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The determinants and implications of corporate cash holdings☆

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Abstract

We examine the determinants and implications of holdings of cash and marketable securities by publicly traded U.S. firms in the 1971–1994 period. In time-series and cross-section tests, we find evidence supportive of a static tradeoff model of cash holdings. In particular, firms with strong growth opportunities and riskier cash flows hold relatively high ratios of cash to total non-cash assets. Firms that have the greatest access to the capital markets, such as large firms and those with high credit ratings, tend to hold lower ratios of cash to total non-cash assets. At the same time, however, we find evidence that firms that do well tend to accumulate more cash than predicted by the static tradeoff model where managers maximize shareholder wealth. There is little evidence that excess cash has a large short-run impact on capital expenditures, acquisition spending, and payouts to shareholders. The main reason that firms experience large changes in excess cash is the occurrence of operating losses.

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1. Introduction

On February 8, 1996 Chrysler Corporation's Chairman Robert J. Eaton and investor Kirk Kerkorian agreed to a 5-year standstill agreement, in which Kerkorian would cease attempts to take over Chrysler. An important element of the agreement was a commitment from Chrysler that liquid assets, defined as cash and marketable securities, in excess of a $7.5 billion target be returned to shareholders in the form of share repurchases or dividends.

The Chrysler/Kerkorian story raises questions that have gone largely unexamined in the finance literature. Is there an optimal level of liquid asset holdings on a corporate balance sheet? And, if so, is the relatively large amount of liquid assets held by firms like Chrysler justified? This question is particularly relevant. The S&P 500 corporations reported a total of $716 billion in cash and marketable securities on their balance sheets as of fiscal year 1994. The largest non-financial holders of liquid assets were Ford ($13.8 billion), General Motors ($10.7 billion), and IBM ($10.5 billion).

Management that maximizes shareholder wealth should set the firm's cash holdings at a level such that the marginal benefit of cash holdings equals the marginal cost of those holdings. The cost of holding liquid assets includes the lower rate of return of these assets because of a liquidity premium and, possibly, tax disadvantages. There are two main benefits from holding liquid assets. First, the firm saves transaction costs to raise funds and does not have to liquidate assets to make payments. Second, the firm can use the liquid assets to finance its activities and investments if other sources of funding are not available or are excessively costly. Keynes (1934) describes the first benefit as the transaction cost motive for holding cash, and the second one as the precautionary motive. The costs considered in the literature have evolved from brokerage costs, in the classic paper by Miller and Orr (1966), to inefficient investment resulting from insufficient liquidity, emphasized in theoretical models such as Jensen and Meckling (1976), Myers (1977), and Myers and Majluf (1984), as well as in empirical papers that build on Fazzari et al. (1988).

Theories that focus on the tradeoff between the costs and benefits of cash holdings can make it possible to answer the question of whether a firm holds too much cash from the perspective of shareholder wealth maximization. In general, however, managers and shareholders view the costs and benefits of liquid asset holdings differently. Agency theory can therefore explain why firms do not hold the amount of cash that maximizes shareholder wealth, and help to identify firms that are likely to hold too much cash. Managers have a greater preference for cash, because it reduces firm risk and increases their discretion. This greater preference for cash can lead managers to place too much importance on the precautionary motive for holding cash. One would therefore expect firms where agency costs of managerial discretion are more important to hold more liquid assets than would be required to maximize shareholder wealth.

An alternative view to the tradeoff model of cash holdings is that there is no optimal amount of cash. With this view, cash holdings are an irrelevant sideshow. The argument is that nothing changes in a corporation if it has one more dollar of cash financed with one more dollar of debt. Hence, even if one believes that there is an optimal capital structure for a corporation, this optimal capital structure specifies an optimal amount of net debt, which is debt minus cash. As a result, there is no optimal amount of cash, because cash is simply negative debt. The same reasoning holds with the pecking order or financing hierarchy model. According to the pecking order model, a firm's leverage, defined using net debt, reacts passively to changes in the firm's internal funds. As a firm accumulates internal funds, its leverage falls. The firm avoids issuing equity because adverse selection costs make equity too expensive. As the firm maintains a surplus of internal funds, it accumulates cash and pays back debt when it becomes due. Faced with a deficit of internal funds, the firm decreases cash holdings and eventually raises debt. With this view, changes in internal resources are the driving force for changes in cash holdings, but it is a matter of indifference whether a firm uses the internal resources to accumulate cash or repay debt. A firm that is not constrained in its investment policy simply uses cash flow to increase cash, unless it has debt to repay.

Myers and Majluf (1984) provide a theoretical foundation for the pecking-order model that makes it consistent with shareholder wealth maximization. A challenge that arises with extending the financing hierarchy model to explain cash holdings is that the conditions under which this extension is consistent with shareholder wealth maximization are rather restrictive. As long as there is any cost to holding cash, a firm that simply accumulates cash will at some point have an excessive amount of cash, and shareholders would be better off if the firm used that cash to pay additional dividends or to repurchase shares. If management is reluctant to use cash in this way, for the reasons discussed in Jensen's (1986) free cash flow theory, empirical evidence will support the financing hierarchy view, even though there is an amount of cash that maximizes shareholder wealth.

This paper proceeds in three steps. We first examine simple dynamic models of changes in cash holdings to assess the success of the static trade-off and financing hierarchy views in explaining changes in cash holdings. Though Shyam-Sunder and Myers (1998) demonstrate that the financing hierarchy view is extremely successful at explaining changes in leverage, we find here that the static tradeoff theory of cash holdings cannot be dismissed as irrelevant, and that the theory makes important predictions that find support in the empirical evidence. In our second step, we show that the predictions of the static tradeoff theory for the determinants of cash holdings are empirically relevant. At the same time, some firms hold dramatically more cash than predicted by the static tradeoff theory. In our third step, we investigate these firms in detail to understand how these large cash holdings come about, and what these excessive

holdings imply about the future behavior of these firms. Jensen's free cash flow theory predicts that these firms will increase their investments, rather than return the cash to the shareholders. We find that firms with large amounts of excess cash acquired it through the accumulation of internal funds. Surprisingly, spending on new projects and acquisitions is only slightly higher for firms with excess cash. Firms typically lose excess cash by covering losses, rather than by spending on new projects or making acquisitions. There is little evidence, therefore, that excess cash 'burns a hole in management's pockets'. Further work will be required to find out whether shareholders are made better off by management's hoarding of cash.

Our results build on an extensive, but generally older, literature on corporate liquidity. Chudson (1945), for example, finds that cash-to-assets ratios tend to vary systematically by industry, and tend to be higher among profitable companies. Vogel and Maddala (1967) find that cash balances have been declining over time, and that larger firms tend to have lower cash-to-assets and cash-to-sales ratios. This finding suggests that there are economies of scale in the transaction motive for cash.[1] Baskin (1987) argues that firms may use cash holdings for competitive purposes. He concludes that '[t]he empirical evidence is entirely consistent with the model wherein liquid assets are employed both to signal commitment to retaliate against encroachment and to enable firms to rapidly preempt new opportunities' (Baskin, 1987, p. 319). A paper by John (1993) argues that firms wish to hold greater amounts of cash when they are subject to higher financial distress costs. Using a 1980 sample of 223 large firms, John finds that firms with high market-to-book ratios and low tangible asset ratios tend to hold more cash. This observation is consistent with the financial distress theory if one agrees that a high market-to-book ratio is a proxy for financial distress costs. Finally, in a contemporaneous paper, Harford (1998) explores the relation between a firm's acquisition policy and its liquid asset holdings. He finds that cash rich firms are more likely to make acquisitions, that these acquisitions are more likely to be diversifying acquisitions, and that they are more likely to decrease shareholder wealth. He views his evidence as strongly supportive of free cash flow theory.

The next section of this paper describes our empirical hypotheses. We present our data in Section 3. In Section 4, we report estimates from time-series and cross-sectional regressions. In Section 5, we investigate whether the investment and payout policies of firms with given investment opportunities are related to

[1] A number of early studies considered the question of whether there are economies of scale in holding cash, including Frazer (1964) and Meltzer (1963). Beltz and Frank (1996) provide evidence on these economies of scale that extends to the 1980s. Mulligan (1997) shows that cash balances fall with respect to sales, and that firms located in U.S. counties with higher wages hold more cash. He views his evidence to support the hypothesis that time can substitute for money in the provision of transaction services and to support the presence of economies of scale in cash holdings.

their liquid asset holdings in the short run. Section 6 examines how likely firms are to keep excess cash over a number of years, and examines the characteristics of firms that experience large changes in excess cash. Section 7 summarizes the findings, and suggests future directions for empirical research in this area.

2. Theory and empirical hypotheses

In a world of perfect capital markets, holdings of liquid assets are irrelevant. If cash flow turns out to be unexpectedly low, such that a firm has to raise funds to keep operating and to invest, it can do so at zero cost. Since there is no liquidity premium in such a world, holdings of liquid assets have no opportunity cost. Hence, if a firm borrows money and invests it in liquid assets, shareholder wealth is unchanged.

However, if it is costly for the firm to be short of liquid assets, the firm equates the marginal cost of holding liquid assets to the marginal benefit of holding those assets. Holding an additional dollar of liquid assets reduces the probability of being short of liquid assets, and decreases the cost of being short of cash, under the reasonable assumption that the marginal benefit of liquid assets declines as holdings of liquid assets increase. We define a firm to be short of liquid assets if it has to cut back investment, cut back dividends, or raise funds by selling securities or assets. A firm can make it less likely that it will be short of liquid assets in a particular state of the world by having lower leverage, or by hedging. Consequently, an optimal theory of liquid asset holdings has to address the issue of why it is more efficient for the firm to hold an additional dollar of liquid assets instead of decreasing leverage by some amount, or increasing hedging.

In the remainder of the section, we first address the role of transaction costs as a determinant of cash holdings, and then turn to the impact of information asymmetries and agency costs on cash holdings. The section concludes with a discussion of the financing hierarchy model.

2.1. The transaction costs model

Keynes' (1936) transaction motive for holding cash arises from the cost of converting cash substitutes into cash. Consider the effect of transaction costs on the irrelevance result within the framework we have just discussed. We now assume that there are costs to buying and selling financial and real assets. In particular, let us assume that there is a cost to raising outside funds that takes the form of a fixed cost, plus a variable cost which is proportional to the amount raised. In this case, a firm short of liquid assets has to raise funds in the capital markets, liquidate existing assets, reduce dividends and investment, renegotiate

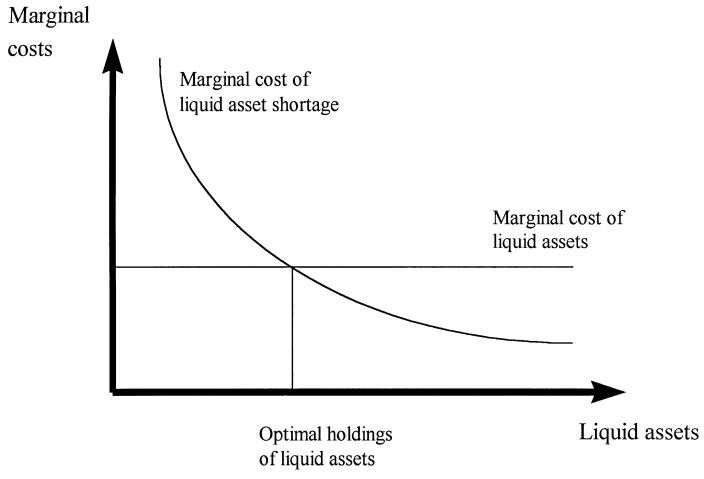

Fig. 1. Optimal holdings of liquid assets. The optimal amount of liquid assets is given by the intersection of the marginal cost of liquid assets curve and the marginal cost of liquid asset shortage curve. The marginal cost of liquid assets curve is non-decreasing while the marginal cost of liquid asset shortage curve is decreasing.

existing financial contracts, or some combination of these actions. Unless the firm has assets that can be liquidated at low cost, it prefers to use the capital markets. However, it is costly to raise funds, regardless of whether the firm does so by selling assets or using the capital markets. The fixed costs of accessing outside markets induce the firm to raise funds infrequently, and to use cash and liquid asset holdings as a buffer. As a result, for a given amount of net debt, there is an optimal amount of cash, and cash is not simply negative debt.

Fig. 1 shows the marginal cost curve of being short of liquid assets, and the marginal cost curve of holding cash. The marginal cost curve of being short of liquid assets is downward sloping and the marginal cost curve of holding liquid assets is assumed to be horizontal. With the transaction costs model, the cost of liquid assets is their lower pecuniary expected return, because part of the benefit from holding liquid assets is that they can be more easily converted into cash. There is no reason to think that this cost varies with the amount of liquid assets held. If the firm has a shortage of liquid assets, it can cope with the shortage by either decreasing investment or dividends, or by raising outside funds through security issuances or asset sales. A greater shortage has greater costs, because addressing a larger shortage involves decreasing investment more or raising more outside funds. For a given amount of liquid assets, an increase in the cost of being short of liquid assets, or an increase in the probability of being short of liquid assets, both shift the marginal cost curve to the right, and increase the firm's holdings of liquid assets.

With the assumptions that lead to Fig. 1, one would expect the marginal cost of being short of funds, and a related increase in holdings of liquid assets to respond to the following variables:[2]

Magnitude of transaction costs of raising outside funds. One would expect transaction costs to be lower for firms that have already accessed public markets. This expectation means that firms with a debt rating have less liquid assets. Firms could also raise outside funds more easily if they have credit lines outstanding, but credit lines may get canceled precisely when outside funds are the most valuable for a company.

Cost of raising funds through asset sales, dividend cuts, and renegotiation. Shleifer and Vishny (1993) discuss the role of assets sales as a source of financing. A firm with assets on its balance sheet that can be cheaply converted into cash can raise funds at low cost by selling these assets. Hence, firms with mostly firm-specific assets have higher levels of liquid assets. To the extent that diversified firms are more likely than specialized firms to have substantial assets that can be sold, because they can sell non-core segments, diversified firms have lower levels of liquid assets. Also, a firm that currently pays dividends can raise funds at low cost by reducing its dividend payments, in contrast to a firm that does not pay dividends, which has to use the capital markets to raise funds.

Investment opportunities. An increase in the number of profitable investment opportunities means that, if faced with a cash shortage, the firm has to give up better projects.

Cost of hedging instruments. By hedging with financial instruments, a firm can avoid situations where it has to seek funds in the capital markets because of random variation in cash flow. Hence, firms for which hedging is expensive are expected to hold more liquid assets.

Length of the cash conversion cycle. One would expect the cash conversion cycle to be short for firms in multiple product lines and firms with low inventory relative to sales. Consequently, these firms should have less liquid assets.

Cash flow uncertainty. Uncertainty leads to situations in which, at times, the firm has more outlays than expected. Therefore, one would expect firms with greater cash flow uncertainty to hold more cash.

Absence of economies of scale. Simple transaction costs models, such as Miller and Orr (1966), suggest that there are economies of scale in cash management.

In a world with significant transaction costs, one would expect assets that can be exchanged for cash, while incurring lower transaction costs, to have a lower

[2] In a contemporaneous paper, Kim et al. (1998) model the transaction costs motive to hold cash and make some similar predictions.

return to reflect this benefit (see Amihud and Mendelson, 1986). This expectation means that there is now a cost to holding liquid assets. We call this the liquidity premium. Note that this liquidity premium cannot be a risk premium. If liquid assets simply earn less because they have different risk characteristics, holding them does not entail a cost. One would expect this cost to be highest for cash, and to decrease for assets that are poor substitutes for cash. Consequently, a firm's liquid assets have an opportunity cost. For liquid assets held in the form of demand deposits, the opportunity cost increases with interest rates. To the extent that cash substitutes are deposited in short-maturity instruments, holding these cash substitutes becomes more expensive when the liquidity premium component of the term structure rises.

So far, our discussion has omitted taxes. Taxes increase the cost of holding liquid assets. The reason is that the interest income from liquid assets is taxed twice. It is taxed first at the corporate level, and then taxed again as it generates income for the shareholders. Consider the case of a shareholder that pays no capital gains taxes. Such a shareholder would prefer the firm to use excess liquid asset holdings to repurchase shares. By taking this action, the marginal tax rate on the liquid asset holdings for that investor would fall by the corporation's tax rate. This relation means that the cost of holding liquid assets increases with the firm's marginal tax rate.

In summary, the transaction costs model implies that liquid assets increase with (1) the volatility of cash flow divided by total assets, and (2) the length of the cash conversion cycle. The model also implies that liquid asset holdings decrease (1) with interest rates and the slope of the term structure, (2) with the cost of raising debt, (3) with the ease of selling assets, (4) with the cost of hedging risk, and (5) with the size of a firm's dividend. The inclusion of taxes has the additional implication that the cost of holding liquid assets increases with the firm's marginal tax rate.

2.2. *Information asymmetries, agency costs of debt, and liquid asset holdings*

We now extend the analysis to allow for information asymmetries and agency costs of debt. In this case, cash flow shortfalls might prevent a firm from investing in profitable projects if the firm does not have liquid assets, so that firms can find it profitable to hold cash to mitigate costs of financial distress. We call this motivation to hold liquid assets the precautionary motive for holding cash.

First, consider the role of information asymmetries. Information asymmetries make it harder to raise outside funds. Outsiders want to make sure that the securities they purchase are not overpriced, and consequently discount them appropriately. Since outsiders know less than management, their discounting may underprice the securities, given management's information (see Myers and Majluf, 1984). In fact, outsiders may require a discount that is large enough that

management may find it more profitable to not sell the securities, and reduce investment instead. Since information asymmetries make outside funds more expensive, the model with information asymmetries makes many predictions that are similar to the model with transaction costs discussed earlier. However, the model with information asymmetries provides an explicit reason why outside funds would be expensive, possibly prohibitively so. This model predicts that the cost of raising outside funds increases as securities sold are more information sensitive, and as information asymmetries are more important. It is important to note that information asymmetries can change over time, so that a firm for which these asymmetries are unimportant at one point in time may later find itself in a situation where these asymmetries become crucial. Myers and Majluf (1984) argue that shifting information asymmetries make it valuable to build up slack in periods when information asymmetries are small. Antunovich (1996) further argues that firms with higher information asymmetries will have a greater dispersion of slack, since these firms have more difficulty accessing capital markets. When information asymmetries are important, a cash flow shortfall forces firms to contract investment, and hence involves greater costs. One would expect this cost of financial distress to be larger for firms with high research and development (R&D) expenses, since R&D expenses are a form of investment where information asymmetries are most important (see Opler and Titman, 1994). Consequently, we would expect that firms with higher R&D expenses will hold more liquid assets.

We now turn to the role of agency costs of debt. These agency costs arise when the interests of the shareholders differ from the interests of the debtholders, and, possibly, when interests differ among various classes of debtholders. Because of these costs, highly leveraged firms find it difficult and expensive to raise additional funds. These firms also sometimes find it impossible to renegotiate existing debt agreements to prevent default and bankruptcy. Such firms have high incentives to engage in asset substitution, as argued by Jensen and Meckling (1976), so that debt will be expensive, both in terms of the required promised yield, and in terms of the covenants attached to the debt. They are also likely to face the underinvestment problem emphasized by Myers (1977), namely, that raising funds to invest may benefit debtholders but not shareholders, so that shareholders prefer not to invest, even though the firm has valuable projects.

Firms want to avoid situations where the agency costs of debt are so high that they cannot raise funds to finance their activities and invest in valuable projects. Obviously, one way to do so is to choose a low level of leverage. However, one would expect firms with valuable investment opportunities, for which the cost of raising additional outside funds is high, or even prohibitive, to hold more liquid assets, since the cost of being short of funds is higher. The market-to-book ratio is often used as a proxy for investment opportunities (see

Smith and Watts, 1992; Jung et al., 1996). Holding the degree of information asymmetry between managers and investors constant, one would expect firms with high market-to-book ratios to hold more cash, since the costs they incur if their financial condition worsens are higher. The problem is that such firms invest a lot, so that if investment expenditures occur discretely, they hold more cash, on average, in order to pay for investment expenditures. Hence, one would expect liquid assets to increase with the market-to-book ratio, controlling for the level of investment expenditures.

2.3. Agency costs of managerial discretion

In the presence of agency costs of managerial discretion, management may hold cash to pursue its own objectives at shareholder expense. First, management may hold excess cash simply because it is risk averse. More entrenched management would therefore be more likely to hold excess cash because it can avoid market discipline. Hence, one would expect firms with anti-takeover amendments to be more likely to hold excess cash. Second, management may accumulate cash to have more flexibility to pursue its own objectives. Cash is like free cash flow. Cash allows management to make investments that the capital markets would not be willing to finance. In this sense, cash is not negative debt for management. While management can spend the cash whenever it wants to, it may not be able to raise debt whenever it wants to. By enabling management to avoid the discipline of capital markets, investing in cash can therefore have an adverse effect on firm value. To put it another way, increasing a firm's holdings of liquid assets by one dollar may increase firm value by less than one dollar. The possibility that management could be using cash for its own objectives raises the costs of outside funds, because outsiders do not know whether management is raising cash to increase firm value or to pursue its own objectives. Third, management may accumulate cash because it does not want to make payouts to shareholders, and wants to keep funds within the firm. Having the cash, however, management must find ways to spend it, and hence chooses poor projects when good projects are not available. In general, the agency costs of managerial discretion are less important, and may be trivial for firms with valuable investment opportunities, because the objectives of management and shareholders are more likely to coincide.

When is it more likely that management will not be disciplined, so that it can afford to hold excess cash to pursue its own objectives? We hypothesize four conditions that increase the likelihood of holding excess cash. First, we expect that firms will hold excess cash where outside shareholders are highly dispersed. As argued by Shleifer and Vishny (1986), the existence of large independent shareholders makes a takeover or a proxy contest, or both, easier. Second, we expect large firms to hold excess cash. Firm size is a takeover deterrent. A larger target requires more resources to be husbanded by the bidder, and a large firm

can more easily use the political arena to its advantage. Third, we expect firms with low debt to hold excess cash. By having low debt, the firm is less subject to monitoring by the capital markets. Fourth, firms that are protected from the market for corporate control through anti-takeover charter amendments will also hold excess cash. These amendments make it less likely that the firm becomes a takeover target.

For entrenched management, accumulating liquid assets can be a double-edged sword. Holding excess cash makes it easier for management to remain independent from the capital markets, and to pursue its investment policies. At the same time, it increases the gain to a bidder from taking over the firm, since the bidder gains control of liquid assets that can help finance the acquisition.

To the extent that agency costs of managerial discretion are higher for low market-to-book firms than for high market-to-book firms, as argued in Stulz (1990), one expects low market-to-book firms with entrenched management to have excess liquid assets. To the extent that low market-to-book firms have poor investment opportunities, and management holds liquid assets to facilitate an investment program that it would find difficult to finance through the capital markets, one would expect low market-to-book firms with more liquid assets to invest more.

Management's holdings of shares help align its interests with those of shareholders. At the same time, however, these holdings protect management against outside pressures, and may make management more risk-averse (see Stulz, 1988). If holding cash is costly and management tends to hold more cash than is optimal from the perspective of maximizing shareholder wealth, then one would expect cash holdings to fall with managerial ownership. However, to the extent that managerial ownership makes management more risk averse, then one would expect cash holdings to increase with managerial ownership.

2.4. The financing hierarchy theory

Consider now the alternative hypothesis that there is no optimal amount of cash. For that to be the case, firms can issue securities at low cost to raise cash whenever they have insufficient cash to finance their plans. It may be that a firm has an optimal amount of net debt, but it is then a matter of indifference for the firm whether it has high cash holdings and high debt, or low cash holdings and low debt, as long as it has the optimal amount of net debt. However, there might not be an optimal amount of cash, because there is no optimal amount of net debt. This result is the case with the financing hierarchy model. Firms find equity expensive because of information asymmetries, so they do not raise funds in the form of equity under normal circumstances. They sell debt when they do not have sufficient resources, and they can do so. If they have sufficient resources

to invest in the profitable projects available, they repay debt that becomes due, and accumulate liquid assets otherwise. With this hypothesis, liquid assets rise and fall with the fortunes of the firm. If holding cash has no costs for the shareholders, there is no reason for them to object if the firm has large amounts of liquid assets at times.

The distinction between the financing hierarchy model and the static tradeoff model is not as clear-cut as one might want. The distinction becomes blurry as the cost of external capital is allowed to play more of a role in the financing hierarchy model. We will stick to a narrow view of the financing hierarchy model, according to which debt and cash increase mechanically as the firm has more funds available. Even though we focus on an extreme version of the financing hierarchy model, some of its empirical predictions are similar to those of the static tradeoff model, so that it is difficult to distinguish empirically between the two models. In the financing hierarchy model, firms with high cash flow will have more cash. However, as argued by Shyam-Sunder and Myers (1998), it is often the case that firms with high cash flow also have a high market-to-book ratio. This condition occurs because these firms can be expected to be profitable in the future. Hence, discovering that firms with a high market-to-book ratio have more cash is not inconsistent with the financing hierarchy model. With this model, firms that pay more dividends should have lower cash. Everything else equal, however, a firm that invests more should have fewer internal resources, and hence would accumulate less cash. In contrast, with the static tradeoff theory, firms with more capital expenditures have more liquid assets. The same argument applies to R&D investments. There seems to be no reason why the variables emphasized by the agency theory arguments, namely the proxies for managerial entrenchment, would have implications for cash holdings in the financing hierarchy model. Finally, with the financing hierarchy view, firms that are larger presumably have been more successful, and hence should have more cash, after controlling for investment. The static tradeoff model argues that there are economies of scale in liquid assets, so that one would expect firm size to have a negative impact on cash holdings.

3. Data

To investigate our hypotheses on the determinants of cash holdings, we construct a sample of firms for our empirical tests by merging the Compustat annual industrial and full coverage files with the research industrial file for the 1952–1994 period. These data include survivors and non-survivors that appeared on Compustat at any time in the sample period. We exclude financial firms, with Standard Industrial Classification (SIC) codes between 6000 and 6999, because their business involves inventories of marketable securities that

are included in cash, and because of their need to meet statutory capital requirements. We also exclude utilities, because their cash holdings can be subject to regulatory supervision in a number of states. We exclude firms with nonpositive sales for the years in which they have nonpositive sales. Finally, we exclude American Depository Receipts (ADRs), and firms designated as pre-FASB. We present regressions predicting cash and the persistence of cash holdings using the entire dataset. We also present a separate regression analysis of cash holdings in 1994 for the simple reason that data are available to us for the governance structure and risk management activities of firms for that year. Insider share ownership is measured as the fraction of shares outstanding held by officers and directors, as reported by Compact Disclosure. Firm diversification is measured using the Compustat segment tapes.

3.1. Measure of liquid asset holdings

We measure liquid asset holdings as the ratio of cash and marketable securities (Compustat item #1) to total assets (Compustat item #6) minus cash and marketable securities. We deflate liquid asset holdings by the book value of total assets, net of liquid assets, which we call net assets hereafter, with the view that a firm's ability to generate future profits is a function of its assets in place. While not reported in this paper, we also measure liquidity using the cash-to-sales ratio. This alternative measure does not affect our main conclusions in a material way.

We measure the likelihood that a firm will have positive net present value (NPV) projects in the future by using the ratio of the market value of a firm's assets to the book value of its assets. Since the book value of assets does not include future growth options, we would expect the ratio of the market value of the firm, relative to the book value, to be higher when a firm has a high preponderance of growth options. A variety of past papers find that the market-to-book ratio is an important determinant of corporate financing choices thought to depend on a firm's portfolio of growth options (see, Smith and Watts, 1992; Jung et al., 1996; Barclay and Smith, 1995).

We allow for possible effects of regulation by using a dummy variable for industries that are, or have been, subject to entry and price regulation. This variable is identical to that employed by Barclay and Smith (1995). Regulated industries include railroads (SIC code 4011) through 1980, trucking (SIC codes 4210, 4213) through 1980, airlines (SIC code 4512) through 1978, and telecommunications (SIC codes 4812, 4813) through 1982.

We measure firm size as the natural logarithm of the book value of assets in 1994 dollars. We measure leverage using the debt-to-assets ratio defined as (long-term debt + short-term debt)/book value of assets. To distinguish the effects of a firm's dividend payouts, we define a dummy set equal to one in years where a firm pays a dividend. Otherwise, the dummy variable equals zero.

Finally, we measure cash flow as earnings after interest, dividends, and taxes, but before depreciation, divided by net assets.

We measure cash flow riskiness using two measures. First, we use the standard deviation of industry cash flow computed as follows. For each firm, we compute the cash flow standard deviation for the previous 20 years, if available, using Compustat since 1950. We then take the average across the 2-digit SIC code of the standard deviations of firm cash flow (industry sigma). Second, we compute a firm's cash flow standard deviation for 1994 using the previous twenty years of data, if available.

We use the R&D expense-to-sales ratio as a measure of the potential for financial distress costs. Firms that do not report R&D expenses are considered to be firms with no R&D expenses.

Our hypotheses consider the agency costs of managerial discretion. It is difficult to measure the extent of conflict of interest between the managers of a corporation and its shareholders. In theory, the severity of this conflict is affected by a number of hard-to-measure concepts, including the efficiency of the managerial labor market, and the extent of product market discipline (Fama and Jensen, 1983). Nonetheless, there is a large body of literature that suggests that certain types of firms are more likely to suffer from agency conflicts. For example, firms with inside ownership in excess of 5%, but less than 25–40%, appear to trade at somewhat higher market valuations than other firms (Morck et al., 1988; McConnell and Servaes, 1990). We employ a dummy for whether insider ownership of a firm is in the 5–25% range, and a dummy for whether insider ownership is greater than 25%.

Firms may choose to insure themselves against losses by holding liquid assets besides cash, and by having credit lines available. For example, it is common for firms to sell off non-core assets in periods of economic distress (see Lang et al., 1994). It is also becoming increasingly frequent for firms to liquidate receivables through factoring or securitization as a means of raising liquidity. We use net working capital, minus cash, as a measure of liquid asset substitutes. In addition, we employ a count of the number of reported line of business segments to measure whether firms have non-core assets that could be liquidated in periods of economic distress. Unfortunately, we do not have data on credit lines.

Finally, to assess a firm's derivatives usage in 1994, we use the Corporate Risk Management Handbook from Risk Publications for that year. We collect information on whether an S&P 500 corporation uses derivatives, and on the total of the notional amount of the derivatives it reports.

Table 1 describes the main variables used in the study. There is wide variation in the ratio of cash and marketable securities to assets. The median firm has cash equal to approximately 6% of net assets, or total assets less cash. On a dollar basis, the median firm has cash holdings of $6.28 million, a relatively small amount. This statistic reflects the size distribution of firms in our sample: The median firm in the sample has an asset base of $90.1 million.

Table 1
Description of variables for the 1971–1994 Compustat sample

Descriptive statistics on key variables for our sample of firm years from the 1971–1994 sample of U.S.-based publicly traded firms. Assets in the denominators of variables are calculated as assets less cash and marketable securities. Real variables are deflated using the CPI into 1994 dollars. Truncated cash to assets is calculated such that, for any cash-to-assets ratio greater than one, it is given a ratio of one. Size is defined as the natural logarithm of assets. The market-to-book ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. Cash flow is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. Net working capital is calculated without cash. Payout to shareholders is the sum of cash dividends over assets and stock repurchases over assets. Industry sigma is a measure of the volatility of an industry's cash flow for a 20-year period. Industries are defined by 2-digit SIC codes. Total leverage is total debt over total assets. Other variables displayed include measures of research and development (R&D) spending, capital expenditures, and acquisitions. N is the number of non-missing observations in the sample for each variable.

Variable	Mean	25th Percentile	Median	75th Percentile	*N*
Cash/assets	0.170	0.025	0.065	0.174	87,117
Truncated cash/assets	0.153	0.025	0.065	0.174	87,117
Real size	4.586	3.291	4.504	5.821	87,117
Market-to-book ratio	1.533	0.922	1.172	1.694	87,117
R&D/sales	0.027	0.000	0.000	0.019	87,117
Cash flow/assets	0.037	0.024	0.070	0.113	87,117
Net working capital/assets	0.176	0.029	0.192	0.345	87,117
Capital expenditures/assets	0.090	0.034	0.064	0.115	87,117
Acquisitions/assets	0.011	0.000	0.000	0.000	85,926
Payout to shareholders	0.017	0.000	0.006	0.024	85,095
Industry sigma	0.121	0.056	0.086	0.168	87,117
Total leverage	0.261	0.104	0.239	0.378	87,117

Fig. 2 shows the median cash-to-assets ratio in the 1952–1994 period for firms with real assets in the \$90-to-\$110 million range and in the \$900 million-to-\$1.1 billion range in 1994 dollars, adjusted for inflation using the Consumer Price Index (CPI) series. For small firms, cash holdings decline throughout the 1950s and the 1960s. Part of this trend may be due to firms having a surplus of cash at the end of WWII, and part of this trend may be the result of technological improvements in cash management. There was a strong decline of cash holdings in the second half of the 1960s. The other reason why cash holdings might be higher in the 1950s and early 1960s in our sample is that, since Compustat was started in the 1960s, all of these firms are survivors. Except for the 1950s and early 1960s, there is little evidence of dramatic changes in cash holdings over time. For small and large firms, there is little evidence of secular changes in cash to assets since the 1960s.

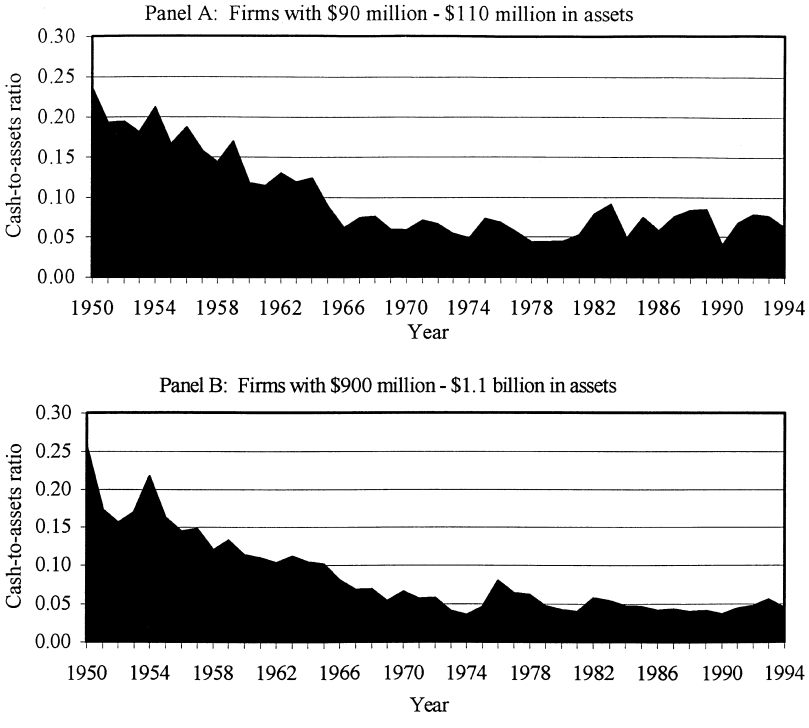

Fig. 2. Median cash-to-assets, 1950–1994. Median cash-to-assets ratio in the 1950–1994 period for Compustat firms with real assets in the $90-110 million range, and in the $900 million to $1.1 billion range, in 1994 dollars (adjusted for inflation using the CPI). The ratio is calculated as cash plus marketable securities, over assets less cash plus marketable securities.

4. The determinants of cash balances

In this section, we first test whether firms have target cash levels. Finding that they do, we then estimate linear regression models where the logarithm of cash to net assets is a function of the variables that theory identifies as determinants of cash balances.

4.1. Do firms have target cash levels?

The first step in investigating whether firms have target cash levels is to examine whether cash holdings revert to the mean. If they do not, we can reject the hypothesis that firms have target cash levels. However, the financing hierarchy model is not inconsistent with mean reversion in cash holdings. In the financing hierarchy model, the time-series properties of changes in cash depend on the time-series properties of the firm's growth in internal resources. Negative

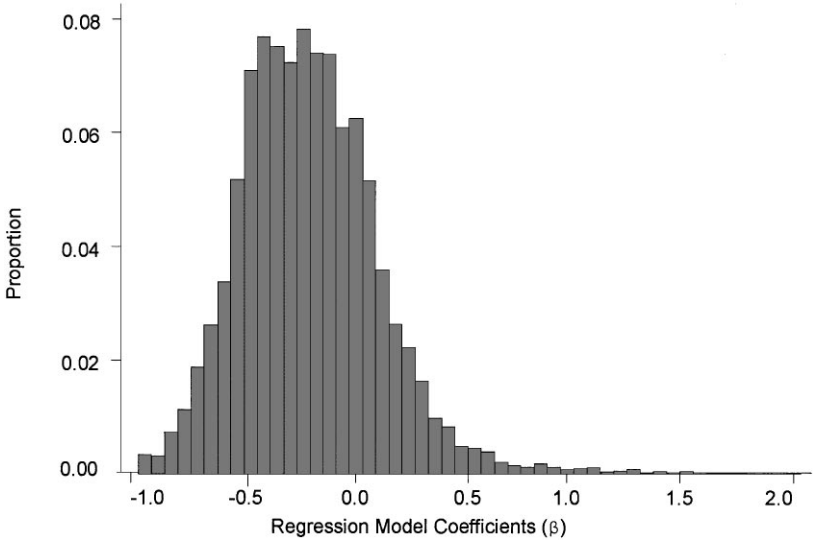

Fig. 3. Distribution of Coefficients on Lagged Change in Cash/Assets. Distribution of coefficients on lagged change in cash/assets from the firm-wise regression:

$$\Delta(\text{Cash/Assets})_t = \alpha + \beta\Delta(\text{Cash/Assets})_{t-1} + \varepsilon_t,$$

where Δ is a first difference operator, and time steps are annual. Cash/assets is defined as cash and marketable securities, over assets less cash and marketable securities. The chart includes information on 10,441 U.S. based firms included on Compustat with at least five years of data on cash holdings in the 1950–94 period. The median coefficient value is -0.242.

autocorrelation in the growth in internal resources would lead to negative autocorrelation in cash holdings. We test the hypothesis that cash holdings are mean reverting by estimating a first order autoregressive model for each Compustat firm of the form

$$\Delta(\text{Cash/Assets})_t = \alpha + \beta\Delta(\text{Cash/Assets})_{t-1} + \varepsilon_t, \quad (1)$$

where ε_t is an independent and identically distributed disturbance with zero mean. Fig. 3 shows the distribution of the autoregressive coefficients (β) from this regression for all Compustat firms with more than five years of data in the 1950–94 period.[3] The median coefficient is negative, indicating that cash balances are mean reverting. It appears that there are systematic factors that cause firms to not let cash balances rise too high or fall too low.

In Table 2, we attempt to distinguish more directly between the static tradeoff model and the financing hierarchy model. The sample used in this table is much

[3] It should be noted that these coefficients are biased downwards in small samples, so that we may be underestimating the extent of mean-reversion (see Hamilton, 1994, p. 217).

Table 2
Time series analysis of liquid asset holdings

Regressions examining whether firms have target cash levels. The dependent variable is the change in level of cash/net assets from the prior year where net assets are assets net of cash and marketable securities. Target adjustment is the difference between the estimated target level of cash/net assets and the previous year's level. The target is estimated in three different ways. Mean target adjustment is an average of the prior five years of cash/net assets. Size and sigma target adjustment is calculated as the predicted value from a regression of cash/net assets on real size and industry sigma. Sophisticated target is calculated as the predicted value from the Fama-MacBeth regressions in Table 4. Pecking order is the flow of funds deficit, defined as cash dividends plus capital expenditures, change in net working capital (less cash) and current portion of long term debt due, less operating cash flow, where all variables are deflated by net assets. Pecking order * above target is an interactive dummy variable which equals Pecking order if the firm is above its target level of cash, and zero otherwise. Real size is the natural logarithm of assets, deflated using the CPI into 1994 dollars. Industry sigma is the mean of the standard deviation of the prior 20 years of cash flow divided by net assets for each industry. Industries are defined by 2-digit SIC code. The sample is restricted to 1048 firms for which cash data is available for every year of the sample. Heteroskedastic-consistent standard errors are used to calculate *t*-statistics, shown in parentheses.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept	0.0002	− 0.0013	− 0.0037	0.0041	0.0056	0.0059	0.0005	0.0054	0.0055	0.0011
	(0.21)	(− 1.70)	(− 4.45)	(5.12)	(6.47)	(8.01)	(0.50)	(6.42)	(7.47)	(1.12)
Mean target Adjustment	− 0.3283				− 0.3519			− 0.3400		
	(− 8.69)				(− 8.20)			(− 7.87)		
Size and sigma target adjustment		− 0.2117				− 0.2270			− 0.2157	
		(− 11.54)				(− 12.13)			(− 11.37)	
Sophisticated target			− 0.2586				− 0.2555			− 0.2525
			(− 13.22)				(− 11.68)			(− 11.41)
Pecking order				− 0.2195	− 0.2103	− 0.2204	− 0.2020	− 0.1310	− 0.1212	− 0.1705
				(− 15.10)	(− 12.60)	(− 15.61)	(− 16.83)	(− 6.38)	(− 6.78)	(− 11.19)
Pecking order * above target								− 0.1573	− 0.2410	− 0.0673
								(− 4.86)	(− 8.65)	(− 2.82)
N	19,912	22,851	21,582	16,086	12,028	15,351	15,078	12,028	15,351	15,078
Adjusted R^2	0.082	0.104	0.140	0.130	0.214	0.244	0.266	0.230	0.280	0.270

smaller than the sample used in the first test. We use only the 1048 firms for which flow-of-funds data are available every year from 1971 to 1994. The target adjustment model we posit states that changes in cash holdings in year $t+1$ depend on the difference between actual cash holdings and the target cash holdings at the end of year t. The first model uses the average cash holdings of a firm during the five previous years as the firm's target cash holdings. This model is similar to the models tested in the capital structure literature discussed in Shyam-Sunder and Myers (1999). As shown in column (1) of Table 2, the adjustment coefficient is -0.3283, with a t-statistic of -8.69. The regression R^2 is 0.08. This regression indicates that a simple target adjustment model explains some of the change in cash holdings. The second regression presents estimates of a model where the target for a firm is obtained each year from the fitted values of a cross-sectional regression of cash holdings on real firm size and industry volatility. The target estimate for a given year is obtained without using information from subsequent years. The motivation for this model comes from theoretical models of cash holdings, the fact that there are returns to scale in cash holdings, and that the precautionary motive to hold cash specifies a negative relation between cash holdings and volatility. This model has a regression R^2 of 0.10, and the slope coefficient is highly significant. Finally, we use as the target the fitted values from the Fama–MacBeth cross-sectional model presented later in this paper. This model is estimated annually, so that all information required to estimate the target is available in the year in which the target is used in the regression. Using this target increases the regression R^2 to 0.14, as shown in column (3) of Table 2. All three target adjustment models are supported.

We then turn to the financing hierarchy model. We test that model by assuming that changes in cash holdings are given by the flow of funds deficit, measured as cash dividends plus capital expenditures plus the change in net working capital (less cash), plus the current portion of long-term debt due, minus the operating cash flow. Note that the flow of funds deficit is computed before financing, so that we are not estimating an identity. Both cash holdings and the flow of funds deficit are normalized by assets minus liquid assets. The coefficient on the flow of funds deficit is -0.2195, with a t-statistic of -15.10 (see column (4) of Table 2). Consequently, there is support for the financing hierarchy model as well. When the financing hierarchy model is used for debt, the financing hierarchy model has an extremely high R^2, in excess of 0.7, but this result is not true here. The R^2 of the financing hierarchy model is 0.13, which is slightly less than the result for the target adjustment model, using our cross-sectional model for the target.

The next three regressions of Table 2, columns (5)–(7), allow the change in cash to be influenced by both the target adjustment model and the financing hierarchy model. In all three regressions, both models are significant. It seems that the two models capture different aspects of the change in cash holdings of

firms. Adding the financing hierarchy model to the target adjustment model has little impact on the coefficient estimates or t-statistics of either model. Further, the R^2s for the regressions that combine both models are almost equal to the sum of the R^2s of the individual regressions.

Agency considerations suggest that managers who want to keep resources within the firm would let cash accumulate if the firm does well. However, this management would also take steps to remedy a situation where the firm has too little cash, relative to some target, even if the firm has a cash flow deficit. This reasoning makes it plausible that the financing hierarchy model would better predict changes in cash for firms that exceed their target. The last three regressions of Table 2, shown in columns (8)–(10), test this hypothesis. For all three target models, the coefficient of the flow of funds deficit is significantly higher in absolute value for firms that have liquid assets in excess of their target.

4.2. Univariate tests

Table 3 presents univariate comparisons of key descriptive variables by cash-to-assets quartile. The quartiles are constructed each year, which explains why the ranges of the cash-to-assets ratio overlap across quartiles. We are interested in whether the characteristics of companies which hold high cash balances, such as those companies in the fourth quartile, differ from those with low cash balances, such as those in the first quartile. We test the hypothesis that the fourth-quartile firms differ significantly from the first-quartile firms using a t-test. However, it turns out that firm characteristics do not always change monotonically with cash holdings, so that comparing the firms in the first and fourth quartiles of cash holdings is not sufficient to describe the relation between cash holdings and firm characteristics.

Firms in the fourth quartile of cash holdings differ significantly from firms in the first quartile of cash holdings at the 10% level, or better, for all variables we are considering. As expected, the firms with the most cash are smaller than the ones with the least cash. However, the univariate relation between cash and firm size is not monotonic. Firms in the first three quartiles of cash holdings are similar in size, but firms in the fourth quartile are substantially smaller. The market-to-book ratio increases monotonically with cash holdings. The same result holds for the R&D-to-sales ratio. The average ratio of cash flow-to-assets increases over the first three quartiles, and then falls dramatically so that the firms in the fourth quartile have the lowest average cash flow-to-assets ratio. Yet, the median cash-to-assets ratio increases monotonically, as predicted by the financing hierarchy model. Capital expenditures increase monotonically with the cash-to-assets ratio, which seems inconsistent with the financing hierarchy model. Somewhat surprisingly, the acquisition spending-to-assets ratio is lower

Table 3
Firm characteristics by cash/assets quartiles

Univariate comparison of means and medians of measures of firm characteristics of 87,135 firm years from the 1971–1994 sample of U.S.-based publicly traded firms. Median values are bracketed. Assets in the denominators of all variables are assets net of cash holdings. Real variables are deflated using the CPI into 1994 dollars. Size is defined as the natural log of assets. The market-to-book ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. Cash flow is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. Net working capital is calculated without cash. Payout to shareholders is the sum of cash dividends over assets and stock repurchases over assets. Industry sigma is a measure of the volatility of an industry's cash flow for a 20-year period. Industries are defined by 2-digit SIC codes. Total leverage is total debt over total assets. Other variables are included to control for research and development (R&D) spending, acquisitions, and capital expenditures. Quartiles for cash-to-assets are determined each year. The *t*-statistic is for a difference of means test from the first to the fourth quartile. Each quartile contains approximately 21,780 firm years.

Variable	First quartile	Second quartile	Third quartile	Fourth quartile	*t*-statistic (*p*-value)
Cash/assets range	0.00 to 0.04	0.02 to 0.09	0.05 to 0.28	0.09 to 3.47	
Cash/assets	0.0129 [0.0125]	0.0427 [0.0412]	0.1142 [0.1034]	0.5082 [0.3437]	− 154.22 (0.0001)
Real size	4.773 [4.645]	4.801 [4.769]	4.687 [4.657]	4.083 [4.000]	39.32 (0.0001)
Market-to-book ratio	1.322 [1.090]	1.351 [1.102]	1.503 [1.177]	1.958 [1.458]	− 56.24 (0.0001)
R&D/sales	0.0152 [0.0000]	0.0158 [0.0000]	0.0213 [0.0000]	0.0545 [0.0000]	− 35.85 (0.0001)
Cash flow/assets	0.0324 [0.0586]	0.0390 [0.0638]	0.0488 [0.0769]	0.0288 [0.0930]	1.69 (0.0911)
Net working capital/assets	0.1828 [0.2064]	0.1783 [0.1948]	0.1729 [0.1813]	0.1686 [0.1870]	5.96 (0.0001)
Capital expenditures/assets	0.0805 [0.0578]	0.0847 [0.0603]	0.0918 [0.0666]	0.1023 [0.0736]	− 26.03 (0.0001)
Acquisitions/assets	0.0108 [0.0000]	0.0125 [0.0000]	0.0119 [0.0000]	0.0094 [0.0000]	4.14 (0.0001)
Payout to Shareholders	0.0131 [0.0048]	0.0150 [0.0063]	0.0180 [0.0082]	0.0233 [0.0056]	− 35.87 (0.0001)
Industry sigma	0.1111 [0.0801]	0.1147 [0.0819]	0.1213 [0.0866]	0.1362 [0.0988]	− 28.45 (0.0001)

for firms in the fourth quartile of cash holdings than for firms in the first quartile. In contrast, payouts to shareholders increase monotonically across quartiles of cash holdings. Neither of these results seems consistent with free cash flow theory. Finally, industry volatility increases monotonically across quartiles.

4.3. Regression tests on the 1971–1994 sample

Table 4 presents panel regressions predicting liquidity levels in the 1971–1994 period, using the independent variables described earlier. The variables predicting liquidity levels are observed in the same fiscal year as the liquidity levels. In most, but not all, regressions, firms are allowed to enter and leave the panel. We use the logarithm of liquidity as our dependent variable.[4] In cases where we look at industry-adjusted variables, we include dummy variables for each industry, defined by the 2-digit SIC code.

The first column of Table 4 reports estimates using the method presented in Fama and MacBeth (1973), referred to hereafter as the Fama-MacBeth model. With this approach, a cross-sectional regression is estimated each year. This method eliminates the problem of serial correlation in the residuals of a time-series cross-sectional regression. The Fama-MacBeth model effectively treats each year as an independent cross-section. We find that cash holdings decrease significantly with size, net working capital, leverage, whether a firm pays dividends, and whether it is regulated. Cash holdings increase significantly with the cash flow-to-assets ratio, the capital expenditures-to-assets ratio, industry volatility, and the R&D-to-sales ratio. The coefficients are not only statistically significant but, in general, they are also economically significant. Going from small firms to large firms, increasing real assets by a factor of 100, for example, multiplies the log of the liquid assets ratio by about 0.80. An increase in the market-to-book ratio, from the first to the fourth quartile of the market-to-book distribution, more than doubles the cash-to-assets ratio.

With the Fama–MacBeth regressions, the coefficients of the market-to-book, cash flow-to-assets, and the dividend dummy variables are consistent with the static tradeoff theory, as well as with the financing hierarchy model. However, the coefficients of the size, capital expenditures, and R&D variables are more consistent with the static tradeoff theory than with the financing hierarchy model. It is not clear that the financing hierarchy model has predictions for the sign of working capital and industry volatility. The coefficients of these variables are consistent with the static tradeoff theory. Finally, the static tradeoff theory does not make clear predictions about the coefficient of leverage, but the result for this coefficient is consistent with the financing hierarchy model. To the extent that the evidence supports the static tradeoff model, it cannot be the case that cash holdings are a matter of indifference. Students of the determinants of leverage will notice that it is generally the case that the variables that affect cash holdings are also variables that affect leverage, but usually with the opposite sign, so that variables that are associated with more cash are variables that are

[4] Our qualitative results are not affected when using the level of liquidity as the dependent variable.

Table 4
Regressions predicting firm liquidity levels, 1971–1994

The dependent variable in all regressions is the natural log of cash/assets, which is calculated as cash divided by assets less cash holdings. In all the independent variable denominators, assets are net of cash. The year dummy regressions are run with a dummy variable for each year from 1972–1994. Real size is the natural log of assets, deflated using the CPI to 1994 dollars. The market-to-book ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. Cash flow is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. Net working capital is calculated without cash. Total leverage is total debt over total assets. Industry sigma is the mean of standard deviations of cash flow over assets over 20 years, for firms in the same industry, as defined by 2-digit SIC code. Dividend dummy is a variable set to one if the firm paid a dividend in the year, and set to 0 if it did not. Regulation dummy is a variable set to 1 if the firm is in a regulated industry for the year, and set to 0 if it is not. Other variables are included to control for research and development (R&D) spending and capital expenditures. Industry dummy variables are constructed for each industry, defined by the 2-digit SIC code. The Fama-MacBeth model gives the average of the time series of coefficients from annual cross-sectional regressions. The cross-sectional regression uses the means of all variables for each firm. Only firms for which a full panel of data is available are used in the cross-sectional specification. All *t*-statistics are corrected for heteroskedasticity using White's (1980) correction. The adjusted R^2 of the fixed-effects model is computed without the fixed effects. The fixed-effects regression excludes firms with only one observation.

Independent variable	Fama–MacBeth model	Regressions using dummy variables for:		Cross-sectional regression	Fixed-effects regression
		Year	Year and industry		
Intercept	− 2.017 (− 35.35)	N.A.	N.A.	− 1.1247 (− 6.91)	N.A.
Market-to-book ratio	0.1515 (16.47)	0.1422 (27.60)	0.1328 (25.64)	0.3058 (6.58)	0.0998 (18.10)
Real size	− 0.0439 (− 6.79)	− 0.0402 (− 13.37)	− 0.0332 (− 10.77)	− 0.1214 (− 7.57)	− 0.0826 (− 10.14)
Cash flow/assets	0.6601 (3.71)	0.1618 (4.44)	0.0963 (2.65)	− 0.4337 (− 0.66)	0.0742 (1.93)
Net working capital/assets	− 0.9713 (− 11.71)	− 0.8136 (− 31.24)	− 0.7742 (− 25.84)	− 1.8038 (− 9.15)	− 0.5560 (− 16.95)
Capital expenditures/assets	0.0703 (0.32)	0.4850 (7.38)	0.6832 (10.11)	− 2.2110 (− 2.71)	0.6524 (10.52)
Total leverage	− 2.8145 (− 29.16)	− 3.0234 (− 101.61)	− 3.0504 (− 100.45)	− 3.3587 (− 15.40)	− 2.3395 (− 65.80)
Industry sigma	0.4533 (1.98)	1.1636 (14.92)	1.0194 (9.65)	1.0538 (2.25)	− 0.8903 (− 12.51)
R&D/sales	1.2783 (10.03)	1.6606 (19.81)	1.5452 (18.47)	− 0.4762 (− 0.52)	0.7631 (9.04)

Table 4. Continued.

Independent variable	Fama–MacBeth model	Regressions using dummy variables for:		Cross-sectional regression	Fixed-effects regression
		Year	Year and industry		
Dividend dummy	− 0.1001 (− 2.67)	− 0.1275 (− 11.35)	− 0.1247 (− 11.05)	− 0.1815 (− 2.11)	0.0403 (3.10)
Regulation dummy	− 0.1438 (− 2.59)	− 0.0968 (− 2.16)	− 0.2414 (− 4.06)	− 1.0230 (− 2.42)	− 0.0284 (− 0.60)
N	24	87,117	87,117	1,048	86,955
Adjusted R^2	0.223	0.219	0.234	0.381	0.101

associated with less debt.[5] This reasoning suggests that variables that make debt costly make cash holdings advantageous. At the same time, however, our regressions do not imply that firms are indifferent between having one more dollar of cash or one less dollar of debt. If this were the case, one would expect the coefficient on debt to be insignificantly different from minus one. In our regressions, the coefficient on leverage is significantly different from minus one.[6]

We present four additional regression estimates in Table 4. First, we use a time-series cross-sectional regression with year dummies, and a time-series cross-sectional regression with year dummies where the variables are adjusted for industry, using dummy variables at the 2-digit SIC code level. These two regressions lead to the same results as the Fama-MacBeth regressions, but they have much higher absolute value t-statistics. Second, we estimate the regression using the average of the variables over the sample period for the firms used in the estimates of the target adjustment model in Table 2. The coefficient estimates in that regression are consistent with the estimates of the other regressions, except for cash flow, which is not significant, capital expenditures, which has a negative coefficient, and the R&D-to-sales ratio, which has a negative coefficient. Finally, we use a fixed-effects regression. Except for two variables, this regression has the same results as the time-series cross-sectional regressions. First, industry volatility has a significant negative coefficient. Second, the dividend dummy has a significant positive coefficient.

Table 5 addresses some concerns that arise from reviewing the results shown in Table 4. First, some of the variables in Table 4 may be determined for each

[5] See Harris and Raviv (1991) for a review of capital structure theories and the empirical evidence.

[6] Interestingly, Graham (1998) finds that the correlation between excess cash and excess debt capacity to be only 11.4%.

Table 5
Modified regressions predicting firm liquidity levels, 1971–1994

The dependent variable in all regressions is the natural log of cash/assets, which is calculated as cash divided by assets less cash holdings. In all the independent variable denominators, assets are net of cash. Panel A shows reduced form regressions that omit capital expenditures, leverage and dividends. Panel B shows regressions that include a measure for the difference in cash holdings. The year dummy regressions are run with a dummy variable for each year from 1972–1994. Real size is the natural log of assets, deflated using the CPI to 1994 dollars. The market-to-book ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. Cash flow is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. Net working capital is calculated without cash. Total leverage is total debt over total assets. Industry sigma is the mean of standard deviations of cash flow over assets over 20 years, for firms in the same industry, as defined by the 2-digit SIC code. Dividend dummy is a variable set to one if the firm paid a dividend in the year, and set to 0 if it did not. Regulation dummy is a variable set to 1 if the firm is in a regulated industry for the year, and set to 0 if it is not. Other variables are included to control for research and development (R&D) spending and capital expenditures. Difference in cash is the change in cash over net assets from year t to year $t+1$. Industry dummy variables are constructed for each industry, defined by 2-digit SIC code. The Fama–MacBeth model gives the average of the time series of coefficients from annual cross-sectional regressions. The cross-sectional regression uses the means of all variables for each firm. Only firms for which a full panel of data is available are used in the cross-sectional specification. All t-statistics are corrected for heteroskedasticity using White's (1980) correction. The adjusted R^2 of the fixed-effects model is computed without the fixed effects. The fixed-effects regression excludes firms with only one observation.

Independent variable	Fama–MacBeth model	Regressions using dummy variables for:		Cross sectional regression	Fixed-effects regression
		Year	Year and industry		
Panel A: Reduced form regressions					
Intercept	− 3.0135 (− 57.48)	N.A.	N.A.	− 2.7252 (− 19.00)	N.A.
Market-to-book ratio	0.2270 (20.62)	0.2411 (43.71)	0.2299 (41.51)	0.4512 (8.27)	0.1416 (24.57)
Real size	− 0.0727 (− 13.33)	− 0.0734 (26.00)	− 0.0666 (− 22.68)	− 0.1434 (− 8.91)	− 0.1518 (− 18.60)
Cash flow/assets	1.4205 (5.75)	0.7366 (16.94)	0.6289 (14.50)	1.2965 (2.23)	0.3762 (9.01)
Net working capital/assets	− 0.2174 (− 2.51)	− 0.1037 (− 4.01)	0.0613 (1.93)	− 0.6907 (− 3.95)	0.1442 (4.37)
Industry sigma	0.9554 (4.04)	1.6970 (20.13)	1.2452 (10.89)	1.2115 (2.23)	− 0.8924 (− 12.20)
R&D/sales	1.7285 (9.51)	2.3590 (24.45)	2.2972 (23.74)	1.2027 (1.30)	1.0643 (11.79)

Table 5. Continued.

Independent variable	Fama–MacBeth model	Regressions using dummy variables for:		Cross sectional regression	Fixed-effects regression
		Year	Year and industry		
Regulation dummy	(− 0.2184 (− 3.51)	− 0.2178 (− 4.89)	− 0.3038 (− 5.11)	− 1.1217 (− 2.55)	− 0.1540 (− 3.21)
N	24	87,117	87,117	1,047	86,955
Adjusted R^2	0.098	0.091	0.111	0.190	0.026
Panel B: Regressions adding a measure for difference in cash holdings					
Intercept	− 2.0311 (− 40.99)	N.A.	N.A.	− 1.2033 (− 7.86)	N.A.
Market-to-book ratio	0.1463 (16.34)	0.1335 (27.85)	0.1249 (25.94)	0.3501 (7.60)	0.0750 (16.32)
Real size	− 0.0455 (− 7.69)	− 0.0437 (− 15.37)	− 0.0374 (− 12.85)	− 0.1224 (− 7.84)	− 0.1447 (− 20.52)
Cash flow/assets	0.7182 (4.77)	0.3099 (8.65)	0.2383 (6.69)	− 0.7788 (− 1.23)	0.1625 (5.02)
Net working capital/assets	− 0.9952 (− 13.80)	− 0.8725 (− 35.23)	− 0.8098 (− 28.37)	− 1.7247 (− 9.19)	− 0.4739 (− 16.63)
Capital expenditures/assets	− 0.2863 (− 1.55)	0.0394 (0.64)	0.1842 (2.89)	− 1.5559 (− 2.06)	0.1012 (1.90)
Total Leverage	− 2.6744 (− 28.95)	− 2.8652 (− 100.34)	− 2.8798 (− 98.98)	− 3.2711 (− 15.63)	− 1.8138 (− 59.11)
Industry sigma	0.5908 (2.56)	1.2470 (16.75)	1.0366 (10.36)	0.6657 (1.47)	− 0.7739 (− 12.31)
R&D/sales	1.3082 (11.11)	1.7484 (21.17)	1.6423 (19.92)	− 0.9932 (− 1.10)	0.5932 (8.06)
Dividend dummy	− 0.1015 (− 2.78)	− 0.1267 (− 11.82)	− 0.1211 (− 11.27)	− 0.0826 (− 0.97)	0.0381 (3.31)
Regulation dummy	− 0.1453 (− 2.73)	− 0.1120 (− 2.56)	− 0.2528 (− 4.35)	− 1.1620 (− 2.73)	− 0.0548 (− 1.30)
Difference in cash	− 0.4356 (− 56.18)	− 0.4405 (− 85.83)	− 0.4394 (− 86.97)	2.6344 (7.66)	− 0.4792 (− 135.92)
N	24	81,819	81,819	1,047	81,775
Adjusted R^2	0.331	0.328	0.345	0.422	0.354

firm, jointly with their cash holdings. The static tradeoff theory would suggest that firms choose leverage, cash holdings, and investment policy simultaneously. This simultaneous determination could make our estimates inconsistent.We therefore re-estimate the regressions of Table 4 omitting

the capital expenditures, dividend, and leverage variables. These regressions, shown in Panel A of Table 5, have the interpretation of reduced-form regressions. The resulting regressions lead to the same conclusions as those of Table 4.

Another concern arising from a review of Table 4 is that some of the cash holdings are transitory, because a firm might have raised funds that it is waiting to spend, or the firm has raised funds simply because it is away from its target holdings. To allow for the existence of transitory cash holdings, we add next year's change in cash holdings as an explanatory variable. If a firm has unusually high cash because the firm just raised funds that will be spent next year, this variable should capture the part of cash holdings that is transitory. As shown in Panel B of Table 5, introducing this additional variable has little impact on the coefficients of the other variables, except that the coefficient of capital expenditures is no longer as reliable.

The fact that the univariate results indicate that firms in the fourth quartile of cash holdings are quite different from other firms, and that some variables do not change monotonically across quartiles of cash holdings, raises the issue that our results might be excessively influenced by firms that hold especially large amounts of cash. Although we do not report the results in the table, we investigate whether our results are driven by firms with large amounts of cash relative to net assets. For this investigation, we re-estimate the regressions in Table 4 after eliminating from the sample the firms that are in the top decile of cash holdings each year. The estimated coefficients in the regressions without the firms in the top decile of cash holdings have the same implications as the estimated coefficients in the regressions we report in Tables 4 and 5. The significance of our results does not depend on the firms that are in the top decile of cash holdings.

4.4. Regression tests on the 1994 sample

For 1994, we also have data on managerial ownership, derivatives usage, bond ratings, and anti-takeover charter amendments. We restrict the sample to firms for which the degree of diversification, as measured by the number of industry segments, is available. Table 6 estimates cross-sectional regressions using the explanatory variables from Tables 4 and 5, and additional explanatory variables available for 1994. The first two regressions in Table 6 use the full sample. The other two regressions use the subsample of S&P 500 firms for which derivatives usage information is available, and for which all our other variables are also available. Looking at the first two columns, we find that the explanatory variables that are in these regressions, as well as in the earlier regressions, lead to the same inferences. In most cases, the coefficient estimates are very similar. For instance, the coefficient of the market-to-book variable is 0.1445 in Table 6 and 0.1515 in the first column of Table 4.

Table 6
Derivative use and cash/assets, 1994

Two samples are used for these regressions. The full 1994 sample includes all firms on Compustat for 1994 for which we have data on insider ownership, bond rating, and the number of industry segments. The subsample of firms reporting derivatives includes only S&P 500 firms for which we have data on derivative usage. We measure derivatives as the actual value of the derivatives as reported by Risk Publications. The dependent variable in all regressions is the natural log of cash/assets, which is calculated as cash divided by assets less cash holdings. In all the independent variable denominators, assets are net of cash. Real size is the natural log of assets, deflated using the CPI to 1994 dollars. The market-to-book ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. Cash flow is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. Net working capital is calculated without cash. Total leverage is total debt over total assets. Firm sigma is the standard deviation of cash flow over assets over 20 years. Dividend dummy is a variable set to one if the firm paid a dividend in the year, and set to 0 if it did not. Number of segments is measured using the Compustat segment tapes. INSIDE 0% to 5% equals inside ownership if inside ownership is less then 5% and 5% if inside ownership is greater than 5%. INSIDE 5% to 25% equals zero if inside ownership is less than 5%, equals inside ownership minus 5% if inside ownership is greater than 5% but less than 25% and equals 20% if inside ownership is greater than 25%. INSIDE over 25% equals zero if board ownership is less than 25% and equals inside ownership minus 25% if inside ownership is greater than 25%. The bond rating dummy is equal to 1 if the firm's debt has an investment grade rating (BBB or higher), and 0 if it is below investment grade (BBB- or lower), or it has no rating reported on Compustat for 1994. The anti-takeover dummy is equal to one if the firm had an anti-takeover amendment in place, and set to zero otherwise. Derivative use dummy is a variable set equal to one if the firm uses derivatives, and set to zero otherwise. Derivative use $>10\%$ of assets is a variable set to one if the firm uses derivatives with a value greater than 10% of the firm's assets, and set to zero otherwise. Other variables are included to control for research and development (R&D) spending and capital expenditures. Due to some very significant outliers in the R&D-to-sales variable, we delete observations at the 1% tails.

Independent variable	Full 1994 sample		Firms reporting derivatives	
Intercept	− 2.3514	− 2.050	− 3.0222	− 2.9136
	(− 16.06)	(− 15.14)	(− 3.44)	(− 3.35)
Market-to-book ratio	0.1445	0.1597	0.2351	0.2422
	(7.35)	(8.17)	(1.88)	(1.98)
Real size	− 0.0360	− 0.0463	0.0388	0.0336
	(− 1.67)	(− 2.14)	(0.41)	(0.35)
Firm sigma	0.4446	0.5127	4.7610	4.7900
	(3.65)	(4.21)	(2.08)	(2.09)
R&D/sales	0.9018	1.0394	6.5442	7.6400
	(6.52)	(7.61)	(2.45)	(3.22)
Cash flow/assets	0.6320	0.6676	− 1.9262	− 1.9811
	(3.93)	(4.14)	(− 1.01)	(− 1.04)
Net working capital/assets	− 1.2330	− 1.2333	− 0.8547	− 0.9188
	(− 9.39)	(− 9.35)	(− 1.20)	(− 1.30)

Table 6. Continued.

Independent variable	Full 1994 sample		Firms reporting derivatives	
Capital expenditure/assets	0.6426	0.4575	1.6739	1.5133
	(1.67)	(1.19)	(0.97)	(0.89)
Total leverage	− 3.0598	− 3.1271	− 4.0950	− 4.1210
	(− 20.51)	(− 20.92)	(− 5.99)	(− 6.04)
Number of segments	− 0.0234	− 0.0201	− 0.1011	− 0.1001
	(− 0.74)	(− 0.63)	(− 1.74)	(− 1.72)
Industry sigma	1.2546		0.5488	
	(5.23)		(0.90)	
Dividend dummy	− 0.1422	− 0.1701	− 0.2718	− 0.2548
	(− 1.95)	(− 2.33)	(− 0.97)	(− 0.91)
INSIDE 0% to 5%	3.8038	4.1918	3.5415	3.7571
	(1.85)	(2.03)	(0.66)	(0.70)
INSIDE 5% to 25%	− 0.9004	− 1.0007	− 0.1298	− 0.1029
	(− 1.47)	(− 1.63)	(− 0.05)	(− 0.04)
INSIDE over 25%	− 0.0870	− 0.1090	0.3899	0.5101
	(− 0.33)	(− 0.40)	(0.07)	(0.09)
Bond rating dummy	− 0.5211	− 0.4770	− 0.1240	− 0.1005
	(− 4.51)	(− 4.11)	(− 0.62)	(− 0.51)
Anti-takeover dummy			− 0.1870	− 0.1841
			(− 1.17)	(− 1.15)
Derivative use dummy			0.0319	0.0107
			(0.11)	(0.04)
Derivative use > 10% of assets			0.2822	0.3100
			(1.68)	(1.88)
N	2400	2400	216	216
Adjusted R^2	0.286	0.278	0.364	0.364

The static tradeoff model implies that firms with a higher debt rating hold less cash, whereas the financing hierarchy model implies the contrary, since firms that have done well have less debt and hence a higher bond rating. The financing hierarchy model has no clear predictions for the other variables. In Table 6, firm volatility has a strong positive effect on cash holdings, even when we control for industry volatility using our industry sigma variable. Management ownership has a positive effect on cash holdings, significant at the 0.10 level for low ownership, but cash holdings do not increase further as ownership increases past 5%. This result is consistent with managerial risk aversion, insofar as managers may wish to protect their human capital with a cash buffer. Not surprisingly, from the perspective of the static tradeoff theory, firms that have an investment

grade bond rating hold less cash. Although the diversification variable has the predicted sign, it is not statistically significant.

In the last two columns of Table 6, we present regressions for the subsample of S&P 500 firms reporting derivatives usage. The results are largely similar to the ones for the full sample. One exception is that diversification has a negative coefficient, significant at the 0.10 level. Whether a firm pays dividends or not does not seem to matter, which may reflect the fact that most firms in this subsample pay dividends. The coefficients on the dummy variables denoting inside ownership, presence of anti-takeover amendments, and the bond rating level are not statistically significant. This result may be due to a lack of cross-sectional variation for these variables among S&P 500 firms. Cash holdings are unrelated to whether a firm uses derivatives, but not to the intensity of derivatives usage. A dummy variable that takes the value of one if a firm has derivatives, with a notional amount in excess of 10% of assets, has a significant positive coefficient. Consequently, the regressions in Table 6 do not provide support for the view that cash holdings and derivatives are substitutes, but are not inconsistent with the view that cash holdings and derivatives are complements.

5. Does excess cash affect spending?

We think of the regressions of Section 4 as providing a measure of the cash a firm should hold. We compute a measure of excess cash from the residuals from the Fama–MacBeth regression of Table 4. A company with positive excess cash is one that holds more cash than predicted by our model in that year. Since the cross-sectional regressions are estimated yearly, the regression model has no implication for the behavior of excess cash for a firm over time. Hence, the regression model does not imply that excess cash exhibits mean reversion, but it does imply that average excess cash across firms is equal to zero in a given year. It is interesting to note that Chrysler held $5.145 billion of cash in 1994, of which over $3.9 billion was excess cash, according to our model. Other large companies with excess cash are IBM, Procter and Gamble, and Ford. Companies with negative excess cash include DuPont, RJR, and Wal-Mart. Since theory provides only limited guidance for our empirical model, alternate specifications of our regressions might affect our estimates of excess cash. At the same time, however, our results do not seem to be sensitive to the alternate specifications we have explored.

To more fully understand how firms manage their cash, we show in Table 7 how spending patterns in year $t + 1$ are related to positive excess cash in year t. We use the Compustat flow of funds data to identify spending patterns on an annual, as well as on a cross-sectional, basis. Firm years are separated into quartiles on the basis of the market-to-book (MB) ratio. If the market-to-book

Table 7
Spending patterns based on market-to-book ratio and previous years excess cash

The sample includes only firm years in which the firm has positive lagged excess cash. Firm years are ranked into quartiles by the market-to-book ratio as measured by the book value of assets, less the book value of equity, plus the market value of equity, divided by assets in the current year. High (low) market-to-book firms are those ranked in the top (bottom) quartile. The firm years are also independently broken into quartiles based on the previous year's holdings of excess cash. The table shows the cross-tabulations of high and low market-to-book firm years and quartiles of excess cash holdings. The excess cash holding is the antilog of a residual from a first pass regression to predict the natural log of cash divided by assets less cash. The cash quartiles are generated for every year, and firms are regrouped each year. Panel A shows capital expenditures, Panel B shows expenditures on acquisitions, Panel C shows payments to shareholders, which is defined as stock repurchases plus cash dividends, and Panel D shows the operating cash flow. All variables are from the flow of funds statement, and are deflated by total assets less cash. Number of firm years of each quartile is in brackets. The *t*-statistic is generated from a difference of means test between the first and fourth quartiles of excess cash (column values) or the difference between high and low market-to-book (row values).

Market-to-book ratio performance	Quartiles of previous year excess cash holdings				
	First	Second	Third	Fourth	(*t*-statistic) *p*-value
Panel A: Capital expenditures					
High market-to-book firms	0.1027 [1411]	0.1019 [1971]	0.1075 [2601]	0.1166 [3539]	(− 4.64) 0.0001
Low market-to-book firms	0.0637 [3456]	0.0711 [2896]	0.0755 [2266]	0.0766 [1327]	(− 5.36) 0.0001
t-statistic (*p*-value)	(− 14.57) 0.0001	(− 13.28) 0.0001	(− 14.25) 0.0001	(− 14.39) 0.0001	
Panel B: Acquisitions					
High market-to-book firms	0.0125 [1397]	0.0128 [1954]	0.0139 [2588]	0.0166 [3478]	(− 3.17) 0.0015
Low market-to-book firms	0.0047 [3445]	0.0066 [2869]	0.0081 [2249]	0.0121 [1312]	(− 6.43) 0.0001
t-statistic (*p*-value)	(− 7.39) 0.0001	(− 5.95) 0.0001	(− 5.81) 0.0001	(− 3.22) 0.0013	
Panel C: Payments to shareholders					
High market-to-book firms	0.0206 [1375]	0.0260 [1933]	0.0228 [2490]	0.0228 [3277]	(− 1.90) 0.0577
Low market-to-book firms	0.0133 [3418]	0.0151 [2862]	0.0193 [2240]	0.0265 [1267]	(− 12.30) 0.0001
t-statistic (*p*-value)	(− 8.27) 0.0001	(− 11.74) 0.0001	(− 9.45) 0.0001	(2.94) 0.0033	

Table 7. Continued.

Market-to-book ratio performance	Quartiles of previous year excess cash holdings				
	First	Second	Third	Fourth	(*t*-statistic) *p*-value
Panel D: Operating cash flow					
High market-to-book firms	0.1035 [793]	0.1150 [1105]	0.1180 [1432]	0.0519 [1788]	(4.92) 0.0001
Low market-to-book firms	0.0731 [2981]	0.0800 [2379]	0.0843 [1765]	0.0781 [832]	(− 0.69) 0.4886
t-statistic (*p*-value)	(− 4.13) 0.0001	(− 5.64) 0.0001	(− 5.26) 0.0001	(2.51) 0.0120	

ratio is a good proxy for the presence of profitable growth opportunities, then our discussion of the agency costs of managerial discretion predicts that these agency costs are small in high-MB firms. We therefore compare firms in the highest and lowest quartiles of the market-to-book measure for different quartiles of positive excess cash. The excess cash quartiles are computed separately across all firms each year, so that the number of firms in each cell varies, but firms in the same excess cash quartile have similar amounts of excess cash irrespective of their market-to-book ratio.

We find that capital expenditures increase monotonically in excess cash for both high-MB and low-MB firms. For all quartiles of excess cash, high-MB firms invest significantly more than low-MB firms but there is no evidence that capital expenditures increase faster for low-MB firms than for high-MB firms as excess cash increases.[7] The increase in capital expenditures across excess cash quartiles is small compared to the increase in excess cash. Moving from the first quartile to the fourth quartile of excess cash, capital expenditures increase by about 1.4% of net assets for high-MB firms and 1.3% for low-MB firms. However, excess cash increases dramatically, since average excess cash is 1.2% of net assets in the first quartile and 58.05% in the fourth quartile. The increase in capital expenditures across quartiles seems therefore to be almost trivial relative to the increase in excess cash. Although we do not reproduce results for firms with negative excess cash, it is interesting to note that capital expenditures are U-shaped in excess cash, when we look both at positive and negative excess

[7] The ratio of high-MB to low-MB capital expenditures is 1.57 for the first quartile of positive excess cash, 1.42 for the second, 1.43 for the third, and 1.54 for the fourth quartile.

cash. Low-MB firms in the lowest quartile of negative excess cash have capital expenditures that are similar to those of low-MB firms in the highest quartile of positive excess cash (0.0766 versus 0.0794). The same result holds for high-MB firms (0.1166 versus 0.1150). In summary, there is no evidence that the firms where one would expect the agency costs of managerial discretion to be the highest, namely low-MB firms, have a higher propensity to spend excess cash on capital expenditures than other firms.

Spending on acquisitions increases with excess cash, and is significantly greater for firms in the fourth quartile of excess cash than for firms in the first quartile. Hence, the evidence shown in Table 7 is consistent with Harford (1998), who predicts that more spending takes place on acquisitions as excess cash increases. When one looks at spending on acquisitions in relation to excess cash for both positive and negative amounts of excess cash, firms with negative excess cash spend less than half as much on acquisitions as do firms in the fourth quartile of positive excess cash. Again, however, spending increases much more slowly than excess cash across the excess cash quartiles.

Payments to shareholders, which are the sum of dividends and stock repurchases, do not seem to be related to excess cash for high-MB firms but are related for low-MB firms. As shown in Table 7, low-MB firms pay out less to shareholders in the first three quartiles of excess cash than do high-MB firms, but pay out more in the fourth quartile.

The bottom line from this analysis is that the spending of low-MB firms is more sensitive to excess cash. Rather surprisingly, in light of the predictions of free cash flow theory, the impact of excess cash on payouts to shareholders is of the same magnitude as the impact of excess cash on investment and spending on acquisitions. Not surprisingly, firms with negative excess cash have lower payouts than other firms.

Firms with more excess cash have higher capital expenditures, and spend more on acquisitions, even when they have poor investment opportunities. To investigate further the relation between excess cash and investment, we add excess cash to traditional investment equations. Table 8 reports such investment equations for firms in our sample. We find that, after controlling for the determinants of investment, it is still the case that greater excess cash leads firms to invest more, whether they have good investment opportunities or not. At the same time, however, it appears that the impact of excess cash on investment is significantly smaller for positive excess cash than negative excess cash. In other words, negative excess cash reduces investment more than positive excess cash increases investment. This relation could be viewed as evidence for credit constraints of the type discussed in Fazzari, Hubbard and Petersen (1988). Overall, the results suggest that the propensity to spend positive excess cash is small. Table 8 also provides no evidence to support the view that it takes time for excess cash to affect investment, since most of the effect seems to take place within one year.

Table 8
Determinants of capital expenditures

Ordinary least squares (OLS) and fixed-effects regression results for uses of cash using a sample of firms for which excess cash can be calculated. A firm had to be observed for at least 2 years to be included in the regressions. The t subscripts indicate time periods. The dependent variable in all regressions is capital expenditures divided by assets in year t. Assets are net of cash holdings in all variables. All data for right-hand-side numerators come from the flow of funds statements. Cash flow is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. Sales Growth is the natural log of sales in year t, minus the natural log of sales in year $t-1$. $(\text{Excess Cash/Assets})_{t-1}$ is the antilog of a lagged residual from a first pass regression to determine the natural log of cash divided by assets less cash. $(\text{Normal Cash/Assets})_{t-1}$ is the antilog of a lagged predicted value from a first pass regression to determine the natural log of cash divided by assets less cash. POSX is a dummy variable which is given a value of 1 if there is positive excess cash in the firm year, and zero otherwise. For the industry-adjusted data, industry dummy variables are included in the specification. Industries are defined by 2-digit SIC codes. t-statistics are in parentheses, and are calculated using White's (1980) correction for heteroskedasticity. The adjusted R^2 for fixed-effects models are computed without the fixed effects.

Independent variable	Raw regression results:				Industry-adjusted results:			
	OLS	OLS	Fixed-effects	Fixed-effects	OLS	OLS	Fixed-effects	Fixed-effects
Intercept	0.0549 (52.67)	0.0543 (54.77)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
$(\text{Cash flow/assets})_t$	0.0885 (23.61)	0.0872 (23.29)	0.0178 (4.96)	0.0217 (6.25)	0.0794 (22.40)	0.0787 (22.22)	0.0175 (4.96)	0.0212 (6.15)
Sales growth	0.0165 (11.68)	0.0168 (11.86)	0.0183 (12.48)	0.0165 (11.54)	0.0171 (12.46)	0.0173 (12.54)	0.0169 (11.82)	0.0158 (11.18)
Market-to-book ratio	0.0075 (14.17)	0.0075 (14.23)	0.0107 (17.17)	0.0100 (16.32)	0.0076 (15.38)	0.0075 (15.35)	0.0097 (15.83)	0.0095 (15.68)
$(\text{Normal cash/assets})_{t-1}$	0.0541 (3.59)	0.1196 (6.34)	0.0879 (4.69)	0.1267 (6.25)	0.0454 (3.69)	0.1127 (6.68)	0.0840 (4.67)	0.1110 (5.79)

(Normal cash/assets)$_{t-2}$	0.0547	0.0531	0.0533	0.0524	0.0447	0.0419	0.0514	0.0521
	(4.18)	(4.13)	(3.71)	(4.25)	(4.27)	(4.18)	(3.73)	(4.20)
(Normal cash/assets)$_{t-3}$	0.0052	0.0025	0.0149	0.0157	− 0.0016	− 0.0037	0.0157	0.0155
	(0.72)	(0.35)	(2.53)	(2.44)	(− 0.23)	(− 0.56)	(2.72)	(2.64)
(Excess cash/assets)$_{t-1}$		0.0959		0.0720		0.0983		0.0479
		(3.94)		(12.98)		(4.85)		(7.65)
(Excess cash/assets)$_{t-2}$		− 0.0025		0.0064		− 0.0020		0.0067
		(− 0.83)		(2.30)		(− 0.70)		(2.44)
(Excess cash/assets)$_{t-3}$		− 0.0079		0.0042		− 0.0055		0.0043
		(− 3.59)		(1.97)		(− 2.63)		(2.04)
POSX	0.0011	0.0020	− 0.0026	− 0.0038	− 0.0028	− 0.0021	0.0057	0.0016
	(0.91)	(1.66)	(− 5.96)	(− 8.68)	(− 2.53)	(− 1.96)	(9.39)	(2.44)
POSX * (Normal cash/assets)$_{t-1}$	0.0326	− 0.0260	0.0338	− 0.0130	0.0787	0.0142	0.0400	0.0031
	(1.92)	(− 1.27)	(1.35)	(− 0.55)	(5.29)	(0.77)	(1.65)	(0.13)
POSX * (Excess cash/assets)$_{t-1}$		− 0.0885		− 0.0418		− 0.0906		− 0.0178
		(− 3.62)		(− 6.74)		(− 4.46)		(− 2.60)
Sample size	57,495	57,495	35,235	35,235	57,495	57,495	35,235	35,235
Adjusted R^2	0.069	0.070	0.061	0.079	0.236	0.237	0.073	0.085

6. What happens to excess cash?

In Section 5, we saw that an increase in excess cash leads to a surprisingly small increase in capital expenditures, acquisitions spending, and payouts to shareholders. This observation suggests that there is substantial persistence in excess cash. To examine this persistence, we divide the firm-years in our sample into quartiles of excess cash. In Table 9, we show the status in subsequent years of firms that have entered the fourth quartile of excess cash in our sample for the first time. 55.5% of these firms are in the same quartile the following year. This indicates that being in the fourth quartile is a transitory state for more than 40% of the firms. However, firms which are in the fourth quartile for more than one year tend to be in that quartile for a substantial amount of time. The percentage of firms that are in the fourth quartile five years after the first time that they are in the fourth quartile of excess cash is 38.8%. A similar result holds for the firms that enter the first quartile of excess cash. Hence, there is persistence both in the highest quartile of excess cash, and in the lowest quartile.

The counterpart of this persistence is that neither firms in the first quartile nor firms in the fourth quartile change their spending patterns dramatically. Table 10 shows spending patterns for firms in the first and fourth quartiles for five years. Comparing the results from Panel A to those in Panel B, firms in the fourth quartile spend more. They still spend more on acquisitions and shareholder payouts five years after having been identified as firms in the fourth quartile of excess cash.

Why is it that firms experience large changes in excess cash? We have seen that, on average, expenditure patterns of high excess cash firms are not such that they use up their excess cash quickly. We therefore look at firms that go from the top quartile of excess cash to the bottom quartile of excess cash in one year. We then look at the expenditure and cash flow patterns for these firms. The results are reproduced in Table 11. The clear result in that table is that firms that experience large changes in excess cash, on average, experience large negative operating cash flows. Note that in Table 11, the end of year 0 is used to assign a firm to an excess cash quartile. We then select the firms that go from quartiles 4 to 1. The largest swing in the ratios reported is the one for operating cash flow. This swing represents a change, on average, of more than 3.5% of assets. Neither capital expenditures nor acquisitions increase by as much as one percent of assets. The results in Table 11 also show that lumpiness of capital expenditures and acquisitions is not an important reason for large changes in excess cash. Firms that experience large increases in excess cash also experience them because of large swings in operating cash flow. In Panel A, firms that go from the first quartile of excess cash to the fourth quartile experience an average swing in operating cash flow of more than 15% of net assets. Strikingly, however, this dramatic shift in cash flow has a small impact on capital expenditures, acquisitions, and payments to shareholders. In other words, the firms that experience such a large increase in excess cash keep it.

Table 9
Persistence of excess cash

Persistence of levels of excess cash for firms selected based on the first time they enter the highest (lowest) quartile of excess cash. The excess cash holding is the antilog of a residual from a first pass regression to predict the natural log of cash divided by assets less cash. The firms are followed for the next five years to determine the quartile in which they belong in the subsequent years. Quartile 4 represents the highest excess cash quartile, and Year 0 is the measurement year. Numbers shown are percentages. The number of firm years in each quartile, each year, is in brackets.

	Quartile 4	Quartile 3	Quartile 2	Quartile 1
Panel A. Persistence of excess cash for firms that are in the highest quartile of excess cash in year 0				
Year 0	100.0 [6221]			
Year 1	55.5 [3010]	22.8 [1235]	8.8 [476]	12.9 [701]
Year 2	46.4 [2155]	24.6 [1140]	13.8 [641]	15.2 [706]
Year 3	41.4 [1664]	26.4 [1060]	14.5 [581]	17.7 [712]
Year 4	40.6 [1432]	25.8 [909]	15.7 [552]	18.0 [634]
Year 5	38.8 [1192]	27.3 [841]	15.9 [489]	18.0 [554]
Panel B. Persistence of excess cash for firms that are in the lowest quartile of excess cash in year 0				
Year 0				100.0 [6417]
Year 1	8.9 [494]	13.4 [741]	25.0 [1383]	52.7 [2912]
Year 2	11.8 [565]	16.6 [792]	28.0 [1335]	43.6 [2082]
Year 3	13.4 [563]	19.8 [829]	28.0 [1175]	38.8 [1629]
Year 4	14.8 [543]	20.9 [767]	27.1 [993]	37.1 [1359]
Year 5	15.8 [510]	20.8 [674]	26.5 [856]	37.0 [1196]

We also investigate firms that end up in the top or bottom quartile of excess cash for the five years before they end in that state. These results are not reported, although they are fully consistent with our other results. Firms that end up with excess cash are firms that have done well, and firms that end up with low excess cash are firms that have done poorly in the most recent years.

Table 10
Future cash disposition for firms with high and low excess cash

The sample includes firms that enter the highest or lowest excess cash quartile for only the first year that they were in the first or fourth excess cash quartile, designated as year zero. The firm years are independently broken into quartiles based on the previous year's holdings of excess cash. The excess cash holding is the antilog of a residual from a first pass regression to predict the natural log of cash divided by assets less cash. The cash quartiles are generated for every year, and firms are regrouped each year. Panel A shows firms in the fourth quartile, and Panel B shows firms in the first quartile. Panel C shows the *t*-statistics and the *p*-values for the tests of differences of means between the first and fourth quartile for each variable and each year. The table shows operating cash flow, capital expenditures, expenditures on acquisitions, and payments to shareholders, which is defined as stock repurchases plus cash dividends. All variables are from the flow of funds statement, and are deflated by total assets less cash. Number of firm years of each quartile is also included in brackets. *t*-statistics for the difference in means from year 0 are shown in parentheses in Panels A and B.

Variable	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A. Firms entering the top quartile of excess cash holdings in year 0						
Operating cash flow	− 0.0011	0.0604	0.0673	0.0749	0.0839	0.0884
	[3575]	[3949]	[3351]	[2904]	[2522]	[2200]
		(− 11.94)	(− 13.36)	(− 14.70)	(− 16.37)	(− 17.44)
Capital expenditures	0.1127	0.0968	0.0911	0.0874	0.0847	0.0834
	[6342]	[5458]	[4724]	[4137]	[3642]	[3224]
		(8.39)	(11.38)	(13.37)	(14.61)	(15.30)
Acquisitions	0.0123	0.0105	0.0104	0.0094	0.0085	0.0094
	[6203]	[5370]	[4645]	[4068]	[3579]	[3177]
		(2.58)	(2.60)	(3.91)	(5.15)	(3.74)
Payments to shareholders	0.0121	0.0126	0.0135	0.0149	0.0159	0.0174
	[6136]	[5332]	[4613]	[4044]	[3565]	[3160]
		(− 1.07)	(− 3.06)	(− 5.69)	(− 7.44)	(− 9.38)

Panel B. Firms entering the bottom quartile of excess cash holdings in year 0

Operating cash flow	0.0561	0.0419	0.0732	0.0817	0.0990	0.1041
	[3511]	[3726]	[3114]	[2680]	[2284]	[1869]
		(1.95)	(− 2.43)	(− 3.69)	(− 6.16)	(− 6.69)
Capital expenditures	0.1149	0.1132	0.0983	0.0911	0.0859	0.0851
	[6231]	[5423]	[4633]	[4007]	[3518]	[3078]
		(0.85)	(8.56)	(12.17)	(14.88)	(14.84)
Acquisitions	0.0104	0.0159	0.0136	0.0141	0.0115	0.0114
	[6114]	[5309]	[4559]	[3945]	[3485]	[3054]
		(− 6.68)	(− 4.01)	(− 4.22)	(− 1.25)	(− 1.11)
Payments to shareholders	0.0143	0.0152	0.0161	0.0177	0.0186	0.0200
	[5977]	[5272]	[4514]	[3922]	[3443]	[3009]
		(− 1.81)	(− 3.22)	(− 5.66)	(− 6.90)	(− 8.34)

Panel C. t-statistics and p-values for difference in means of firms entering the first and fourth quartiles in year 0

Operating cash flow	− 7.85	3.62	− 1.24	− 1.45	− 3.20	− 3.16
	0.0001	0.0003	0.2161	0.1459	0.0014	0.0016
Capital expenditures	− 1.10	− 8.57	− 3.92	− 2.01	− 0.66	− 0.90
	0.2718	0.0001	0.0001	0.0443	0.5120	0.3703
Acquisitions	2.68	− 6.57	− 3.90	− 5.23	− 3.51	− 2.15
	0.0074	0.0001	0.0001	0.0001	0.0004	0.0317
Payments to shareholders	− 4.51	− 5.22	− 4.68	− 4.53	− 4.12	− 3.42
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0006

Table 11
Future cash disposition for firms going from the highest to the lowest quartile, or vice versa, in one year

The sample includes firms that enter the highest or lowest excess cash quartile for only the first year that they were in the first or fourth excess cash quartile, designated as year zero, and then the fourth, or first, excess cash quartile, respectively, the next year, designated as year one. The firm years are independently broken into quartiles based on the previous year's holdings of excess cash. The excess cash holding is the antilog of a residual from a first pass regression to predict the natural log of cash divided by assets less cash. The cash quartiles are generated for every year, and firms are regrouped each year. Panel A shows firms which moved from the first to the fourth quartile, and Panel B shows firms which moved from the fourth to the first quartile. Panel C shows the *t*-statistics and the *p*-values for the tests of differences of means between the first and fourth quartile for each variable and each year. The table shows operating cash flow, capital expenditures, expenditures on acquisitions, and payments to shareholders, which is defined as stock repurchases plus cash dividends. All variables are from the flow of funds statement, and are deflated by total assets less cash. Number of firm years of each quartile is also included in brackets. *t*-statistics for the difference in means from year zero are shown in parentheses in Panels A and B.

Variable	Year − 1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Panel A. Bottom quartile excess cash holdings in year 0, top quartile in year 1							
Operating cash flow	− 0.0604	− 0.0759	0.0744	− 0.0012	0.0346	0.0211	0.0438
	[215]	[248]	[276]	[230]	[188]	[152]	[129]
	(− 0.45)		(− 5.25)	(− 2.63)	(− 3.99)	(− 3.40)	(− 4.32)
Capital expenditures	0.1182	0.1105	0.1006	0.1044	0.0875	0.0907	0.0818
	[243]	[430]	[430]	[338]	[286]	[254]	[215]
	(− 0.84)		(1.41)	(0.86)	(3.31)	(2.55)	(3.84)
Acquisitions	0.0107	0.0152	0.0146	0.0219	0.0128	0.0130	0.0115
	[236]	[418]	[424]	[331]	[281]	[252]	[213]
	(1.28)		(0.19)	(− 1.69)	(0.72)	(0.61)	(1.05)
Payments to shareholders	0.0146	0.0092	0.0113	0.0126	0.0136	0.0159	0.0143
	[234]	[411]	[418]	[330]	[280]	[248]	[208]
	(− 2.42)		(− 1.28)	(− 1.94)	(− 2.29)	(− 3.06)	(− 2.40)

Panel B. Top quartile excess cash holdings in year 0, bottom quartile in year 1

Operating cash flow	−0.0150 [213] (−1.40)	−0.0637 [342]	−0.1015 [408] (1.37)	0.0043 [343] (−2.42)	0.0390 [284] (−3.59)	0.0188 [232] (−2.74)	0.0654 [171] (−4.18)
Capital expenditures	0.0989 [201] (5.04)	0.1435 [629]	0.1468 [629] (−0.44)	0.0976 [487] (6.86)	0.0904 [386] (7.52)	0.0848 [339] (8.49)	0.0885 [300] (7.62)
Acquisitions	0.0106 [195] (0.28)	0.0116 [614]	0.0204 [613] (−3.06)	0.0126 [482] (−0.38)	0.0144 [380] (−0.92)	0.0132 [338] (−0.55)	0.0116 [297] (0.01)
Payments to shareholders	0.0139 [193] (−0.68)	0.0123 [604]	0.0099 [616] (1.46)	0.0106 [481] (0.98)	0.0106 [384] (1.05)	0.0123 [333] (−0.02)	0.0124 [296] (−0.07)

Panel C. t-statistics for difference in means of firm groups

Operating cash flow	−1.21 0.2252	−0.39 0.6998	7.31 0.0001	−0.23 0.8207	−0.18 0.8542	0.09 0.9324	−0.81 0.4199
Capital expenditures	1.86 0.0636	−4.51 0.0001	−6.54 0.0001	1.04 0.2991	−0.44 0.6609	0.79 0.4296	−0.91 0.3652
Acquisitions	0.03 0.9777	1.20 0.2309	−1.91 0.0563	2.47 0.0137	−0.48 0.6297	−0.06 0.9534	−0.04 0.9722
Payments to shareholders	0.24 0.8103	−1.90 0.0578	0.82 0.4110	1.09 0.2755	1.56 0.1195	1.53 0.1262	0.79 0.4322

7. Conclusion

We examine the determinants of corporate holdings of cash and marketable securities among publicly traded US firms from 1971–1994, as well as how firms change their holdings over time. We find evidence supportive of a target adjustment model, but it is also clearly the case that firms that do well accumulate more cash than one would expect with the static tradeoff theory, where managers maximize shareholder wealth. Our results indicate that firms with strong growth opportunities, firms with riskier activities, and small firms hold more cash than other firms. Firms that have the greatest access to the capital market, such as large firms and those with credit ratings, tend to hold less cash. These results are consistent with the view that firms hold liquid assets to ensure that they will be able to keep investing when cash flow is too low, relative to investment, and when outside funds are expensive. Our analysis provides limited support for the view that positive excess cash leads firms to spend substantially more on investment or acquisitions. Whereas acquisitions increase with excess cash, payouts to shareholders increase with excess cash as well. However, in both cases, the propensity to use excess cash on investment and acquisitions is quite limited.

The evidence in this paper is consistent with the view that management accumulates excess cash if it has the opportunity to do so. The motivation for this behavior seems to be that the precautionary motive for holding cash is excessively strong. The result that the firm's flow of funds deficit has a stronger impact on changes in cash holdings for firms that have cash in excess of their target supports this conclusion. At the same time, however, using cross-sectional data for 1994, we are not successful in demonstrating that proxies for agency costs have an important impact on cash holdings. Therefore, our results suggest that more work needs to be done to explain why firms appear to hold excess cash, as well as to understand the cost of this practice. An important issue for further research is whether, when a firm runs into difficulties, excess cash allows management to avoid making required changes, using up the firms cash to finance losses. If this behavior is the case, it would not be surprising that management is not as concerned about hoarding excess cash as shareholders might be.

Our results provide support for a static tradeoff view. At the same time, however, it is also quite clear that variables that make debt costly for a firm are variables that make cash advantageous. Because the determinants of cash are so closely related to the determinants of debt in our analysis, it is important in future work to figure out, both theoretically and empirically, to what extent cash holdings and debt are two faces of the same coin.

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