasses both fixed and smooth adjustment costs. The fixed component is captured by the first term, $ck\Phi_i$, in which c is a constant, and Φ_i is an indicator variable that takes the value of one if investment is not equal to zero, and zero otherwise. The fixed cost is proportional to the capital stock so that the firm can never grow out of the fixed cost. The second term is a standard quadratic adjustment cost function commonly found in the empirical investment literature.

We also assume that the firm faces a corporate income tax at a rate τ_c. For simplicity, we do not model personal interest and dividend taxes. What is important for our model is the existence of a tax penalty for saving, which is consistent with recent U.S. tax code. See Hennessy and Whited (2005).

To preserve tractability, we do not model costs of external equity as the outcome of an asymmetric information problem. Rather, we capture adverse selection costs and underwriting fees in a reduced-form fashion. Accordingly, we define the excess of cash inflows over cash outflows as

$$e(k,k',p,p',z) \equiv (1-\tau_c)\,\pi(k,z) + p - \frac{p'}{(1+r(1-\tau_c))} - (k'-(1-d)k) - A(k,k'). \quad (4)$$

If $e(k,k',p,p',z) > 0$, the firm is paying dividends, and if $e(k,k',p,p',z) < 0$, the firm is issuing equity. The cost of external equity function is linear-quadratic and weakly convex:

$$\begin{aligned} \phi(e(k,k',p,p',z)) &\equiv \Phi_e \left(\lambda_0 + \lambda_1 e(k,p,k',p',z) - \frac{1}{2}\lambda_2 e(k,p,k',p',z)^2 \right) \\ \lambda_i &\geq 0 \quad i = 0,1,2, \end{aligned}$$

in which Φ_e is an indicator variable that takes a value of one if $e(k,p,k',p',z) < 0$. Convexity of the external finance function is consistent with the evidence on underwriting fees in Altinkilic and Hansen (2000).

The firm chooses (k',p') each period to maximize the value of expected future cash flows, discounting at the opportunity cost of funds, r. The Bellman equation for the problem is

$$V(k,p,z) = \max_{k',\ p'} \left\{ e(k,k',p,p',z) + \phi(e(k,k',p,p',z)) + \frac{1}{1+r} \int V(k',p',z')\, dq(z',z) \right\}. \quad (5)$$

The model satisfies the conditions for Theorem 9.6 in Stokey and Lucas (1989), which guarantees a solution for (6) and (7). Theorem 9.8 in Stokey and Lucas (1989) ensures a unique optimal policy function, $\{k',p'\} = g(k,p,z)$, if $v^n(k,p,p',z)$ and $v^i(k,p,k',p',z)$ are weakly concave in their first two arguments. This requirement puts easily verified restrictions on $\phi(\cdot)$, which are satisfied by all functional forms chosen below.

2.2. Optimal Financial Policies

This subsection develops the intuition behind the model by examining its optimality conditions. To simplify the exposition, this subsection assumes V is concave and once differentiable. We present optimal financial policies, heuristically, in two steps. First, we determine optimal financing under the assumption that the manager ignores fixed costs of external equity; that is, treats $\lambda_0 = 0$. Second, we determine whether the intra-marginal benefits of equity issuance justify the fixed cost.

The optimal interior financial policy, obtained by solving the optimization problem in (5) must satisfy

$$1 + (\lambda_1 - \lambda_2 e)\,\Phi_e = \frac{1 + r\,(1-\tau_c)}{1+r} \int V_2(k', p', z')\,dq(z', z)\,. \tag{6}$$

The right side represents the shadow value of cash balances and the left side represents the marginal cost of external equity finance. To develop the intuition behind the optimal policy, we use the envelope condition to rewrite (6) as:

$$1 + (\lambda_1 - \lambda_2 e)\,\Phi_e = \frac{1 + r\,(1-\tau_c)}{1+r} \int (1 + (\lambda_1 - \lambda_2 e')\,\Phi_e')\,dq(z', z)\,. \tag{7}$$

Rewriting (6) as (7) makes it clear that in the absence of costly external finance, equation (7) holds as an inequality. In this case the tax penalty for saving implies that the firm never saves; i.e. $p = p' = 0$. In contrast, in the face of costly external finance, if a firm saves a dollar today, it reduces the probability that it will have to issue new equity tomorrow. If this probability is sufficiently high, the gain from reducing future equity costs will outweigh the tax penalty for saving.

In some instances the fixed costs of external equity will be larger than the intra-marginal gains from equity issuance. In these cases the firm will be in a financial inertia region, in which it neither issues equity nor pays dividends. Internal funds are the marginal source of funds and the firm saves any excess cash flows not used for positive NPV projects.[1]

3. Simulations

We solve the model numerically and investigate its implication for reduced-form regressions via simulation. We first describe the parameterization of our baseline simulation. We then explain the experiments we perform on the model and the results of these experiments

[1] The model contains several simplifying features. First, the firm does not use external debt finance. If the firm were to issue defaultable debt, then an extra incentive to hoard cash would arise as the firm would want to avoid default. Second, the firm does not smooth dividends. This model feature would also produce more cash hoarding relative to our model because the firm would want to avoid missing a dividend payment. Finally, the firm has no fixed costs of production. This model feature would produce less cash holding relative to our model because the firm would have smaller profits to funnel into liquid assets. The firm would, nonetheless, hold cash to avoid costly external finance. We choose not to include any of these features in our model, because they would not change the qualitative outcomes of the simulations and because we want to highlight the tradeoff between the tax penalty on saving and costly external finance.

3.1. Model Parameterization

The profit function is given by

$$\pi(k,z) = zk^{\theta}, \tag{8}$$

in which we set θ equal to 0.75. This setting is from the estimates of labor shares and markups in Rotemberg and Woodford (1992, 1999). These estimates, along with the assumption of a Cobb-Douglas production function and a constant-elasticity demand function, imply that $\theta \approx 0.75$.

To find values for the adjustment cost parameters, c and a, we turn to Cooper and Haltiwanger (2006), who find that both convex and fixed costs of adjustment are important for investment. From their estimates we set $c = 0.039$ and $a = 0.049$. Next, we set the depreciation rate equal to 0.15, a figure approximately equal to the average in our data of the ratio of depreciation to the net capital stock. We set the interest rate, r, equal to 4%.

Next, we specify a stochastic process for the shock, z. Following Gomes (2001), we assume that z follows an $AR(1)$ in logs,

$$\ln(z') = \rho \ln(z) + v', \tag{9}$$

in which $v' \sim N(0, \sigma_v^2)$. Our baseline parameter choices for ρ and σ_v are the averages of the estimates of these two parameters in Hennessy and Whited (2006): $\rho = 0.66$ and $\sigma_v = 0.121$.

We again follow Hennessy and Whited (2006) for our parameterization of the financing function, setting $\lambda_0 = 0.389$, $\lambda_1 = 0.053$, and $\lambda_2 = 0.0002$. These settings are from their estimates of the costs of external equity finance for large firms, and are therefore conservative, lying only slightly above the figures for underwriting costs in Altinkilic and Hansen (2000).

Finally, to find a numerical solution we need to specify a finite state space for the three state variables. We let the capital stock lie on the points

$$\left[\overline{k}(1-d)^{40}, \ldots, \overline{k}(1-d), \overline{k}\right].$$

We let the productivity shock have 20 points of support, transforming (14) into a discrete-state Markov chain using the method in Tauchen (1986). We let p have 20 equally spaced points of support in the interval $[0, \overline{p}]$, in which $\overline{p}$ is set to $\overline{k}/2$. This upper bound never binds for the optimal choices of p determined by the simulation procedure.

We solve the model via iteration on the Bellman equation, which produces the value function $V(k, p, z)$ and the policy function $\{k', p'\} = h(k, p, z)$. In the subsequent model simulation, the space for z is expanded to include 80 points, with interpolation used to find corresponding values of V, k, and p. The model simulation proceeds by taking a random draw from the conditional (on z) distribution z' shock, and then computing $V(k, p, z)$ and $h(k, p, z)$. We then generate an artificial panel of firms by simulating the model for 10,000 identical firms for 200 time periods, keeping only the last 20 observations for each firm.

3.2. Experiments

The intent of this exercise is to ascertain the dependence of corporate saving on not only the firm's financial environment, but also its technological environment. To this end, we investigate the sensitivity to changes in the model parameters of the following commonly used gauges of a firm's saving behavior. The first such gauge is simply the ratio of cash holdings to assets, which in our model is p/k. The second is the cash flow sensitivity of cash—a measure that first appears in Almeida, Campello, and Weisbach (2004). In terms of our model this sensitivity can be defined as the regression coefficient, α_1, in the following regression:

$$\frac{p' - p}{k} = \alpha_0 + \beta \frac{V(k, p, z)}{k} + \alpha_1 \frac{\pi(k, z)}{k} + u, \tag{10}$$

in which α_0, α_1, and β are regression coefficients and u is a regression disturbance, which in our simulations is, by definition, orthogonal to the regressors.

We examine the sensitivity of these two measures of cash holding with regard to eight key model parameters: the variance and serial correlation of income shocks, the three equity-cost parameters, λ_0, λ_1, and λ_2, the curvature of the profit function, θ, and the fixed and quadratic adjustment cost parameters, c and a.

In each of the experiments that follow, we set all but one of the parameters equal to their baseline levels as defined above, allowing the free parameter to range within a given interval.

We allow θ to range between 0.6 and 0.9, ρ to range from -0.8 to 0.8, σ_v to range from 0.075 to 0.15, λ_0 to range from 0 to 0.8, λ_1 to range from 0 to 0.1, λ_2 to range from 0 to 0.0004, c to range from 0 to 0.8, and a to range from 0 to 0.1. In thinking about the results that follow, it is crucial to separate cash levels from cash changes (savings).

Figure 1 illustrates the dependence of the average level of cash holdings (as a fraction of the capital stock) on the model parameters. We first examine the parameters that govern the stochastic shock process. The first panel shows that the relation between the serial correlation of shocks, ρ, and cash holdings is slightly u-shaped. For both highly positively and highly negatively correlated shocks, the firm holds high cash balances, opting for lower balances if the shocks are less highly correlated. This result occurs because the higher the serial correlation of an $AR(1)$ process, the higher its variance. If the firm faces an uncertain environment, it expects to tap external finance more often, and it holds higher cash balances. The same intuition is evident in the second panel, which depicts a positive relation between cash holdings and the variance of the innovations to the income shock process.

We next examine the effects of costly external finance. The third through fifth panels illustrate the relationships between each of the external finance parameters and cash holdings. Not surprisingly, panels 3 and 4 show that cash increases with the fixed and linear components of the external finance function, λ_0 and λ_1, because the value of financial flexibility increases as external finance becomes more costly. However, the relationship shown in panel 5 between the quadratic component, λ_2, and cash holdings is only slightly upward sloping. With λ_0 and λ_1 set to their baseline levels, the effect of λ_2 is second-order. These results mirror those in the two-period model of Almeida, Campello, and Weisbach (2004), which produces a partial derivative of cash with respect to internal funds that is positive for a financially constrained firm, and zero otherwise.

Finally, we examine the effects of technology in panels 6 through 8. Panel 6 shows that the effect of θ on cash is hump-shaped, initially rising and then falling slightly. Two different economic forces create this pattern. First, as θ rises, the production function becomes flatter, and the average size of desired investments rises. The firm holds more cash because large investments imply a greater likelihood of needing external finance. Second, as θ rises, the firm is less likely to have to tap external finance, because a higher θ implies that a given capital stock can create more output, which alleviates the external finance premium, and the firm needs to hold less cash. Clearly, the first effect is stronger for lower levels of θ, and the second effect is stronger for higher levels of θ. The seventh panel shows that cash holding increases with the fixed cost of adjustment. This effect occurs because higher fixed adjustment costs lead to larger investments that occur less frequently. The firm then uses episodes of inaction to accumulate cash. Parenthetically, this type of phenomenon is likely to be in part behind the recent tendency in the U.S. and Europe for firms to hoard cash, as these firms concentrate less on internal organic growth in favor of growth via large acquisitions. Finally, the eighth panel shows the effect of an increase in the convex component of adjustment costs. Not surprisingly, convex adjustment costs have the opposite effect on cash holding. As a increases, the firm makes smaller investment more often, is therefore less likely to have to tap external finance, and holds less cash.

These results on the level of cash balances reassuringly confirm those in Gamba and Triantis (2006), in particular their results on the effects of uncertainty and costly external finance. Our results on cash levels are also useful in providing intuition for the main focus of this paper, which is not cash levels, per se, but the propensity to save.

Figure 2 is analogous to Figure 1, except that it deals with the change in cash balances instead of the level, depicting the dependence on the model parameters of the sensitivity of changes in cash balances (saving) to cash flow. We once again start with a discussion of the parameters governing uncertainty. The first panel shows the effect of ρ on the cash flow sensitivity of cash, which is the most interesting result in our simulations. For a highly negatively correlated shock process the sensitivity is large and positive, for a highly positively correlated shock process the sensitivity is large and negative, and for a predominantly serially uncorrelated shock process the sensitivity is small and negative. This result is due to the firm's expectation about future needs to tap external finance and about the future productivity of capital. For example, if profit shocks are negatively serially correlated, then if a firm experiences a positive shock, it knows that it will likely experience an income shortfall in the future and consequently be forced to find outside finance for any desired investment projects. It therefore saves. Further, it knows that the productivity of capital goods will decline, and in the face of costly capital reversibility it will therefore funnel any extra cash flow into saving rather than investment. On the other hand, if the firm faces positively correlated income shocks, then when it experiences a positive shock, it knows that it will be unlikely to need external finance in the future, and it reduces its cash holdings.[2] Also, because it expects the future productivity of capital to rise, it will funnel extra cash flow into investment rather than saving.

The second panel illustrates the effect of the shock variance. Cash sensitivity is always negative, but becomes less so as σ_v increases. As the firm's environment becomes more uncertain, its level of cash holdings increases, but it also becomes more reluctant to change its cash holdings aggressively in response to shocks, which convey little information in an uncertain environment. This panel does not imply that the firm always dissaves. Instead, the firm saves and dissaves to counteract profit shocks.

We now turn to the effects of costly external finance. The patterns evident in panels 3 through 5 mirror those in the corresponding panels in Figure 1. In all cases, as costly external finance increases, the level of cash holdings increases, and the sensitivity of cash to cash flow becomes more negative. As costly external finance increases, the firm accumulates more financial slack. It can therefore respond to shocks more aggressively by changing the level of cash. For example, if a firm with a great deal of financial slack is hit by a positive profit shock, it will dissave a great deal in order to invest. A firm with little financial slack will not be able to dissave as much.

Finally, we turn to technology. Cash sensitivity becomes more negative as θ increases; that is, as the production function becomes flatter. With a flat production function shocks induce large desired changes in the capital stock, and the firm dissaves to fund these investments.

[2] In a more fundamental information-theoretic model of the cost of external finance, a positive shock to the firm might induce recontracting between the firm and its supplier of funds. The resulting contract would likely be more favorable to the firm, which would reinforce its tendency to dissave.

Cash sensitivity also becomes more negative as both types of adjustment costs increase. As higher adjustment costs cause investment policy to become less flexible, the firm compensates by making its saving policy more flexible.

In sum these experiments highlight one final general point. Although the levels and changes in cash are clearly related, a high level of cash does not imply a high sensitivity of the change in cash (saving) to cash flow; nor does a low level of cash imply a low sensitivity of saving to cash flow. We emphasize again that this distinction is impossible to uncover in a static model because the change in cash is essentially the level. A dynamic model is therefore fundamental to understanding corporate saving behavior.

4. Data and summary statistics

We draw data for non-financial firms from Standard and Poor's Compustat Global Industrial/Commercial and Global Issue for six countries: Canada, France, Germany, Japan, the U.K., and the U.S.[3] Data cover the period 1997-2004. We select the sample by first deleting any firm-year observations with missing data. Next, we delete any observations for which total assets, the gross capital stock, or sales are either zero or negative. We next delete observations in which the firm made acquisitions in excess of 15% of total assets. Then for each firm we select the longest consecutive times series of data and exclude firms with only one observation. Finally, we omit all firms whose primary SIC classification is between 4900 and 4999, between 6000 and 6999, or greater than 9000, because our model is inappropriate for regulated, financial, or quasi-public firms.

Data variables from Global Industrial/Commercial are defined as follows: Book assets is Item 89; investment is Item 193; cash flow is the sum of Items 11 and 32; and cash is Item 60. The numerator of the market-to-book ratio is the sum of the market value of equity (Item 3 times Item 13 in Global Issue) and total book assets minus the book value of equity

[3]We also separately estimated our model with data from Thompson Financial's Worldscope, and found similar results to those reported here. The Worldscope sample was much smaller, due primarily to missing data, and we chose to omit those results. We also chose not to blend the two datasets in order to preserve measurement consistency in our reported results.

(Item 105+Item 135), and the denominator is book assets. In our regressions we scale both the change in cash and cash flow by total assets.

The number of observations available varies across years, and these numbers are shown in Tables 2-7 by year and country. Summary statistics are in Table 1. We see large differences in most instances between our means and medians—a result that implies we do not have normally distributed variables. This skewness is key for the identification of our GMM methodology below. The mean and median measures of Tobin's q (market to book) are greatest in the U.S. and lowest in Japan and France. Not surprisingly, the investment rates in Japan and France are low. Only France shows negative mean investment, but its median investment level is positive, though small compared to other countries. All means and medians of Tobin's q are greater than one. Although this pattern is commonly viewed as an indication of positive investment opportunities, adjustment and installation costs in the investment process and market power can leave q above one even for firms without positive investment opportunities. During our sample period the typical firm in four of our countries (U.K., Japan, France and Germany) had a negative change in cash stock, while the U.S. and Canada experienced positive changes.

5. Estimation

This section first outlines the econometric methodology and the model specification: details are provided in the Appendix. It next specifies the hypotheses to be tested and presents the results and their interpretation. It concludes by examining the robustness of the results with respect to alternative specifications.

5.1. Methods

Our testing strategy is based on the estimators in Erickson and Whited (2000, 2002). These estimators employ the structure of the classical errors-in-variables model. Applied to a single cross section, this model can be written as

$$y_i = z_i\alpha + q_i\beta + u_i, \tag{11}$$

$$x_i = \gamma + q_i + \varepsilon_i. \tag{12}$$

In our application y_i is the ratio of the change in cash to assets, q_i is the true q of firm i, x_i is an estimate of its true q, and z_i is a row vector of perfectly measured regressors, whose first entry is 1. The regression error, u_i, and the measurement error, ε_i, are assumed independent of each other and of (z_i, q_i), and the observations within a cross section are assumed *i.i.d.* We do not require any assumptions about the temporal dependence or independence of $(q_i, z_i, u_i, \varepsilon_i)$. Note that the intercept in (12) allows for systematic bias in the measurement of true q. Using the third and higher order moments of (x_i, y_i), the Erickson and Whited estimators provide consistent estimates of the slope coefficients, α and β, as well as the variances of the unobservable variables $(q_i, u_i, \varepsilon_i)$. These estimators are only identified if $\beta \neq 0$ and q_i is nonnormally distributed. Erickson and Whited (2002) develop a test of the null hypothesis that $\beta = 0$ and q_i is nonnormally distributed—a test we refer to hereafter as an "identification test." Although q_i is a price and is therefore by definition nonnormally distributed, it may be impossible to detect this nonnormality in small samples. For details see Erickson and Whited (2000, 2002) and the Appendix.

The Appendix also presents Monte Carlo simulations to assess the finite sample performance of these estimators on data closely resembling our own. Of particular interest in these Monte Carlos are the tiny actual sizes of many of the tests of the null hypothesis that the coefficient on cash flow equals its true value. This result indicates that the GMM standard errors are conservative estimates of the true standard errors. This last result is the opposite of that found in Erickson and Whited (2000) for *investment* regressions. This result prompts us to used bootstrapped critical values for the t-statistics on the cash flow coefficient. We use the GMM bootstrapping procedure in Brown and Newey (2002), which resamples from the empirical likelihood distribution that imposes the moment restrictions.

Because these estimators can only be applied to samples that are arguably *i.i.d.*, we estimate (11) and (12) for each cross section of our unbalanced panel. We do not include firm fixed effects in our regressions for two reasons. First, the resulting model almost never passes the identification test. Second, our OLS results are little changed by the inclusion of fixed effects, suggesting that the within-firm variation in investment and q mirrors the cross sectional variation. As an informal summary of our yearly results, we pool the yearly estimates from our unbalanced panel via the procedure in Fama and MacBeth (1973). Recently, Petersen (2005) has re-emphasized that Fama-Macbeth standard errors are often inappropriate in panel data. However, we report these standard errors only as an informal summary of our results and instead focus on the GMM standard errors for each cross section. Interestingly, the two sorts of standard errors lead to the same inference.

5.2. Results

Results from estimating (11) via OLS and from estimating (11) and (12) via GMM are in Tables 2 through 7, by country. In each table the left panel shows the OLS results, and the right panel shows the GMM results. We report the OLS estimate of the coefficient of determination of (11) (the regression R^2) in column 3, and the measurement-error consistent GMM estimate of the coefficient of determination of (11) (denoted r^2) in column 6. Column 7 contains the coefficient of determination of (12) (denoted τ^2), which is a useful index of measurement quality for our observable proxy for unobservable investment opportunities. A value close to one indicates a nearly perfect proxy, and a value close zero indicates a nearly worthless proxy. The eighth column reports the J-test of the overidentifying restrictions of the model. The null hypothesis of this test is that the overidentifying restrictions are satisfied. The final column contains the identification test results. The null in this case is that the model is unidentified. A number of researchers have used this test as a "pre-sampling" test to select samples on which the estimator is identified. We do not follow this practice. Rather, we select our sample based on the minimal criterion of data availability. A failure to reject the null of the identification test simply means that the estimates are unreliable—a tendency reflected in large standard errors.

Asymptotic standard errors are in parentheses below each parameter estimate, and p-values are in parentheses below the chi-squared tests. Asterisks mark those GMM estimates of the cash-flow coefficient whose t-statistics exceed the 5% bootstrapped critical values. For brevity, we only indicate the significance of the cash-flow coefficients.

For each country we test the prediction that the coefficient on cash flow is negative in a regression of the change in cash on q and cash flow. Our OLS estimates corroborate those in Almeida, Campello, and Weisbach (2004) and Khurana, Pereira, and Martin (2006) that the coefficients on both Tobin's q and cash flow are positive in virtually all years for all countries.

However, when we apply the Erickson and Whited estimators to correct for measurement error in q, this result changes. We continue to find positive coefficients on q, but we now find negative coefficients on cash flow in virtually all cases in all six countries. Over half of these estimates are statistically significantly according to our bootstrapped critical values. We note that our ability to find statistical significance is almost surely affected by sample size. As is common when using international data, we have smaller samples than we would wish in some countries, particularly for Canada, France and Germany. Further, low sample size can render the GMM model unidentified and can, therefore, potentially weaken results. Given these difficulties, our finding of a high incidence of significant coefficients is all the more striking. In sum, the GMM results correspond to our simulation results above for firms that have positively serially correlated shocks to income.

It is natural at the point to investigate the serial correlation of income for firms in these countries. To do so we use the panel-VAR approach in Holtz-Eakin, Newey, and Rosen (1988). We estimate a first-order autoregressive model, finding statistically significant autoregressive coefficients of 0.55, 0.43, 0.57, 0.46, 0.46, and 0.65 for the U.S., Canada, the U.K., Japan, France, and Germany, respectively.[4] This evidence of positive serial correlation is reassuring, given our simulation results that positive serial correlation is associated with a negative cash-flow coefficient. The cross-sectional variation in these autoregressive coefficients is, however, sufficiently small that the association between them and the average cash-coefficients is weak, although, as predicted, negative. Such is not the case with the estimates of the error standard deviations from these auto regressions. For our six countries these estimates are 0.115, 0.107, 0.092, 0.038, 0.070, and 0.068. In this case we find

[4]For this procedure we require at least three years of consecutive data per firm, and we therefore drop firms with fewer than three observations.

a positive correlation of 0.64 between the error standard deviations and the average cash flow coefficients. Although it is difficult to draw strong inferences from six data points, this result is all the more striking given that the correlation coefficient is statistically significant at the 10% level. The result confirms the intuition from the model that if a firm is subject to a noisy income process, it tends to change its cash holding less aggressively in response to movements in income.

Further support for our results is provided by our failure to reject the overidentifying restrictions from our yearly GMM estimates in all countries for most years. This result is even more interesting given the result in the Appendix that this test has a slight tendency to over-reject in finite samples. This result mitigates concerns about possible model mis-specification. In other words, even though the classical errors-in-variables model is not a perfect representation of the relationship between saving, cash flow, and Tobin's q, our tests indicate that we have a useful approximation.

We compare our results with those in Erickson and Whited (2000), who find that the measurement-error consistent estimates of the coefficients on cash flow in a regression of investment on q and cash flow are near zero. As explained in the introduction, measurement error in a variable biases other coefficients via the correlation between the mismeasured variable and the other regressors.[5] Because the regressions in this paper and those in Erickson and Whited (2000) have the same sets of right-hand-side variables and only differ in the dependent variable, one would expect estimates of cash-flow coefficients in our regressions to be near zero—not negative. However, the measurement quality of the proxy for investment opportunities used in the savings literature, the market-to-book ratio, is of particularly low quality, most the estimates of our index of measurement quality, τ^2, falling between 0.1 and 0.2. In contrast, the measurement quality of the proxy used by Erickson and Whited (2000) is approximately 0.4. Therefore, the positive OLS estimates of the cash-flow coefficients in our regressions are much more severely upward biased than those in Erickson and Whited (2000), and correcting for measurement error in our regressions results in negative

[5] Not required for bias is a correlation between the measurement error and other regressors.

coefficients. In results not reported for brevity we also find negative GMM estimates of the cash-flow coefficients when we use the proxy used by Erickson and Whited (2000); we are unable, however, to generate positive OLS cash-flow coefficients with proxy from Erickson and Whited (2000).

Next we examine whether large and small firms have different relationships between saving, cash flow, and q. Tables 8 through 11 report results for the U.S. and Japan, with the sample in each country split at the median between big and small firms. Sample sizes in the remaining countries are too small to allow GMM estimation with a split sample. It is well established that firm size is important in many research questions. In particular, in the literature on external finance constraints size is often used as an indicator of the difficulty firms may have in raising external funds. As argued and seen in Almeida, et al. (2004), small firms' saving is more positively related to cash flow than large firms' saving. Using size as an indicator of costly access external finance confers an important advantage over other indicators such as dividend payout. It can be considered exogenous, because firm size is not a choice variable for the manager in the short run and is unlikely to depend on investment over the short time period covered by our panel.

We find that in the U.S. most of the yearly cash-flow coefficients are negative and significant for the large firms, and the average is quite large at -0.692. In contrast, only two of the yearly cash-flow coefficients for the small firms are significantly negative, and the average is much lower at -0.033. When we examine differences between the large and small firms, the one characteristic that stands out is the uncertainty that these two groups of firms face. The standard deviation of the error in a first-order autoregression of income for the small firms is 0.140, whereas for the large firms it one third as large at 0.046. As demonstrated in the model simulations, firms that face a great deal of uncertainty do not make large changes in their cash holdings in response to income shocks. Our empirical result supports this hypothesis.

Our result does not appear to support the model prediction that more financially constrained firms have more negative cash-flow coefficients. As shown in Hennessy and Whited (2006), small firms do face more costly external finance than large firms. We conjecture that the effect of finance constraints on cash policy is operating in our sample but that the effect of uncertainty overwhelms the effect of finance constraints.[6] This conjecture is supported by a model simulation in which we double σ_v, λ_0, λ_1, and λ_2 relative to the baseline case, finding that the cash-flow coefficient remains roughly the same after this change in our simulated data. To compare this simulation result to our results from U.S. data, we turn to the estimates of costly external equity finance in Hennessy and Whited (2006). They find that external equity costs for small firms are about twice as large as those for large firms. If we combine these results with ours on the differences in uncertainty facing large and small firms, we see that the difference in uncertainty is larger than the difference in the cost of external finance. Therefore, even though an increase in costly external finance works toward increasing the negative response of cash to cash flow, the dampening effect of uncertainty is stronger.

The results for Japan are not as pronounced. Although we do find that the cash flow coefficients are more negative for small firms than for large firms, the difference is small. Also small, however, is the difference between the level of uncertainty that these two groups of Japanese firms face. The standard deviations of the error in a first-order autoregression of income for the small and large firms are 0.042 and 0.035, respectively.

It is natural to ask if the degree of uncertainty that is so important in understanding these results is somehow merely proxying for financial constraints. However, these two factors are conceptually separate. Financial constraints arise because external finance is costly or, at the extreme, unavailable. Income shocks, their magnitudes, and their correlation patterns arise from technological innovations or changes in demand. Although it is possible that external finance is more costly for firms that face more uncertainty, two pieces of evidence make this possibility unlikely. First, if uncertainty were proxying for external finance constraints, we ought to have seen a more negative cash-flow coefficient for small than for large firms. We do not. Second, we find a relationship across countries between uncertainty and cash-flow

[6] Because both saving and investment decisions respond less to shocks in the face of increased uncertainty, this result is consistent with the results in Kadapakkam, Kumar and Riddick (1998), who find that investment levels of small firms respond less to cash flow than those of large firms.

sensitivity, and it is unlikely that this result is due to differential access to external finance in the six highly developed countries we examine.

6. Conclusion

The issue of corporate saving has recently received much attention, in large part because of the tendency in recent years of both U.S. and European firms to accumulate a great deal of liquid assets. Prior empirical research, including papers by Opler, Pinkowitz, Stulz, and Williamson (1999), Almeida, Campello, and Weisbach (2004), Faulkender and Wang (2006), and Khurana, Pereira, and Martin (2006), has addressed two related issues: why firms hold cash and why firms change their cash holdings. We have, for the most part, addressed the second issue. In so doing, we have taken care to form a strong link between our theory and our empirical tests and to account for measurement error in our empirical work.

Both of these research strategies have led us to conclusions that are quite different from those in existence. Our model predicts that firms who face costly external finance have a strong tendency to counteract movements in cash flow with opposite movements in saving. This result is due in large part to firms wanting to funnel excess cash flow into investment rather than into cash when they receive good cash-flow news. This result is also quite different from that produced by the static model in Almeida, Campello, and Weisbach (2004), and the difference underlines the importance of thinking about corporate decisions in a dynamic framework. Finally, a comparison with the intuition from consumption models is in order. A consumer's marginal propensity to save is almost always positive. However, a consumer can do only two things with income: consume and save. A firm can do a variety of things: save, invest, pay employees, and pay dividends, for example. Given the complexity of a firm's decision making process, it should not be surprising that a firm's marginal propensity to save can be negative.

We find strong empirical support for our negative-sensitivity result in data for six countries. When we examine this sensitivity using OLS regressions, we find the standard result in the literature that the sensitivity of saving to cash flow is positive. However, when we correct econometrically for measurement error in Tobin's q, we find the opposite result. Interestingly, we find the magnitude of the sensitivity of saving to cash flow has less to do with access to external finance than to the amount and type of uncertainty a firm faces. A natural consequence of this finding is that propensities to save cannot be used as summary measures of external finance constraints.

Taken together, our simulations and empirical evidence suggest that income shocks are at least as important as financial constraints in determining corporate saving. We believe that our results also reemphasize that researchers should determine if any model estimation involving Tobin's q has similarly significant bias from mismeasurement. The variable q is important in many contexts, and its mismeasurement has the potential to bias results in any context where q is correlated with other variables in the model. Because q is a broad measure of firm health, it is likely that this correlation issue will be important in many situations, as it is here.

Appendix. Estimation procedure and Monte Carlo experiments

For reference we reproduce (11) and (12) from the text

$$y_i = \alpha_0 + \beta\chi_i + \alpha_1 z_i + u_i \quad (13)$$

$$x_i = \gamma_0 + \chi_i + \varepsilon_i. \quad (14)$$

ε_i is a mean-zero error independent of (u_i, z_i, χ_i), and u_i is independent of (χ_i, z_i). The intercept γ_0 allows for the non-zero means of some sources of measurement error. The EW estimators also require the assumption that $(\varepsilon_i, u_i, z_i, \chi_i)$, $i = 1, \ldots, n$, are *i.i.d.*, that the residual from the projection of χ_i on z_i has a skewed distribution, and that $\beta \neq 0$. The last two assumptions are required for estimator identification and are testable. The one questionable assumption here is the independence of u_i and (χ_i, z_i). Clearly, investment, q, and cash flow are determined simultaneously. However, as delineated in Erickson and Whited (2000), plausible economic assumptions do exist under which the independence assumption holds. Further, because the EW estimators are based on GMM, the J-test can be used to detect assumption violations.

Let $(\dot{y}_i, \dot{x}_i, \dot{\chi}_i)$ be the residuals from the linear projection of (y_i, x_i, χ_i) on z_i. Then (13) and (14) can be written as

$$\dot{y}_i = \beta\chi_i + u_i \quad (15)$$

$$\dot{x}_i = \dot{\chi}_i + \varepsilon_i. \quad (16)$$

If we square (15), multiply the result by (16), and take unconditional expectations of both sides, we obtain

$$E\left(\dot{y}_i^2 \dot{x}_i\right) = \beta^2 E\left(\dot{\chi}_i^3\right). \quad (17)$$

Analogously, if we square (16), multiply the result by (15), and take unconditional expectations of both sides, we obtain

$$E\left(\dot{y}_i \dot{x}_i^2\right) = \beta E\left(\dot{\chi}_i^3\right). \quad (18)$$

As shown in Geary (1942), if $\beta \neq 0$ and $E\left(\dot{\chi}_i^3\right) \neq 0$, dividing (17) by (18) produces a consistent estimator for $\beta \equiv \beta^2 E\left(\dot{\chi}_i^3\right) / \beta E\left(\dot{\chi}_i^3\right)$. (17) and (18) are third order moment equations. The innovation in Erickson and Whited (2002) consists of combining the information in moment equations of order two up through seven via GMM to obtain a more efficient estimator for β. Note that α_1 can be recovered by the identity

$$\alpha_1 = \mu_y - \beta \mu_x,$$

in which $\left(\mu_y, \mu_x\right)$ are the slope coefficients in the projection of (y_i, x_i) on z_i.

The coefficients of determination (R^2's) for (13) and (14) are calculated as

$$r^2 = \frac{\mu_y' \operatorname{var}(z_i)\mu_y + E\left(\dot{\chi}_i^2\right)\beta^2}{\mu_y' \operatorname{var}(z_i)\mu_y + E\left(\dot{\chi}_i^2\right)\beta^2 + E(u_i^2)} \tag{19}$$

$$\tau^2 = \frac{\mu_x' \operatorname{var}(z_i)\mu_x + E\left(\dot{\chi}_i^2\right)}{\mu_x' \operatorname{var}(z_i)\mu_x + E\left(\dot{\chi}_i^2\right) + E(\varepsilon_i^2)}. \tag{20}$$

In order to allay skepticism of empirical results that have been produced by unusual estimators on fairly small samples, in Table 12 we report the results of a Monte Carlo simulation using artificial data similar to our real data, both in terms of sample size and observable moments. These simulations are of particular interest because these estimators have most commonly been used on investment regressions instead of savings regressions, and because savings and investment have different statistical properties. Most importantly, the distribution of investment is highly skewed, whereas the distribution of savings is much more symmetric.

We do three experiments. For both we generate 10,000 simulated cross sections. The first has a sample size of 2576 the second a sample size of 1200, and the third a sample size of 208. These numbers correspond to the size of the largest and smallest cross sections in our data set, as well as an intermediate size. For each simulation we set the parameters β, α, r^2, and τ^2 approximately equal to the averages of the corresponding GMM estimates from Tables 2 through 7. Each observation is of the form (y_i, x_i, z_i), where we generate (y_i, x_i, z_i) according to (11)-(12) so that (y_i, x_i, z_i) have, on average over the simulation samples, first and second moments equal to, and higher-order moments comparable to, the corresponding average sample moments from our real data.

For the third-, fourth- and fifth-, and sixth-order GMM estimators, Table 12 reports the mean value of the estimator of our parameter of interest, α_1. It also reports its mean absolute deviation (MAD), the probability an estimate is within 20% of its true value, and the actual size of a nominal 5% two-sided test of the null hypothesis that α_1 equals its true value. For the small and intermediate sample sizes Table 12 shows that the fourth-order GMM estimator (GMM4) gives the best estimates in terms of expected value, MAD, and probability concentration. For the large sample size the GMM6 estimator performs best. Because the performance of the GMM4 and GMM6 estimators are similar for the large sample size, for our empirical work we therefore use the GMM4 estimator. Also of interest in this table is the tiny actual sizes for the intermediate and large sample sizes of the test of the null hypothesis that α_1 equals its true value. This result indicates that the GMM standard errors are conservative estimates of the true standard errors.

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Table 1: Summary Statistics

	Investment	q	Cash Flow	Cash Stock	Change in Cash Stock
United States					
Mean	0.0733	1.7398	0.0655	0.1383	0.0093
Median	0.0483	1.3869	0.0863	0.0541	0.0013
Canada					
Mean	0.1202	1.3935	0.0729	0.1026	0.0047
Median	0.0690	1.1634	0.0898	0.0349	0.0000
United Kingdom					
Mean	0.0680	1.4619	0.0872	0.1113	-0.0014
Median	0.0427	1.2630	0.0954	0.0662	0.0000
Japan					
Mean	0.0269	1.0796	0.0344	0.1620	-0.0043
Median	0.0183	1.0145	0.0338	0.1344	-0.0026
France					
Mean	-0.0027	1.2150	0.0613	0.1291	-0.0156
Median	0.0016	1.0725	0.0644	0.0911	-0.0031
Germany					
Mean	0.0348	1.2108	0.0673	0.1100	-0.0174
Median	0.0308	1.1070	0.0729	0.0572	-0.0041

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. q stands for the market-to-book ratio. Investment, cash flow, the cash stock, and the change in the cash stock are all deflated by total assets.

Table 2: Cash Regressions: USA

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.039	0.060	0.108	0.263	-0.219*	0.615	0.148	3.743	10.139	2576
	(0.007)	(0.036)	(0.026)	(0.017)	(0.071)	(0.043)	(0.033)	(0.154)	(0.006)	
1998	0.031	0.155	0.107	0.233	-0.120*	0.534	0.134	6.185	10.661	2615
	(0.007)	(0.037)	(0.028)	(0.024)	(0.078)	(0.075)	(0.038)	(0.045)	(0.005)	
1999	0.013	0.197	0.090	0.238	-0.314*	0.383	0.056	2.063	10.740	2567
	(0.004)	(0.030)	(0.019)	(0.035)	(0.130)	(0.070)	(0.021)	(0.356)	(0.005)	
2000	0.021	0.151	0.079	0.298	-0.241*	0.385	0.070	3.643	4.106	2430
	(0.005)	(0.029)	(0.017)	(0.040)	(0.086)	(0.079)	(0.021)	(0.162)	(0.128)	
2001	0.057	0.057	0.183	0.277	-0.102	0.722	0.205	8.610	5.586	2249
	(0.012)	(0.045)	(0.038)	(0.019)	(0.067)	(0.044)	(0.036)	(0.013)	(0.061)	
2002	0.010	0.317	0.212	0.273	0.062	0.348	0.036	3.413	13.291	2383
	(0.003)	(0.019)	(0.021)	(0.065)	(0.068)	(0.043)	(0.016)	(0.182)	(0.001)	
2003	0.033	0.258	0.171	0.273	-0.235*	0.428	0.122	0.480	8.798	2248
	(0.007)	(0.035)	(0.021)	(0.033)	(0.070)	(0.072)	(0.029)	(0.787)	(0.012)	
2004	0.027	0.145	0.088	0.242	-0.236*	0.353	0.111	4.720	9.314	2076
	(0.007)	(0.036)	(0.024)	(0.031)	(0.076)	(0.079)	(0.028)	(0.094)	(0.009)	
Average	0.029	0.168	0.130	0.262	-0.176	0.471	0.110			
	(0.005)	(0.032)	(0.018)	(0.008)	(0.042)	(0.049)	(0.019)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 3: Cash Regressions: Canada

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.080	-0.098	0.224	0.249	-0.166*	0.693	0.401	4.285	4.017	357
	(0.018)	(0.066)	(0.084)	(0.041)	(0.088)	(0.073)	(0.063)	(0.117)	(0.134)	
1998	0.018	0.211	0.069	0.331	0.273	0.294	0.050	4.701	7.103	358
	(0.011)	(0.065)	(0.032)	(0.134)	(0.182)	(0.124)	(0.032)	(0.095)	(0.029)	
1999	0.018	0.275	0.130	0.444	-0.392*	0.418	0.072	3.161	3.851	364
	(0.011)	(0.070)	(0.043)	(0.237)	(0.192)	(0.202)	(0.019)	(0.206)	(0.146)	
2000	0.045	0.223	0.138	0.335	-0.395*	0.532	0.090	3.189	7.078	367
	(0.017)	(0.072)	(0.065)	(0.100)	(0.226)	(0.105)	(0.046)	(0.203)	(0.029)	
2001	0.058	0.161	0.256	0.171	0.115	0.651	0.268	2.130	3.959	337
	(0.015)	(0.047)	(0.084)	(0.015)	(0.067)	(0.109)	(0.087)	(0.345)	(0.138)	
2002	0.023	0.072	0.045	0.212	0.072	0.315	0.242	3.087	4.892	328
	(0.020)	(0.057)	(0.049)	(0.051)	(0.074)	(0.186)	(0.077)	(0.214)	(0.087)	
2003	0.060	0.010	0.136	0.293	-0.164	0.651	0.219	1.204	3.685	319
	(0.022)	(0.090)	(0.070)	(0.078)	(0.145)	(0.134)	(0.048)	(0.548)	(0.158)	
2004	0.032	0.142	0.087	0.283	0.198	0.549	0.112	0.071	3.417	297
	(0.010)	(0.068)	(0.032)	(0.098)	(0.122)	(0.137)	(0.043)	(0.965)	(0.181)	
Average	0.042	0.125	0.136	0.290	-0.057	0.513	0.182			
	(0.008)	(0.044)	(0.026)	(0.030)	(0.092)	(0.055)	(0.043)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 4: Cash Regressions: United Kingdom

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.013	0.130	0.065	0.184	-0.530*	0.238	0.003	2.022	2.185	616
	(0.006)	(0.043)	(0.026)	(0.105)	(0.416)	(0.078)	(0.013)	(0.364)	(0.335)	
1998	0.004	0.162	0.038	0.511	-1.558*	0.154	0.065	1.586	3.635	822
	(0.005)	(0.047)	(0.017)	(0.285)	(1.000)	(0.163)	(0.022)	(0.452)	(0.162)	
1999	0.016	0.163	0.069	0.226	-0.538*	0.255	0.149	6.480	4.832	784
	(0.008)	(0.055)	(0.025)	(0.045)	(0.185)	(0.089)	(0.031)	(0.039)	(0.089)	
2000	0.034	-0.003	0.079	0.257	-0.689*	0.540	0.175	1.653	5.849	711
	(0.011)	(0.064)	(0.036)	(0.036)	(0.156)	(0.094)	(0.038)	(0.438)	(0.054)	
2001	0.011	0.110	0.043	0.173	-0.204*	0.250	0.110	3.780	5.160	714
	(0.006)	(0.044)	(0.017)	(0.034)	(0.094)	(0.115)	(0.026)	(0.151)	(0.076)	
2002	-0.000	0.195	0.074	-0.473	1.001	0.023	0.021	5.576	4.229	733
	(0.005)	(0.039)	(0.027)	(0.507)	(0.870)	(0.200)	(0.026)	(0.062)	(0.121)	
2003	0.015	0.223	0.077	0.230	-0.280*	0.163	0.004	1.093	4.177	698
	(0.012)	(0.068)	(0.021)	(0.077)	(0.198)	(0.084)	(0.009)	(0.579)	(0.124)	
2004	-0.017	0.306	0.096	-0.242	0.842	0.214	0.105	2.407	2.185	613
	(0.007)	(0.060)	(0.035)	(0.116)	(0.287)	(0.084)	(0.051)	(0.300)	(0.335)	
Average	0.010	0.161	0.068	0.227	-0.363	0.230	0.079			
	(0.005)	(0.032)	(0.007)	(0.081)	(0.241)	(0.052)	(0.023)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 5: Cash Regressions: Japan

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.021	0.283	0.058	0.229	-0.096	0.178	0.107	2.038	9.237	1984
	(0.006)	(0.035)	(0.013)	(0.036)	(0.091)	(0.044)	(0.029)	(0.361)	(0.010)	
1998	0.014	0.138	0.024	0.280	-0.446*	0.187	0.054	2.659	0.546	2101
	(0.004)	(0.033)	(0.008)	(0.098)	(0.231)	(0.048)	(0.022)	(0.265)	(0.761)	
1999	0.009	0.133	0.018	0.217	-0.287*	0.069	0.047	1.904	17.986	2220
	(0.004)	(0.030)	(0.007)	(0.120)	(0.249)	(0.032)	(0.027)	(0.386)	(0.000)	
2000	0.019	0.287	0.079	0.288	-0.262*	0.214	0.033	4.080	7.532	2231
	(0.006)	(0.033)	(0.019)	(0.092)	(0.205)	(0.051)	(0.018)	(0.130)	(0.023)	
2001	0.036	0.227	0.074	0.238	-0.224*	0.252	0.151	1.889	8.813	2345
	(0.014)	(0.032)	(0.029)	(0.025)	(0.078)	(0.053)	(0.037)	(0.389)	(0.012)	
2002	0.014	0.183	0.041	0.228	-0.187*	0.146	0.127	11.240	14.975	2353
	(0.004)	(0.026)	(0.010)	(0.077)	(0.148)	(0.024)	(0.037)	(0.004)	(0.001)	
2003	0.017	0.235	0.059	0.397	-0.547*	0.306	0.080	12.930	10.520	2423
	(0.005)	(0.030)	(0.011)	(0.125)	(0.287)	(0.051)	(0.017)	(0.002)	(0.005)	
2004	0.031	0.199	0.070	0.232	-0.237*	0.278	0.108	4.532	4.882	2402
	(0.007)	(0.034)	(0.016)	(0.054)	(0.134)	(0.043)	(0.025)	(0.104)	(0.087)	
Average	0.020	0.211	0.053	0.264	-0.286	0.204	0.088			
	(0.003)	(0.021)	(0.008)	(0.021)	(0.051)	(0.027)	(0.015)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 6: Cash Regressions: France

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.029	0.068	0.103	0.098	-0.390*	0.194	0.292	0.212	2.286	233
	(0.010)	(0.071)	(0.065)	(0.073)	(0.130)	(0.132)	(0.292)	(0.899)	(0.319)	
1998	0.021	0.065	0.067	0.129	-0.430*	0.265	0.165	0.433	8.097	318
	(0.009)	(0.076)	(0.038)	(0.056)	(0.145)	(0.142)	(0.113)	(0.806)	(0.017)	
1999	0.043	0.329	0.155	0.373	-0.611	0.587	0.116	1.641	3.952	312
	(0.027)	(0.081)	(0.061)	(0.053)	(0.397)	(0.225)	(0.063)	(0.440)	(0.139)	
2000	-0.019	0.503	0.159	-0.190	0.595*	0.116	0.099	2.375	6.286	308
	(0.013)	(0.089)	(0.047)	(0.068)	(0.102)	(0.076)	(0.084)	(0.305)	(0.043)	
2001	0.038	0.784	0.127	-0.917	2.542	-0.433	-0.041	1.416	1.036	447
	(0.013)	(0.146)	(0.027)	(2.092)	(0.605)	(0.927)	(0.101)	(0.493)	(0.596)	
2002	0.021	0.154	0.060	1.246	-3.145	1.286	0.017	0.390	12.808	445
	(0.007)	(0.049)	(0.020)	(2.880)	(3.281)	(3.140)	(0.037)	(0.823)	(0.002)	
2003	0.020	0.161	0.067	0.137	-0.169	0.099	0.146	9.223	26.820	407
	(0.009)	(0.053)	(0.032)	(0.159)	(0.159)	(0.095)	(0.219)	(0.010)	(0.000)	
2004	0.011	0.173	0.059	0.661	-1.655	0.416	0.017	2.154	4.925	318
	(0.007)	(0.054)	(0.030)	(1.486)	(2.423)	(0.812)	(0.046)	(0.341)	(0.085)	
Average	0.021	0.280	0.100	0.192	-0.408	0.316	0.112			
	(0.007)	(0.089)	(0.015)	(0.222)	(0.580)	(0.174)	(0.033)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 7: Cash Regressions: Germany

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	-0.019	0.051	0.029	-0.101	0.266	0.218	0.191	4.615	3.466	208
	(0.009)	(0.060)	(0.025)	(0.030)	(0.144)	(0.107)	(0.102)	(0.099)	(0.177)	
1998	0.066	-0.025	0.139	0.267	-0.418*	0.430	0.248	2.000	5.818	270
	(0.037)	(0.118)	(0.115)	(0.013)	(0.238)	(0.137)	(0.132)	(0.368)	(0.055)	
1999	0.042	0.103	0.139	0.206	-0.182*	0.180	0.206	0.334	5.636	279
	(0.022)	(0.075)	(0.117)	(0.021)	(0.114)	(0.159)	(0.106)	(0.846)	(0.060)	
2000	0.016	0.161	0.053	0.335	-0.721*	0.336	0.048	1.618	0.822	301
	(0.008)	(0.055)	(0.021)	(0.285)	(0.703)	(0.192)	(0.055)	(0.445)	(0.663)	
2001	0.019	0.252	0.067	0.627	-0.244*	0.367	0.030	2.609	4.565	330
	(0.012)	(0.080)	(0.029)	(0.613)	(0.216)	(0.159)	(0.045)	(0.271)	(0.102)	
2002	0.005	0.446	0.099	0.183	-0.157	0.581	0.026	5.244	4.177	384
	(0.010)	(0.087)	(0.034)	(0.484)	(0.267)	(0.220)	(0.037)	(0.073)	(0.124)	
2003	0.017	0.293	0.120	0.476	-0.237	0.483	0.035	2.113	4.690	367
	(0.009)	(0.048)	(0.037)	(1.527)	(0.319)	(0.284)	(0.124)	(0.348)	(0.096)	
2004	0.030	0.358	0.133	0.593	-0.084	0.400	0.051	0.824	2.427	214
	(0.018)	(0.101)	(0.051)	(0.305)	(0.222)	(0.116)	(0.053)	(0.662)	(0.297)	
Average	0.022	0.205	0.097	0.323	-0.222	0.374	0.104			
	(0.009)	(0.057)	(0.015)	(0.085)	(0.099)	(0.047)	(0.033)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 8: Cash Regressions: USA, Small Firms

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.047	0.088	0.132	0.276	-0.117	0.610	0.168	2.839	7.596	1422
	(0.009)	(0.040)	(0.032)	(0.020)	(0.073)	(0.049)	(0.039)	(0.242)	(0.022)	
1998	0.039	0.185	0.137	0.236	-0.050	0.632	0.165	3.541	7.664	1397
	(0.009)	(0.044)	(0.036)	(0.025)	(0.087)	(0.065)	(0.046)	(0.170)	(0.022)	
1999	0.018	0.245	0.124	0.237	-0.117	0.473	0.077	2.827	10.364	1335
	(0.005)	(0.038)	(0.027)	(0.038)	(0.115)	(0.061)	(0.027)	(0.243)	(0.006)	
2000	0.027	0.185	0.101	0.309	-0.047	0.440	0.088	0.354	7.730	1208
	(0.007)	(0.036)	(0.025)	(0.044)	(0.091)	(0.077)	(0.028)	(0.838)	(0.021)	
2001	0.077	0.106	0.244	0.290	0.068	0.763	0.264	2.410	6.784	1048
	(0.016)	(0.050)	(0.053)	(0.018)	(0.076)	(0.042)	(0.049)	(0.300)	(0.034)	
2002	0.013	0.373	0.240	0.299	0.233*	0.350	0.045	3.822	8.708	1142
	(0.005)	(0.024)	(0.026)	(0.087)	(0.083)	(0.051)	(0.023)	(0.148)	(0.013)	
2003	0.055	0.300	0.236	0.274	-0.030	0.439	0.201	1.045	14.582	1044
	(0.011)	(0.042)	(0.031)	(0.035)	(0.074)	(0.071)	(0.045)	(0.593)	(0.001)	
2004	0.028	0.176	0.087	0.210	-0.203*	0.486	0.132	2.063	15.297	913
	(0.006)	(0.045)	(0.022)	(0.044)	(0.153)	(0.056)	(0.045)	(0.356)	(0.000)	
Average	0.038	0.207	0.163	0.266	-0.033	0.524	0.143			
	(0.007)	(0.034)	(0.023)	(0.012)	(0.047)	(0.047)	(0.025)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 9: Cash Regressions: USA, Large Firms

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.002	0.098	0.023	0.341	-1.048	0.111	0.017	3.368	4.335	1218
	(0.004)	(0.039)	(0.012)	(0.330)	(1.155)	(0.109)	(0.013)	(0.186)	(0.114)	
1998	0.004	0.054	0.015	0.175	-0.523*	0.129	0.056	4.386	4.845	1232
	(0.005)	(0.028)	(0.012)	(0.069)	(0.249)	(0.099)	(0.036)	(0.112)	(0.089)	
1999	0.012	0.044	0.036	0.136	-0.532*	0.226	0.132	3.379	6.260	1222
	(0.004)	(0.045)	(0.013)	(0.040)	(0.201)	(0.082)	(0.057)	(0.185)	(0.044)	
2000	0.018	0.070	0.071	0.232	-0.762*	0.591	0.075	7.018	6.034	1201
	(0.005)	(0.071)	(0.024)	(0.039)	(0.186)	(0.101)	(0.015)	(0.030)	(0.049)	
2001	0.008	0.149	0.088	0.234	-0.484	0.395	0.031	1.908	9.680	1214
	(0.003)	(0.030)	(0.021)	(0.132)	(0.409)	(0.130)	(0.017)	(0.385)	(0.008)	
2002	0.011	0.139	0.110	0.120	-0.177*	0.307	0.172	6.255	0.870	1241
	(0.003)	(0.026)	(0.026)	(0.031)	(0.101)	(0.089)	(0.056)	(0.044)	(0.647)	
2003	0.010	0.135	0.067	0.244	-0.964*	0.338	0.061	4.833	4.811	1204
	(0.004)	(0.034)	(0.021)	(0.140)	(0.680)	(0.123)	(0.019)	(0.089)	(0.090)	
2004	0.031	0.022	0.105	0.261	-1.043*	0.686	0.157	3.896	8.579	1163
	(0.017)	(0.044)	(0.060)	(0.040)	(0.222)	(0.189)	(0.064)	(0.143)	(0.014)	
Average	0.012	0.089	0.064	0.218	-0.692	0.348	0.088			
	(0.003)	(0.017)	(0.013)	(0.025)	(0.111)	(0.073)	(0.021)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 10: Cash Regressions: Japan, Small Firms

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.023	0.345	0.075	0.215	-0.246*	0.231	0.114	0.509	8.958	985
	(0.008)	(0.060)	(0.022)	(0.020)	(0.157)	(0.066)	(0.034)	(0.775)	(0.011)	
1998	0.011	0.220	0.034	0.305	-0.777	0.209	0.044	2.979	4.855	1029
	(0.005)	(0.052)	(0.013)	(0.128)	(0.770)	(0.115)	(0.028)	(0.225)	(0.088)	
1999	0.028	0.290	0.098	0.115	-0.062	0.190	0.247	0.226	5.198	1119
	(0.008)	(0.047)	(0.033)	(0.012)	(0.155)	(0.048)	(0.069)	(0.893)	(0.074)	
2000	0.049	0.204	0.096	0.261	-0.262*	0.295	0.212	5.932	5.371	1174
	(0.024)	(0.045)	(0.058)	(0.003)	(0.075)	(0.130)	(0.044)	(0.052)	(0.068)	
2001	0.016	0.187	0.044	0.147	-0.299	0.184	0.159	0.500	5.961	1177
	(0.006)	(0.040)	(0.015)	(0.020)	(0.237)	(0.047)	(0.044)	(0.779)	(0.051)	
2002	0.021	0.313	0.074	0.307	-0.345	0.243	0.093	7.295	8.190	1245
	(0.008)	(0.047)	(0.018)	(0.029)	(0.252)	(0.070)	(0.026)	(0.026)	(0.017)	
2003	0.025	0.262	0.085	0.097	-0.215	0.220	0.299	8.750	7.296	1295
	(0.006)	(0.050)	(0.021)	(0.014)	(0.227)	(0.045)	(0.067)	(0.013)	(0.026)	
2004	0.044	0.206	0.113	0.264	-0.218	0.286	0.155	2.202	5.525	1289
	(0.009)	(0.051)	(0.028)	(0.037)	(0.141)	(0.060)	(0.035)	(0.332)	(0.063)	
Average	0.027	0.253	0.077	0.214	-0.303	0.232	0.165			
	(0.005)	(0.021)	(0.010)	(0.030)	(0.074)	(0.014)	(0.030)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 11: Cash Regressions: Japan, Large Firms

	OLS			GMM						Obs.
Year	q	CF	R^2	q	CF	r^2	τ^2	J-Test	ID Test	
1997	0.014	0.257	0.041	0.262	-0.143	0.093	0.012	2.176	8.300	999
	(0.008)	(0.046)	(0.012)	(0.117)	(0.211)	(0.056)	(0.013)	(0.337)	(0.016)	
1998	0.017	0.104	0.022	0.246	-0.386*	0.160	0.042	1.095	7.790	1072
	(0.006)	(0.043)	(0.010)	(0.090)	(0.212)	(0.054)	(0.027)	(0.578)	(0.020)	
1999	0.009	0.102	0.013	0.171	-0.215*	0.050	0.180	3.804	10.292	1113
	(0.006)	(0.042)	(0.009)	(0.082)	(0.176)	(0.034)	(0.157)	(0.149)	(0.006)	
2000	0.011	0.300	0.074	0.529	-0.731*	0.192	0.063	2.840	9.568	1112
	(0.009)	(0.047)	(0.022)	(0.334)	(0.670)	(0.092)	(0.025)	(0.242)	(0.008)	
2001	0.023	0.275	0.066	0.157	-0.015	0.098	0.145	0.761	9.881	1171
	(0.010)	(0.046)	(0.021)	(0.044)	(0.112)	(0.048)	(0.052)	(0.684)	(0.007)	
2002	0.010	0.192	0.043	0.195	-0.069	0.118	0.153	3.825	9.947	1176
	(0.005)	(0.032)	(0.014)	(0.117)	(0.186)	(0.036)	(0.081)	(0.148)	(0.007)	
2003	0.011	0.155	0.041	0.766	-1.403	0.510	0.066	4.927	9.369	1178
	(0.006)	(0.037)	(0.013)	(0.988)	(2.085)	(0.425)	(0.035)	(0.085)	(0.009)	
2004	0.012	0.161	0.038	0.364	-0.655	0.240	0.024	2.625	9.765	1164
	(0.006)	(0.039)	(0.015)	(0.283)	(0.670)	(0.117)	(0.023)	(0.269)	(0.008)	
Average	0.013	0.193	0.042	0.336	-0.452	0.183	0.086			
	(0.002)	(0.027)	(0.007)	(0.075)	(0.165)	(0.051)	(0.023)			

Calculations are based on a sample of nonfinancial firms from Global Vantage from 1997 to 2004. GMM estimates are from the fourth-order estimator in Erickson and Whited (2000). The dependent variable is the change in the stock of cash divided by total assets. CF stands for cash flow divided by total assets; q stands for the market-to-book ratio; r^2 is the measurement-error consistent estimate of the regression coefficient of determination; and τ^2 is the coefficient of determination of the measurement equation. Asymptotic standard errors are in parentheses below the yearly estimates. Fama-MacBeth standard errors are below the average estimates. An asterisk by a cash-flow coefficient indicates that its t-statistic exceeds the bootstrapped critical value.

Table 12: Monte Carlo Performance of GMM and OLS Estimators

	OLS	GMM3	GMM4	GMM5	GMM6
Sample Size = 202					
$E(\hat{\alpha_1})$	0.180	-0.234	-0.223	-0.168	-0.201
MAD($\hat{\alpha_1}$)	0.481	0.409	0.299	0.326	0.342
P($\mid \hat{\alpha_1} - \alpha_1 \mid \leq 0.2 \mid \alpha_1 \mid$)	0.001	0.085	0.130	0.150	0.130
T-test Size		0.032	0.062	0.072	0.090
J-test Size		0.032	0.062	0.072	0.090
Sample Size = 1200					
$E(\hat{\alpha_1})$	0.183	-0.349	-0.288	-0.275	-0.329
MAD($\hat{\alpha_1}$)	0.483	0.277	0.087	0.094	0.134
P($\mid \hat{\alpha_1} - \alpha_1 \mid \leq 0.2 \mid \alpha_1 \mid$)	0.000	0.151	0.565	0.486	0.357
T-Test Size		0.001	0.008	0.007	0.011
J-test Size		0.032	0.062	0.072	0.090
Sample Size = 2576					
$E(\hat{\alpha_1})$	0.183	-0.345	-0.311	-0.290	-0.300
MAD($\hat{\alpha_1}$)	0.483	0.213	0.066	0.055	0.049
P($\mid \hat{\alpha_1} - \alpha_1 \mid \leq 0.2 \mid \alpha_1 \mid$)	0.000	0.202	0.668	0.675	0.761
T-Test Size		0.001	0.002	0.001	0.003
J-test Size		0.032	0.062	0.072	0.090

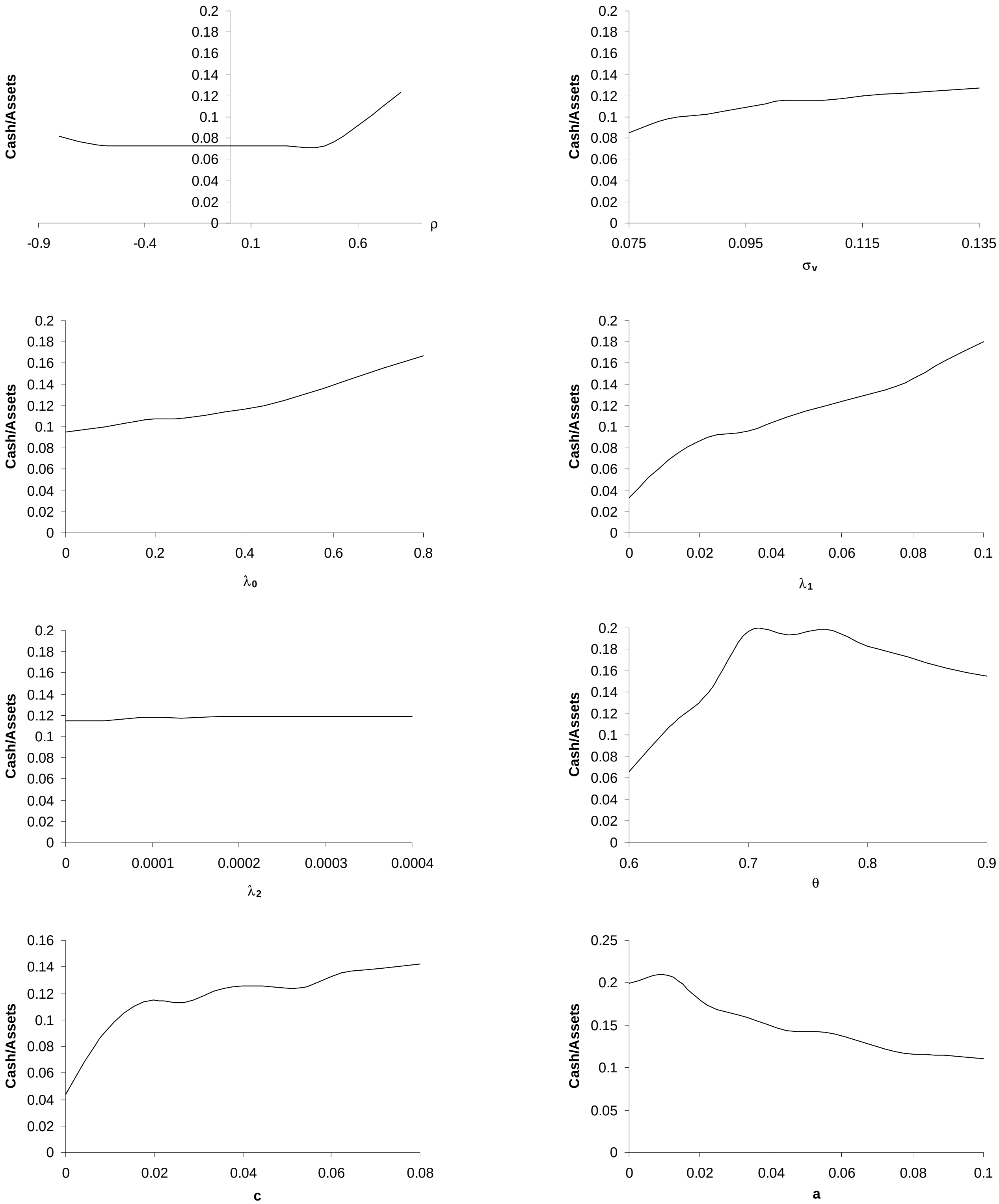
Indicated expectations and probabilities are estimates based on 10,000 Monte Carlo samples of size 336. The samples are generated by

$$
\begin{aligned}
y_i &= q_i\beta + z_i\alpha + u_i \\
x_i &= \gamma + q_i + \varepsilon_i,
\end{aligned}
$$

in which q_i and ε_i are distributed as a chi-squared variables. u_i is distributed as a negative chi-squared variable. GMMn denotes the GMM estimator based on moments up to order $M = n$. OLS denotes estimates obtained by regressing y_i on x_i. MAD denotes mean absolute deviation. "T-Test Size" refers to the actual size of a nominal 5% test of the null hypothesis that α_1 equals its true value. "J-Test Size" refers to the actual size of a nominal 10% test of the overidentifying restrictions.

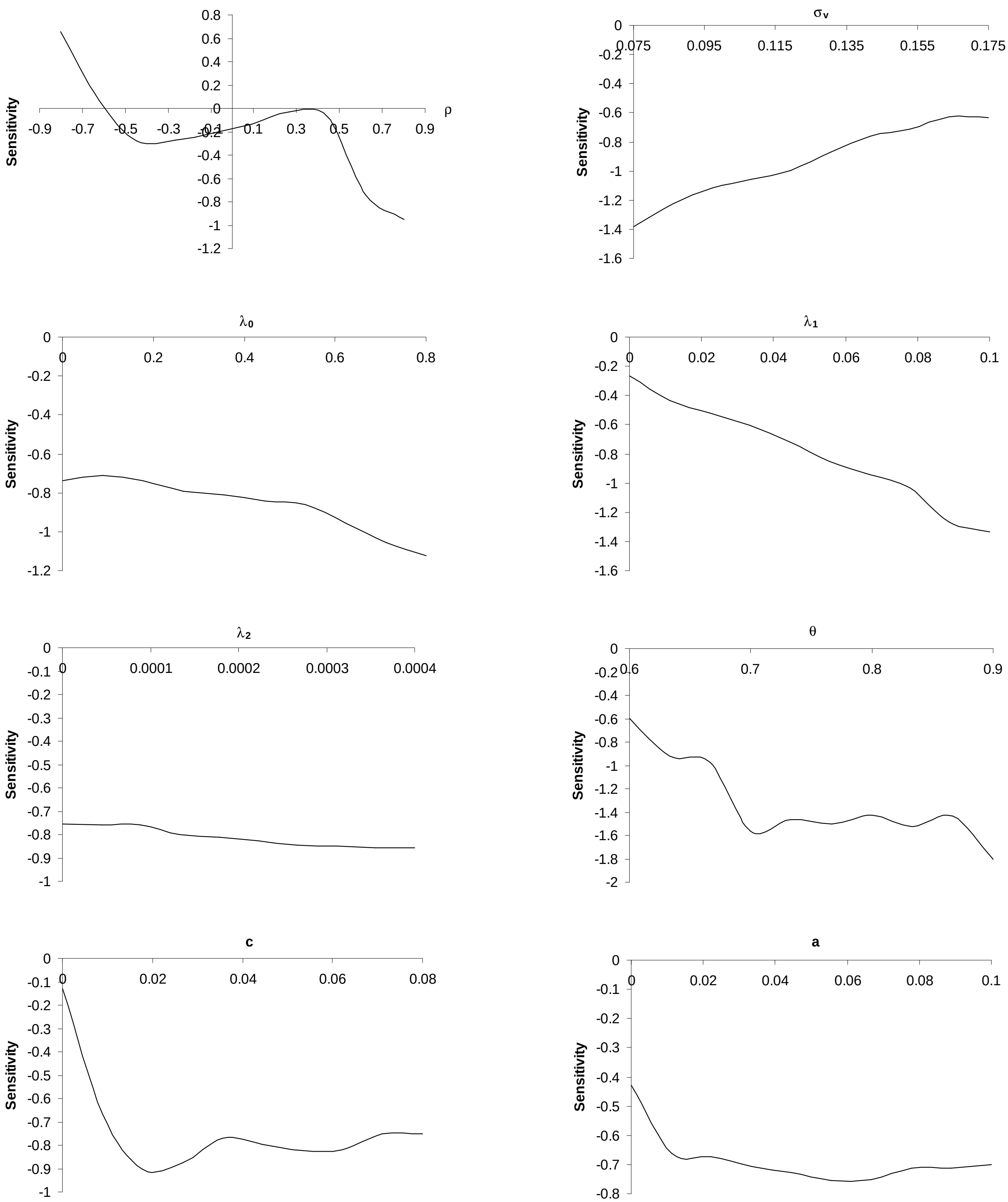
True Value: $\alpha_1 = -0.3$.

Figure 1: The Ratio of Cash to Capital



This figure depicts the relation between various model parameters and the ratio of the stock of cash to assets. The serial correlation of income shocks is ρ; the standard deviation of the innovations to these shocks is σ_v; λ_0, λ_1, and λ_2 are fixed, linear, and quadratic costs of external finance; θ is the curvature of the production function; and c and a are fixed and quadratic costs of adjusting the capital stock.

Figure 2: The Cash-Flow Sensitivity of Cash



This figure depicts the relation between various model parameters and the sensitivity of the change in the cash stock to cash flow, holding constant Tobin's q. The serial correlation of income shocks is ρ; the standard deviation of the innovations to these shocks is σ_v; λ_0, λ_1, and λ_2 are fixed, linear, and quadratic costs of external finance; θ is the curvature of the production function; and c and a are fixed and quadratic costs of adjusting the capital stock.