The marginal value of cash, cash flow sensitivities, and bank-finance shocks in nonlisted firms

Charlotte Ostergaard, Amir Sasson, and Bent E. Sørensen*

Abstract

We examine financing choices for a comprehensive sample of closely-held, nonlisted, firms linked to their main bank and we study how these choices are affected by exogenous shocks to the availability of bank finance. First, we ask how the firms substitute between internal and external financing sources and how that substitution is related to firms' investment and dividend payments to owners. Little is known about how small, nonlisted firms trade off these decisions and we find considerable cross-sectional heterogeneity that systematically link firms' financing mix to the level of their cash balances. Second, we study how firms' financing choices are affected by exogenous shocks to the availability of external finance. We consider firms' adjustments to (instrumented) changes in their main banks' loan loss provisions and find that the cyclicality of real investment is systematically related to the level of firms' cash balances.

Keywords: Cash Holdings, Cash Flow Trade-offs, External Financing Costs, Nonlisted Firms, Bank Lending Channel

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*Ostergaard and Sasson are at BI Norwegian Business School, and Sørensen is at the University of Houston and the CEPR.

1 Introduction

Firms' accumulation of cash balances has recently drawn considerable attention in the finance literature. The accumulation of cash may be a response to financial constraints because cash provides liquidity for investment in the presence of uncertainty about future availability of external finance (Opler, Pinkowitz, Stulz, and Williamson (1999), Almeida, Campello, and Weisbach (2004)) but, as Riddick and Whited (2009) point out, the relationship to financing constraints is not unambiguous. A firm may accumulate only little cash because its capital is so productive that it is optimal to dis-save today in order to invest and increase cash flow tomorrow, even in the presence of constraints. Hence, analyzing cash balances in isolation may give an incomplete picture because firms' financial, investment, and dividend decisions are interlinked through the cash flow identity.[1] To investigate the effect of financing constraints on firms' financing choices, therefore, one needs shocks to the availability of external finance.

In this paper, we examine the financing choices for a comprehensive sample of closely-held, nonlisted, firms linked to their main bank and we study how these choices are affected by exogenous shocks to the availability of bank finance. The firms in our sample are heavily dependent on bank finance and do not rely on public debt and equity markets. Financial frictions are believed to be especially severe for small firms and the use of internal funds to finance investments is likely to be especially important for the firms in our sample.

Our objective is two-fold: First, we ask how the firms substitute between internal and external financing sources and how that substitution is related to firms' investment and dividend payments to owners. Little is known about how small, nonlisted firms trade off these decisions and we find considerable cross-sectional heterogeneity that systematically link firms' financing mix to the level of their cash balances: Firms with low cash balances draw much more on external finance on the margin. Second, we study how firms' financing

[1] Interlinkage through the cash flow identity is also stressed by Gatchev, Pulvino, and Tarhan (2010).

choices are affected by exogenous shocks to the availability of external finance. Specifically, we consider firms' adjustments to changes in their main banks' loan loss provisions, instrumented by provisions against loans to households and sectors other than that of the firm. Again, our results reveal systematic differences in the adjustment to financing shocks related to cash balances and we find real effects on the cyclicality of investment.

We estimate cash flow sensitivities of the entire cash flow identity but focus mainly on deposits, loans, dividends, and real investment. To interpret the results, we formulate a simple deterministic model with a concave shadow value of holding cash which provides simple closed form solutions for cash flow sensitivities. A positive shadow value of cash is implied by the models of Almeida, Campello, and Weisbach (2004), Riddick and Whited (2009), and others. The closed form solutions highlight that the cash flow sensitivity of cash is inversely related to how fast the marginal value/cost of cash—which we refer to as the marginal value of cash (MVC)—changes. Similarly, the cash flow sensitivity of bank loans (or investment, dividends, etc.) measures how fast the marginal cost of drawing on bank debt increases. Fundamentally, we show that cash flow sensitivities contain information about the relative cost of firms' financing choices on the margin. Standard assumptions about the shadow value of cash (convex and decreasing as a function of cash) imply that firms with little cash operate with relatively high MVC and a marginal cost of spending cash that increases quickly. Firms with abundant cash will operate with relatively low MVC and a marginal cost that increases only slowly. We illustrate in Figure 1 how some firms may have a high MVC due to high cost of lending or due to excellent investment opportunities—in our model it it not important *how* the firms got to have high MVC.

Empirically, we split the sample according to the level of firms' cash balances and estimate cash flow sensitivities for each subgroup. For firms that hold little cash we estimate a low cash flow sensitivity of cash and a high cash flow sensitivity of bank debt. These firms operate with high MVC—their cost of using cash increases rapidly as they draw down their cash reserves. Their cost of using bank debt, however, increases comparatively slower. They therefore absorb fluctuations in their cash flow by borrowing in bad times and repaying debt in good times, and draw only little on accumulated balances. Oppositely, for firms with much cash and low MVC, we estimate a high cash flow sensitivity of cash but comparatively lower sensitivity of bank debt implying that these firms prefer to use internal funds to absorb fluctuations in their cash flow. Estimating reactions to exogenous financing shocks, we find that it is the firms that a priori operate with high MVC (low cash flow sensitivities) that are the most affected: Following a bank shock their marginal cost of borrowing increases, causing adjustment in the cyclicality of real investment as revealed by a decrease in the cash flow sensitivity of bank loans and an increased sensitivity of investment. The intuition is that firms with high-MVC find it costly to draw on cash and therefore real investment will bear the brunt of the adjustment to external financing shocks. We obtain similar results when we split the sample according to firms' payment of dividends, as we discuss in detail below.

The study of cash flow sensitivities has recently become an important topic in finance following Almeida, Campello, and Weisbach (2004) while there is a large, more established, literature studying investment sensitivities starting with Fazzari, Hubbard, and Petersen (1988).[2] Our work encompasses both of these literatures. Our analytical expressions generalize the expression for the cash flow sensitivity derived in Almeida, Campello, and Weisbach (2004), with the difference that Almeida et al. distinguish between firms with unlimited credit at a fixed rate and other firms, while we assume that all firms face increasing costs of (bank) borrowing, albeit with different slopes of the cost curve. All firms in our sample display a positive cash flow sensitivity of cash, but we find that it is the firms with the *lowest* sensitivity that are the most affected by financing constraints. We stress that the slope of value/cost curves as revealed by our estimated cash flow sensitivities is informative about important real variables: Firms that have steeper MVC-curves display a higher sensitivity

[2] Other recent papers studying cash flow sensitivities are Almeida and Campello (2007), Bakke and Whited (2008), Riddick and Whited (2009), and Campello, Giambona, Graham, and Harvey (2010).

of real investment to cash flows.

Almost all firms in our sample hold cash, have debt, and invest in physical capital and in equilibrium the cost of using each source must be equalized; i.e., the marginal (shadow) cost of borrowing must equal the marginal value of investing in physical capital ("marginal q") must equal the marginal value of dividends which again must equal the marginal cost of drawing down cash balances. Firms that do not pay dividends or have low cash balances are likely to have higher MVC and our results are consistent with this conjecture. In the literature, such firms are often interpreted as constrained but while we assume that all small firms are constrained, in the sense of facing upward-sloping convex cost of funds, firms with low cash holdings do not necessarily face tighter budget constraints or have higher borrowing costs for a given amount of borrowing—in fact, the firms we label high-MVC firms on average hold more capital and borrow more. This supports the argument of Riddick and Whited (2009) that such sample splits may capture differences in borrowing constraints but may also reflect investment opportunities and (for small firms) the owner's utility of dividends. We illustrate this point graphically by showing that otherwise similar firms may operate with different MVC because they face different costs of bank finance or because the productivity of physical capital differs.

The decisions of whether to pay dividends or hold little cash are endogenous for the firms; nonetheless, our finding that these groups of firms allocate cash flows and react to funding shocks very differently from each other as revealed by the estimated cash flow sensitivities is informative about the firms' costs of adjusting various sources of finance. While this in itself does not tell us the exact reason why some firms face higher adjustment costs than others, the cash flow sensitivities help pinpoint the firms that are most susceptible to tightened financial constraints. This is clearly illustrated by our finding that only the high MVC firms, that a priori rely on mostly external finance, are affected by bank shocks. The finding that some firms react to exogenous shocks is not conditioned on whether the MVC-split is exogenous or endogenous. However, the result that high-MVC firms react more strongly, rests on the assumption that firms do not anticipate shocks to their main bank and allocate cash accordingly. To hedge against such a pattern, we split the firms according to their average cash holdings over the sample (although, for robustness, we show the same pattern using time varying splits according to period t dividends.)

Our main empirical findings are the following:

- The magnitudes of the estimated cash flow sensitivities reveal that firms on average allocate cash flows to deposits ("cash"), trade credit, dividends, taxes, loan-repayment, and investment in this order.
- Cash flow sensitivities are heavily dependent on firms' MVC as proxied by our sample splits.
- High-MVC firms are affected much more by exogenous bank shocks than low-MVC firms with real effects on the cyclicality of investment.
- For non-listed firms the cash flow sensitivity of cash is *lower* for high-MVC firms than for low-MVC firm—contrary to the empirical findings of Almeida, Campello, and Weisbach (2004) for listed firms: Therefore, cash management in small unlisted firms is very different from that of listed firms.

We include the lagged levels of loans, deposits, and capital stock in the regressions and find very strong mean-reversion in the levels; that is, firms appear to revert to an "optimal" (firm-specific) capital structure. For instance, if a firm enters the period with a high level of bank debt, it repays part of that debt in the current period as opposed to borrowing more. Some of the lagged level terms have large coefficients with t-statistics near triple digits and ignoring these terms, as has been common in the literature, potentially leads to left-out variable bias.

The rest of the paper is organized as follows. Section 2 discusses our approach and results in the light of related literature. Section 3 presents a simple model of firms' decision problem demonstrating that cash flow sensitivities have information about changes in the marginal costs of components of the cash flow identity. Section 4 presents our empirical methodology. Sections 5 and 6 present data and results and Section 7 concludes.

2 Relation to the existing literature

Almeida, Campello, and Weisbach (2004) direct attention towards the information contained in firms' accumulation of cash balances. Cash may provide liquidity for investment when there is uncertainty about how much external finance may be raised in the future. They analyze listed firms' cash accumulation out of cash flow, which they coin the "cash flow-sensitivity of cash," and this is one of the cash flow sensitivities that we estimate. Our interpretation of the MVC is related to the value of holding cash in Almeida, Campello, and Weisbach (2004) although they, differently from us, assume that some unconstrained firms can freely borrow and lend at a fixed safe interest rate. In their model, credit constrained firms compensate by retaining more cash and have a larger, positive, cash flow sensitivity compared to unconstrained firms, whose cash flow sensitivity is indeterminate (insignificant). In our sample of small firms, most firms have a positive sensitivity to cash and, in this sense, they are all constrained. The interpretation of our results are therefore not directly comparable to Almeida et al. as we compare firm that are more or less sensitive and do not interpret our results as necessarily capturing the degree of credit constraints.

Other papers focus on the *level* of cash balances and find that firms with relatively poorer access to external finance tend to hold larger buffer-stocks of cash.[3] Many of these papers tend to address the question from the point of view of large widely-held corporations, partly due to availability of data and we believe ours is the first paper to analyze how small firms trade off the accumulation of cash against other uses of cash flow.[4]

[3]See, for example, Opler, Pinkowitz, Stulz, and Williamson (1999), Acharya, Almeida, and Campello (2007), Bates, Kahle, and Stulz (2009), and Mao and Tserlukevic (2009).

[4]Faulkender (2002) examines determinants of the *level* of cash holdings of small firms in the National Survey of Small Business Finance and documents, as found for listed firms, that firms facing greater uncer-

Financial flexibility may also be provided by lines of credit. Sufi (2009) shows that firms without access to a line of credit display a higher cash flow sensitivity of cash and Campello, Giambona, Graham, and Harvey (2010) study firms' use of lines of credit during the 2008 financial crisis. As we do, they focus on how companies substitute between internal and external liquidity and real investment in the face of a shock to external finance. Although they do not consider the marginal value of cash in their analysis they find, consistent with our results where credit lines are a component of bank debt, that cash-rich firms draw less extensively on lines of credit.

External financing costs may have real effects on investment. Initiated by Fazzari, Hubbard, and Petersen (1988), a large literature finds a larger sensitivity of investment to cash flow for firms that are more likely to be credit constrained.[5] We follow the approach of many papers in this literature by comparing subsamples of firms and estimating differential cross-sectional implications of external finance costs.[6] The investment-cash flow sensitivity is, of course, another of the sensitivities from the cash flow identity that we consider in this paper. The typical investment-cash flow sensitivity approach builds on the notion that financial frictions cause a wedge between the cost of external and internal finance. It does not explicitly include a motive for firms' accumulating of cash balances but assumes that the marginal value of internally generated cash is equal to a fixed safe interest rate.[7] In contrast, our analysis incorporates the decision to accumulate cash and assumes that cash holdings are the outcome of a dynamic optimization problem that trades off all current and future uses and sources of funds.

tainty regarding their ability to raise finance in the future tend to hold larger buffer stocks of cash. Brav (2009) examines capital structure determinants in U.K. privately-held firms and finds, among others, that leverage is relatively more sensitive to operating performance (cash flow) compared to listed firms that have easier access to external finance. Although the firms in his sample are much larger than ours (about 10 times), this result is similar to our findings that high-MVC firms use external finance more intensively.

[5]Later contributions include Gilchrist and Himmelberg (1995) and Kaplan and Zingales (1997) who questions the interpretation of the sensitivities estimated in Fazzari, Hubbard, and Petersen (1988).

[6]E.g., Fazzari, Hubbard, and Petersen (1988) split on dividend-payout ratios, Gertler and Gilchrist (1994) split on firm size, and Kashyap, Lamont, and Stein (1994) split their sample on whether firms issue public bonds or not.

[7]A closely related literature is the business cycle models of the so-called financial accelerator; e.g., Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1996).

Finally, our paper is related to the literature arguing that shifts in bank lending policies have real effects because some borrowers are bank dependent and cannot substitute other finance for bank loans (the "bank lending channel").[8] We add to that literature by studying how bank shocks affect corporate trade-offs, thereby identifying a mechanism for how bank shocks are transmitted to the real economy.

3 A simple model of cash management trade-offs

We use a simple deterministic infinite horizon model to derive close form expressions for the cash flow sensitivities of cash, investment, dividends, and loans and we believe that the logic will carry over to more complex setups with uncertainty as outlined at the end of the section.

Consider a firm whose owner maximizes the discounted sum of future dividends. We denote the maximized value by V_t: $V_t = \max \Sigma_{t=0}^{\infty} \beta^t U(\text{DIV}_t)$, where the maximum is taken with respect to decision variables and constraints to be spelled out. β is a discount factor, U is a concave utility function, and DIV_t is period t dividends. Cash flow (EBITDA) is determined from an increasing concave production function with output $f(\text{K}_{t-1})$ where K_t is physical capital at the end of period t. f is increasing, concave, and differentiable with law of motion $\text{K}_t = \text{K}_{t-1} + \text{I}_t$ where I_t is investment during period t (depreciation is ignored for simpler notation). Dividends equal cash flow minus interest paid plus increases in outstanding loans minus increases in deposits minus gross investments. We denote the stock of loans and deposits at the end of period t by L_t and DEP_t, respectively.

The loan interest rate $r^b(\text{L}_t)$, paid at the beginning of period $t+1$, is a positive convex increasing function of the amount of loans outstanding. Depositing DEP_t in period t returns in period $t+1$ the amount $\text{DEP}_t \text{r}^\text{d} + \text{s}(\text{DEP}_t)$ and where the return is composed of

[8] A non-exhaustive list of contributions include Bernanke and Blinder (1988), Bernanke and Lown (1991), Kashyap, Stein, and Wilcox (1993), Peek and Rosengren (2000), Ashcraft (2005), and Jiménez, Ongena, Peydró-Alcalde, and Saurina (2010).

a constant deposit rate of interest, r^d, plus a "shadow value," $s(\text{DEP}_t)$, where s is a positive, differentiable, increasing, concave function.[9] The shadow value of cash is a simple way of capturing that firms hold cash to insure against future states with low cash flows where external finance is limited or costly. A positive shadow value of cash is implied by the models of Almeida, Campello, and Weisbach (2004), Riddick and Whited (2009) and others. For the purpose of interpreting our results, we prefer not to take a stand on the exact mechanism—the point being that the trade-offs we study will occur as long as such a concave shadow value exists.

The positive effect on firm value from accumulated cash stems, among others, from the positive net present value of investment projects that would otherwise not have been undertaken—the mechanism modeled by Almeida, Campello, and Weisbach (2004).[10] It is convenient to capture these features by assuming that cash delivers a direct valuable service—the overall monetary return to holding cash is then $\text{DEP}_t\, \text{r}^\text{d} + \text{s}(\text{DEP}_t)$. We assume that the shadow value of deposits (cash) is positive and concave.

All variables are chosen simultaneously, but in an accounting sense we can write dividends as a residual from the simplified cash flow identity: We derive Euler equations for deposits, loans, and real capital—see Cochrane (2005), p. 5, for a similar derivation of the general Euler equation. Starting from values that are optimally chosen, the Euler equations are derived from permutations of the optimal choice variables. The firm's owner can decide to lower current dividends by a fraction ("one dollar") which decreases current utility by $U'(\text{DIV})$, deposit the cash and in the next period take out the one dollar plus the interest to be used for dividends next period. This would increase next period's utility by $U'(\text{DIV}_{t+1})(1 + \text{r}^\text{d} + \text{s}')$. At the optimum the owner will be indifferent to this permutation and therefore the marginal utility of receiving dividends today will equal the

[9] Using a shadow value, rather than a shadow interest rate, delivers simpler expressions.

[10] In their three-period model, firms may hoard cash in period one to invest in a "short-term" project in the interim period, and the marginal value of cash is the marginal return to that investment, realized in the final period. Alternatively, as in the model of Riddick and Whited (2009), the shadow value of cash stems from a fixed cost of raising outside finance.

discounted marginal utility times the gross return from postponing dividends one period, which provides the Euler equation: $U'(\text{DIV}_t) = \beta U'(\text{DIV}_{t+1})(1 + r^d + s'(\text{DEP}_t))$. Alternatively, the owner may decrease dividends, repay loans, and increase dividends the following period by the same amount plus saved interest, leading to the Euler equation for loans: $U'(\text{DIV}_t) = \beta U'(\text{DIV}_{t+1})(1+r^b_t+L_t\,\frac{dr^b}{dL})$. Similarly, we can derive the standard Euler equation for investment: $U'(\text{DIV}_t) = \beta\, U'(\text{DIV}_{t+1})(1 + f'(K_t))$. Equating the right-hand side of those Euler equations and denoting the marginal value of cash, $\beta U'(\text{DIV}_{t+1})(1 + r^d + s'(\text{DEP}_t))$, by MVC_t, we have in optimum that the marginal value of cash equals the marginal value or cost of other uses of funds in the cash flow identity

$$\begin{aligned}\text{MVC}_t &\equiv \beta U'(\text{DIV}_{t+1})(1 + r^d + s'_t) = \beta U'(\text{DIV}_{t+1})(1 + r^b + L_t\,\frac{dr^b}{dL}) \\ &= \beta U'(\text{DIV}_{t+1})(1 + f'(K_t)) = U'(\text{DIV}_t)\ . \end{aligned} \tag{1}$$

In words, the marginal value of cash equals the marginal cost of borrowing equals the marginal value of physical capital equals the marginal value of dividend pay-outs.

We can derive cash flow sensitivities from this identity. If we write (1) as

$$r^d + s'(\text{DEP}_t) = r^b_t + L_t\,\frac{dr^b}{dL} = f'(K_t) = \frac{U'(\text{DIV}_t)}{\beta U'(\text{DIV}_{t+1})} - 1 \tag{2}$$

and linearize using a simple first order Taylor series expansion (ignoring second derivatives of r^b) we obtain expressions for the cash flow sensitivities as detailed in Appendix B. The solutions are (with all functions except utility evaluated at period t values):

$$\begin{aligned}\Delta\text{DIV}_t &= \frac{1}{1 + U''_t/(\beta U'_{t+1}s'') + U''_t/(\beta U'_{t+1}2r^{b\prime}) + U''_t/(\beta U'_{t+1}f'')}\,\Delta\text{CF}_t\ , \\ \Delta\text{DEP}_t &= \frac{1}{\beta U'_{t+1}\, s''/U''_t + 1 + s''/2r^{b\prime} + s''/f''}\Delta\text{CF}_t\ , \\ \Delta L_t &= \frac{1}{\beta U'_{t+1}\, 2r^{b\prime}/U''_t + 2r^{b\prime}/s'' + 1 + 2r^{b\prime}/f''}\Delta\text{CF}_t\ , \end{aligned} \tag{3}$$

$$\Delta_{K_t} = \frac{1}{\beta U'_{t+1} f''/U''_t + f''/s'' + f''/2r^{b'} + 1} \Delta_{CF_t} .$$

The intuition of the cash flow sensitivity of cash is the same as formula (5) of Almeida, Campello, and Weisbach (2004). In their model, cash is hoarded in period t for the purpose of investing in a short-term production function in period $t+1$ and their cash flow sensitivity of cash depends on the second derivative of a short-term production function relative to the second derivative of a long-term production function.[11]

From equations (3), we observe that the dividend sensitivity of cash is relatively high when U''_t/U'_{t+1} is low (the owner pays large dividends at t), the deposit sensitive is relatively high s'' is low (the owner holds large deposits), the loan repayment sensitivity is relatively high when $r^{b'}$ is low (the owner have a low or zero loan balance), and the investment sensitivity is relatively high when f'' is low (investments are high). Under our assumptions, which we believe are reasonable for small firms, the cash flow sensitivities show these patterns independently of why a firm, say, holds low cash balances.

In Figure 1, we illustrate the optimal allocation of cash deposits, loans, dividends, and physical investment. In terms of the model, the curves outline s' (for deposits), r^b (for loans), and f' (for investment). The figures illustrates in the top panel how some firms may have a high marginal value of cash due to superior investment opportunities. A firm with an MPK curve above that of other firms will have higher investment, higher borrowing, and less deposits (as well as paying less dividends, which we leave out of the figure to ease congestion). The lower panel illustrates how a firm may have a high marginal value of cash due to tighter credit constraints which we illustrate with the cost of borrowing curve being above that of other firms. A small non-diversified firm could also have a high marginal value of cash due to high marginal utility of dividends although we do not illustrate this in the figure.

[11] In our sample, several firms do not pay dividend and the derivations above ignore the non-negativity constraints on dividends—we outline the first order conditions for this case in Appendix B. It is clear that dividends will be zero in period t if $U'(0) < \text{MVC}_t$.

In Figure 2, we illustrate the optimal allocation of cash flows for deposits, loans, dividends, and physical investment for a cash-rich, low-MVC firm, and a cash-poor, high-MVC firm, with identical utility, cost, and production functions. In terms of the model, the curves have the same interpretation as in Figure 1 with U' normalized by $\beta U'_{t+1}$ added for dividends. At the outset, time t, these marginal values are equalized. In this figure, we choose high- and low- MVC firms with identical curves but different positions on the curve—this choice reflects our argument that cash flow sensitivities depend on the level of the MVC more than on the underlying reason for why the MVC is high or low. (Detailed further studies may find that such underlying reasons matter on the margin, but an exploration of this issue will take the present article too far afield.)

A negative cash flow shock at date $t{+}1$ causes re-optimization to a higher MVC level. The figure illustrates the interpretation of the cash flow sensitivities; in particular, it shows how the steepness of the MVC-curve affects the magnitude of the adjustments in deposits, loans, and investment to the new equilibrium. The cash-rich firm operates where the shadow value of cash changes slowly (s'' is small in absolute value) and therefore a large fraction of the firm's cash flow fluctuations will be absorbed by an adjustment in deposits. The curves are drawn such that the same holds for investments, while loans react less.[12] The cash-poor firm, in contrast, operates on a relatively steep segment of the MVC-curve and absorbs relatively less of its cash flow fluctuations through deposits, such that loans react relatively more.

A more extensive model, see for example Riddick and Whited (2009), would have cash flows subject to stochastic shocks $f(\mathrm{K}_{t-1}, \epsilon_t^{p})$ where ϵ^p is a stochastic shock to productivity (potentially correlated over time), costs of adjusting capital, and non-negativity constraints on dividends and deposits, as well as potential constraints on future borrowing—capturing the intuition of Almeida, Campello, and Weisbach (2004). Under suitable concav-

[12] Figure 2 may have a slope that is too steep for low amounts of loans but the same result would hold if a fraction of firms adjusted loans significantly while another fraction of firms didn't adjust loans at all because they were at the zero lower limit.

ity and compactness assumptions, the value of the firm, V, will be a concave differentiable (away from corners) function which satisfies the Bellman equation $V(\text{DEP}_{t-1}, \text{L}_{t-1}, \text{K}_{t-1}) = \max_{\text{I}_t, \Delta\text{DEP}_t, \Delta\text{L}_t} \text{U}(\text{DIV}_t) + \beta \text{E}_0 \text{V}(\text{DEP}_t, \text{L}_t, \text{K}_t)$,where DIV_t is $f(\text{K}_{t-1}, \epsilon_t^p) - \Delta\text{DEP}_t + \text{DEP}_{t-1}\text{r}^d + \Delta\text{L}_t - \text{L}_{t-1}\text{r}^b(\text{L}_{t-1}) - \text{I}_t$ (DIV_t may be zero) and E_0 is the expectation conditional on period zero information. In such a more general framework, the marginal trade-offs still hold and in the case of non-binding constraints, we would have (among other first order conditions): $\text{MVC}_t = \beta \text{E}_0 \{ \frac{\partial \text{V}(\text{DEP}_t, \text{L}_t, \text{K}_t)}{\partial \text{DEP}} (1 + \text{r}^d) \}$,where the value function captures the future expected benefits of holding cash. Riddick and Whited (2009) display such first order conditions for the shadow value of cash balances but in their model V can only be solved by simulation.

4 Empirical methodology

Consider the accounting identity for cash flows. We start by defining symbols for the elements of the cash identity and all variables are signed such that positive values indicate *uses* of cash, such as depositing cash in a bank account, investing in equipment, or repaying loans. Define cash flows (EBITDA) as earnings before interest, taxes, depreciation, and amortization, DIV as dividends paid to owners, DEP as net increase in deposits in financial institutions, LOANS as net repayment on loans (net of new borrowing), TRADECRED as net repayment of trade credit, TRADEDEB as net granting of credit to customers, SECBOUGHT as securities purchased, EQUITY as equity retired, INTPAID as net payments of interest, INV as gross investment in fixed capital and inventories and TAXPAID as taxes paid. Given a dollar of cash inflow, firms can pay out dividends or invest in capital, they typically are obligated to pay (or receive) interest and pay taxes, and they normally grant trade credit to customers as part of routine business transactions. For our firms, purchases of securities and changes in firms' equity are small and we include these terms here for completeness but ignore them in the empirical work. Finally, firms can add to cash holdings, repay (bank) loans, or postpone payments for goods delivered; i.e., borrow from suppliers.

In symbols, the (approximate) cash identity is:

$$\begin{aligned}\text{EBITDA} \;=\;& \text{DIV} + \text{DEP} + \text{LOANS} + \text{TRADECRED} + \text{INV} + \\ & \text{TRADEDEB} + \text{TAXPAID} + \text{INTPAID} + \text{SECBOUGHT} + \text{EQUITY}\,. \end{aligned} \tag{4}$$

Equation (4) is the starting point for our empirical analysis. Empirically, we estimate how an extra dollar of cash flows (EBITDA) is allocated to each of the terms in the cash identity. We estimate panel Ordinary Least Squares (OLS) regressions

$$(\text{Y}_{it} - \overline{\text{Y}}_{i.}) \;=\; \nu_t \;+\; \beta\,(\text{EBITDA}_{it} - \overline{\text{EBITDA}}_{i.}) \;+\; \text{lags} \;+\; \epsilon_{it}\,, \tag{5}$$

where the index i refers to firm i and index t refers to year t. ν_t is a dummy variable for each time period. The variable Y is generic and represents an element of the cash flow identity, such as deposits or net loans repayments.

"Lags" refers to lagged variables. Gatchev, Pulvino, and Tarhan (2010) show that including lagged variables have important effects on the estimated parameters which likely display left-out variable bias in a static specification. In the literature on optimal capital structure the change in loans to assets are typically regressed on explanatory variables and the lagged level in order to allow for mean reversion.[13] Similarly, Opler, Pinkowitz, Stulz, and Williamson (1999) find that the majority of firms display mean reversion in cash to asset ratios. We, therefore, do not follow Gatchev, Pulvino, and Tarhan (2010), who include the lagged flows (the Ys) in the regression—a specification which imply that firms have a target level for cash flows rather than for the levels of deposits, loans, capital, etc.[14] We include the lagged stock of deposits, loans, trade credit, accounts payable, and physical

[13] See, among others, Shyam-Sunder and Myers (1999), Baker and Wurgler (2002), and Fama and French (2002). Relatedly, Graham and Harvey (2001) find, using questionnaires, that most CEOs aim for a target level of debt to equity.

[14] The specification of Gatchev, Pulvino, and Tarhan (2010) is suitable if the level variables are non-stationary. In our specification, non-stationarity of the level variables is a special case where a coefficient of the lagged level near unity indicates non-stationarity.

capital and, as shown below, find strong mean reversion in the stock levels.

We further include lagged EBITDA based on initial explorations: Physical investments take time to implement and we find that, indeed, investment reacts to cash flows with a lag. We control for firm fixed effects by subtracting the average of the variables for each firm, indicated by $\overline{\text{EBITDA}}_{i.}$, because we wish to study how; e.g., the accumulation of cash reacts to cash inflows relative to the firm average, and not cross-sectional differences between firms. (We don't use the standard dummy variable notation because interaction terms, introduced below, act on the variables after removing firm averages.)

The variables are all measured in millions of Norwegian kroner and a coefficient β of, say, 0.25, implies that out of a cash flow of a one hundred kroner in firm i at time t, 25 kroner are paid out on cash flow component Y on average. More precisely, these numbers are deviations from firm- and year-averages.

We estimate equation (5) with each component of the cash identity taking the place of the generic Y variable and if the cash identity holds in the data, the β-coefficients will sum to unity.[15] We present the β-coefficients multiplied by 100 and each coefficient then has the interpretation as the percent of EBITDA allocated to the relevant component. In other words, we provide a decomposition of a typical firm's EBITDA-shock into its components of use. In most of our work we focus on dividends, deposits, net loan repayment, net trade credit repayment, and gross investment. The other components are negligible for the firms in our sample (except for accounts payable).

In order to examine the effect of bank shocks on the decomposition of cash flows, we allow the coefficient β to change with shocks to loans-loss provisions (which we denote PROV) in the main bank of firm i. We specify the coefficient β_{it} as

$$\beta_{it} = \beta_0 + \beta_1 \, \text{X}_{it} \tag{6}$$

[15]The equations all have the same right-hand side regressors and form a so-called Seemingly Unrelated Regression (SURE). It is well known that system estimation provides estimates identical to equation-by-equation OLS estimates for SURE systems.

where $\text{X}_{it} \equiv (\text{PROV}_{jt} - \overline{\text{PROV}}_{j.} - \overline{\text{PROV}}_{.t})$ is a measure of the shock to firm i's main bank j at date t. (The term $\overline{\text{PROV}}_{.t}$ is the average across all banks rather than across firms.) The intuition is that firm i's main bank may tighten lending and/or increase costs if it experiences larger-than-average (over time and over banks in year t) loan loss provisions in a given year .

We estimate regressions with interactions between EBITDA_{it} and X_{it} of the following basic form,

$$(\text{Y}_{it} - \overline{\text{Y}}_{i.}) \;=\; \nu_t \;+\; \beta_{it}\,(\text{EBITDA}_{it} - \overline{\text{EBITDA}}_{i.}) \;+\; \gamma(\text{X}_{it} - \overline{\text{X}}_{i.}) \;+\; \text{lags} \;+\; \epsilon_{it}\,. \qquad (7)$$

We allow for interactions between $\text{EBITDA}_{i,t-1}$ and $\text{X}_{i,t-1}$ as well, because firms may adjust to bank shocks over more than one period.

The coefficient β_1 is the interaction effect and an estimated value larger than zero implies that a larger share of cash flows are allocated to Y on average when X is large (relative to firm- and overall means). In other words, the cash flow sensitivity of Y increases when firm i's main bank makes above-average loan loss provisions.

Our regressions do not include a measure of Tobin's q, as is customary in the investment-cash flow sensitivity literature. Several papers; e.g., Riddick and Whited (2009), have pointed out the difficulties of measuring Tobin's q and measurement error is likely to be an even larger problem in our sample of non-listed firms. The estimated cash flow sensitivities depend on a variety of factors, such as external financing constraints and investment productivity, that are extremely difficult to control adequately for in a regression. Our identification strategy is therefore a different one: The effect of external financing constraints are revealed through the interaction effect which captures the *changes* in estimated sensitivities when firms' main bank receives an exogenous shock and tightens lending.

4.1 Instrumental variables

One may question the causality of the interaction effect in equation (7). That is, it is possible that the interacted cash flow sensitivities are caused by financial difficulties of firms in our sample—such firms may trade off sources of funds differently *and* their financial difficulties might show up as delinquencies and subsequent loan loss provisions at their main banks. Hence, it is possible that a significant interaction term does not reflect an exogenous change in banks' loan supply, but rather that distraught firms behave differently.

It is unlikely that such reverse causality is a problem in our regressions because, on average, a firm's outstanding loans constitute only 0.043 percent of their main bank's outstanding loans and leases. As we show below (Table 6), the loans to *all* the firms in the sample make up less than 5 percent of their main bank's loan portfolio, that is, the banks in our sample have many borrowers that are not included in the sample. The banks' loan loss provisions are therefore unlikely to be caused by delinquencies of the firms in our sample. Further, the banks have many other, larger, loan engagements with corporations that are not included in the sample.[16]

Nevertheless, we perform instrumental variables (IV) regressions to validate our interpretation. We construct instruments from three variables related to banks' loan loss provisions: (1) specified provisions against loan losses in the household sector in percent of firm i's main bank j's loan portfolio; (2) the fraction of delinquent loans in the household and foreign sector, in percent of firm i's main bank j's loan portfolio; and (3) commercial and industrial loan loss reserves held by firm i's main bank j against firms in industries *other* than firm i's industry. Norwegian banks do not report loan loss provisions (flow) by industry but they report loan loss reserves (stock) by industry. We may therefore proxy provisions in industry k in year t by the change in loan loss reserves from year $t-1$ to year t. Such changes will be correlated with the bank's overall loss provisions, but not with

[16]As we explain in Section 5, we exclude firms that belong to a business group from the sample.

idiosyncratic shocks to firm i's cash flow.[17] By similar reasoning, we compute the change in the stock of delinquent loans in the household and foreign sector as a proxy for provisions in those sectors. We retain the (scaled) level of reserves and delinquent loans as instruments, although most power comes from the changes in these variables.

5 Data

Our sample consists of Norwegian limited liability firms operating in Norway between 1995 and 2005. All Norwegian limited liabilities firms must annually report audited balance sheet and income and loss statements to the Company Register, the *Brønnøysund Register*.[18] Norwegian law requires that accounts be audited, irrespective of company size which ensures high quality data even for small and medium size firms.[19]

From the population of all limited liabilities firms we exclude firms which are subsidiaries of larger corporations such that our sample comprise independent firms that are not members of business groups. Because business groups may transfer resources between member firms, thus counteracting credit constraints imposed on individual members, we prefer to focus on independent firms in order to aid identification of the *mechanism* with which bank loan supply shocks are transmitted to the real economy. Also, subsidiaries do not have full autonomy with regards to financial management decisions. We also exclude public (listed) firms and firms whose main owner is the Norwegian state or a foreign firm. Finally, we exclude firms from the following industries: Finance and insurance; professional, scientific, and technical services; public administration, educational services; health care and social assistance; other services; and ocean transportation.

[17] We set negative changes in loan loss reserves to zero. The change in reserves may be negative in years where banks write off large amounts of loans from their balance sheet. Such write-offs are related to provisions made in the past and are unlikely to affect the current loan policy of the banks. Therefore, we prefer to set negative values to zero.

[18] This data is made available to us through the Center for Corporate Governance Research (CCGR) at the Norwegian School of Management.

[19] The failure to submit audited accounts within a specified deadline automatically results in the initiation of a process that may end with the enforced liquidation of the firm.

Some firms-years have missing information on location, industry, and/or establishment year. Missing values are filled where possible, by checking consistency with industry and establishment years before and after the missing entry. Firms with negative assets and sales, firms of average size less than 1 million Norwegian kroner (approx. 167,000 dollars), and firms where the difference between reported total assets and liabilities exceeds 1 million kroner are excluded. We are interested in studying the reaction of variation in the time series of firms' cash flow; hence, we exclude firms whose organization number is missing from the sample in one or more years between the first and the last year they appear in the sample. Finally, we exclude firms for which we observe less than three consecutive years of data leaving us with 119,682 firm-year observations and 23,057 individual firms. Sixty percent of the firms appear in all eleven years of the sample.

We match the sample of independent firms with annual data for outstanding loans and deposits in financial institutions. The data ("tax data") is made available to us by the Norwegian Tax Administration. It specifies each deposit and loan relationship that a given firm has with any loan-giving institution in Norway. This allows us to match up individual firms and loan-giving institutions. In those cases where such institutions are banks, we can merge the sample further with data on Norwegian banks' financial accounts (Norwegian *call reports*) made available to us by the Central Bank of Norway and Statistics Norway.

5.1 Construction and data source of main variables

The construction of the variables in the cash flow identity is as follows: From the tax data, we construct a firm's accumulation of cash as the increase in its outstanding deposits aggregated over all deposit-giving institutions with which it has a deposit account. The repayment of loans (net of new borrowing) is the decrease in outstanding loans aggregated over all loan-giving institutions. Net interest paid is the difference between annual interest paid and received, summed over all institutions.[20]

The remaining variables in the cash flow identity are from firms' annual accounts. EBITDA is earnings before interest, taxes, depreciation and amortization. The repayment of trade credit (net of new borrowing) is the decrease in accounts payable between two consecutive years. Extension of trade credit (net of repayments) is the increase in accounts receivable between years. Capital stock is the value of fixed assets and inventories and gross investment is the change in the capital stock plus depreciation. Accrued taxes is reported accounting taxes and reduction in paid-in equity is the net reduction in share capital; i.e., the cash outflow due to write-downs. All firm-level variables are scaled by the average firm size (total assets averaged over all years with observations for the firm) and winsorized at the 1st and 99th percentile. All data are further scaled by the consumer price index normalized to unity in 1998.

Bank-level variables are constructed from Norwegian call reports. Loan loss provisions comprise gross provisions made on loans, leases, and guarantees.[21] Provisions comprise so-called "specified" and "unspecified" provisions where the former is provisions against delinquent engagements of three months or longer. Norwegian law requires that banks compute loss assessments and set aside reserves for such loans. The latter type of provisions may not be tied to individual engagements but are of a general nature and likely to contain forward-looking information about expected, but not yet realized, delinquencies. The instruments for loan loss provisions are constructed as follows: Specified provisions against loans/leases/guarantees to households is a subset of specified provisions as described above. Delinquent loans in the household and foreign sector is the value of all loans and leases extended to customers that are in delinquency on one or more engagements. We define

[20] Although firms in our data set may borrow from non-financial institutions and non-banks, almost all borrowing is from savings or commercial banks. If we substitute loan from all lenders with bank loans in our regressions, it makes little difference to the results.

[21] Gross provisions are new provisions on engagements for which provisions have not previously been made, plus increased provisions on engagements for which provisions have been made previously, minus reductions in previously made provisions. The measure does not include realized losses on engagements.

delinquent loans as those where payments are at least 30 days behind schedule. Loan loss reserves is the stock of reserves held on the balance sheet against loan/leases/guarantees. Annual changes in loan loss reserves include realized losses on engagements for which provisions were previously made. All bank level variables are scaled by the value of the bank's loans and leases at the end of the previous period (the size of its loan portfolio) and are winsorized at the 1st and 99th percentile.

We construct a bank shock measure from banks' loan loss provisions, by demeaning gross provisions in year t with the bank's average level of provisions during the sample. Higher-than-average provisions thus constitutes a negative shock to a bank. A firm's main bank is defined as the bank with which it has the largest outstanding amount of loans in a given year. Only a very small fraction of firms change main bank during the sample. In each year, the firm is paired up with its main bank and the credit shock to a firm in a given year is the demeaned level of loan loss provisions at this bank in that year.

5.2 Descriptive statistics

Table 1 reports key ratios from the firms' balance sheet and income statements. The firms are on average 11 years of age and the main owner holds a controlling stake of 65 percent. The distribution of assets, and most other variables, is clearly right-skewed. Average turnover is about twice the size of total assets. Fixed assets make up 37 percent of assets and cash holdings, in the form of deposits, 14 percent. Accounts receivable make up 20 percent. On the capital side, equity constitutes 16 percent of assets and the liability-to-asset ratio is high at 84 percent. Part of the explanation for this ratio is the Norwegian value-added tax of 25 percent which accumulates as a liability on firm's balance sheets and constitutes 14 percent of short term liabilities on average (not reported in Table 1). In addition, liabilities include loans from shareholders and other private lenders. Unpaid salaries and unpaid reserves for vacation pay account for 22 and 54 percent of short and long-term liabilities, respectively (not reported in Table 1). Bank debt is the largest financial debt item at 28 percent followed by trade credit at 21 percent. Return on assets is 6 percent and the firms pay out 39 percent of net income as dividends, suggesting that dividends is an important source of income for the owners of these firms.

The industry distribution of the firms is a follows: The largest group is wholesale and retail firms which constitutes 45 percent of the firms in the sample followed by 21 percent of firms in construction and 16 percent in manufacturing. Approximately 6 percent of the firms operate in each of the following sectors: Accommodation and Food Services, Transportation and Warehousing, and Agriculture. Firms operating in the Mining, Utilities, and Information (telecommunication) sectors constitute approximately one percent of the firms in our sample.

Table 2 compares our sample to the 2003 U.S. Survey of Small Business Finance (SSBF)—both a sample of S-corporations and the larger C-corporations.[22] As we have eliminated firms that belong to a business group from our sample, our firms are, not surprisingly, small compared to the SSBF-firms with median assets at approximately 0.7 million dollars compared to assets of 2.5 and 3.7 million dollars for S and C-corporations, respectively. Further, the Norwegian firms operate with substantially lower equity ratios. A large part of this difference in capital-structure can presumably be explained by structural (esp. tax) differences between the two countries. Focusing on the medians and comparing chiefly to the smaller S-corporations, we see that the Norwegian firms tend to have more debt, in particular bank debt, but also substantially more trade credit. The median age is 7 years, substantially less than median age of the U.S. samples which may be due to firms in business groups being eliminated. The median share held by the largest owner is 62 for our sample and 70 percent for U.S. S-corporations. In general, we notice that the higher standard deviations in the U.S. samples indicate more heterogeneity in the SSBF.

[22]S-Corporations must have no more than 100 shareholders and are taxed as partnerships, that is, at the level of the shareholders. C-corporations are limited liability firms.

6 Regression results

6.1 Cash flow decomposition

We start by estimating the cash flow sensitivities of each component of the cash flow identity. The first line of Table 3 gives the coefficient on contemporary EBITDA and shows how a one-hundred dollar increase in cash flow (EBITDA) is allocated to different uses—alternatively, how a one-dollar shortfall may be funded from different sources. Standard errors are estimated robustly with clustering at the firm level. In general, the t-statistics are so large—for instance, about 100 for dividends—that we do not comment on significance for this table.[23]

Firms cover a cash flow shortfall by lowering dividends, drawing on accumulated deposits or bank loans, giving less trade credit and, to a lesser extent, decreasing investment. The sum of these five items indicate that they finance 84 percent of the shortfall. Dividends and deposits react strongly to cash flows with 20 percent of (above average) cash flows being paid out as dividends and 24 percent deposited and similar declines when cash flows fall short of average. Repayment of bank loans (net of new borrowing) in good times, and borrowing in bad times, amounts to about 13 percent of cash flows while repayment of trade credit does not depend on whether firms have high or low cash flows. This likely reflects that trade credit is an expensive source of finance on the margin, with high penalty rates when payments are not made within the standard deadlines. In contrast, firms extend trade credit when their cash flows are high and tighten up when cash flows are low.[24] Hence, the average firm does not use trade credit to cover a shortfall—the estimated cash flow sensitivity is less than 1 percent. This insensitivity, however, hides cross-sectional differences as our subsequent analysis will show.

An additional 19.62 percent of cash flow variations is covered by accrued taxes. The

[23]The estimated coefficients have all been multiplied by 100 to allow interpretation in percentage terms.

[24]Notice, that because we estimate sensitivity to firm's *idiosyncratic* cash flow, the cyclical extension of trade credit is not necessarily mirrored in the use of trade credit, even if our sample contained the entire population of firms.

remaining items, interest paid, increased securities holdings, and paid-in equity are of negligible importance and we disregard these in further analysis. Clearly, small firms accumulate cash but not securities and, as expected, equity is not issued much by this type of firms. We also disregard accrued taxes in our analysis because we cannot observe actually paid taxes. Accrued taxes reflect accounting taxes and this variable has little information about firms' ability to delay tax payment as a source of finance. The estimated coefficients sum up to 104.22 despite the fact that we do not constrain the estimated cash flow sensitivities to add to one. In the data, the cash flow identity is far from satisfied when we consider the levels of the items, but the sum of the estimated cash sensitivities is close to unity and we therefore do not display results that impose the adding-up constraint.

It is obvious from our results that, on the margin, the average firm's financing mix is biased towards internal funds in that it draws mainly on internal funds (including dividends) to absorb cash flow fluctuations. As discussed in Section 3, the sensitivity to cash flow reflects how quickly the marginal cost of each source of funds changes as the firm draws on it. Our results therefore reveal that the average firm operates with a steeper marginal cost-curve for external than for internal funds.

Dividends may be an important source of income to the owners of the firms in our sample as the firms are closely held and owners' wealth not necessarily very diversified. If owners were highly diversified, one would expect the marginal utility of dividends to be roughly constant. Our results suggest that the shadow marginal value of dividends changes at a somewhat higher rate than the marginal value of cash but still at a considerably lower rate than that of external finance. Our results therefore are consistent with dividends being an important, but not the sole, source of income for owners.

We include lagged cash flows as a regressor to account for potential dynamic effects. Table 3 shows that the investment sensitivity to lagged cash flows is actually *larger* than the contemporaneous one, implying that investment reacts to cash flows with a lag. This likely reflects that investment takes time and if one focuses only on the current investment-cash flow sensitivity, a large part of investment is missed and the relation between cash flows and real investment may be severely underestimated. The lagged sensitivities of the remaining coefficients are small compared to the contemporaneous estimates, except for loan repayments, where net borrowing increases in response to last year's EBITDA. Hence, higher cash flow today leads firms to repay loans faster but the subsequent year they repay less, likely in order to finance the increase in investment.

Table 3 has interesting predictions for the capital structure of firms. Firms with high levels of deposits (relative to the firm average) drastically decrease cash savings. The point estimate implies that 100 dollars more in deposits is associated with 70 dollars less deposits in the following period. A 100 dollars of lagged deposits is also associated with significantly higher dividends (6 dollars), higher granting of trade credit (10 dollars), and more investment (14 dollars). Of course, these numbers should not be given a causal interpretation; in particular, firms will accumulate cash for the purpose of financing planned investment. Firms with high levels of outstanding bank loans (100 dollars higher) repay loans (51 dollars) and lower dividends (5 dollars), deposits (4 dollars), trade credit (4 dollars), and investments (3 dollars). Outstanding trade credit is paid off as soon as possible as indicated by the coefficient to the lagged level of 73 and high trade credit leads to lower dividends, deposits, loan repayments, and investments in the 5-10 dollars range per 100 dollars outstanding. Accounts receivable is almost as strongly mean reverting as accounts payable and a high level of accounts receivable predicts higher investments, deposits, loans (marginally), and investments, but a lower extension of further trade credit.[25] A relatively large capital stock affects the allocation of cash the following period with 100 dollars more of physical capital predicting 26 dollars less of investment and around 5 dollars more of dividends, deposits, and extension trade credit, while associated with 5 dollars lower repayment of trade credit and 13 dollars less repayment of loans. The latter negative numbers may re-

[25]One might conjecture that a high level of accounts payable partly is associated with a temporarily high level of goods turnover, in which case accounts receivable might also be temporarily high.

flect that physical investment is associated with a larger scale of operations. Whatever the reason may be is not the focus here, but it is clear that the coefficients of the lagged stocks are large—albeit numerically less than unity, consistent with mean reversion—implying a large potential for left-out variable bias in the coefficients of interest if the lagged levels are not included.

6.2 Firms with high vs. low marginal costs of cash

We split the sample into firms with high versus low marginal value of cash using two measures that a priori would seem to proxy that value well: The level of deposit holdings and firms' dividend payments (both scaled by average firm size).

We first compute various descriptive statistics for these subgroups of firms, displayed in Table 4. Considering the splits by cash holdings and dividends, the difference between the high- and low-MVC groups are quite similar in the two splits. Firms with high cash holdings pay higher dividends and firms that pay higher dividends hold more cash. High-MVC firms also operate with higher levels of external finance, both in terms of bank loans and trade credit and high-MVC firms have more physical capital. They tend to grow less rapidly, although investment levels are about the same as for low-MVC firms (higher in the split by cash holdings, lower in the split by dividends). Clearly high-MVC firms have been able to borrow and they may therefore face a high marginal cost of lending as sketched in Figure 1. However, it does not necessarily follow that, for a given level of lending, these firms face higher borrowing costs and we, therefore, avoid referring to those firms as "financially constrained."

Next, we run the cash flow sensitivity regressions for high- and low-MVC firms separately and we display the estimated coefficients to current and lagged cash flows in Table 5. (Lagged levels are included in the regressions but the estimated coefficients not displayed.) We indicate coefficients that are significant at the 5 percent level by showing them in bold font, while we use stars to indicate whether coefficients are significantly different between high- and low-MVC firms. The results reveal strong differences in financing choices between high- and low-MVC firms. Splitting by average cash holdings, the estimated cash flow sensitivities in Table 5 show that high-MVC firms pay out (about) 12 dollars in dividends (for average current cash flows 100 dollars above average) while low-MVC firms pay out 28 dollars in dividends consistent with the argument that cash has lower value within the firm. Investments are more cash-flow sensitive for high-MVC firms with significance at the 5 percent level. High-MVC firms draw almost 6 times as much on external (loans and trade-credit) than internal finance, whereas low-MVC firms draw 35-times more on internal finance.[26] Considering the ratio of bank finance to deposits saved, the ratio is five in the case of high-MVC banks, and 0.12 in the case of low-MVC firm; i.e., low-mvc firms use internal funds about 8 times more than they use external funds.

Splitting by dividend-payments, the picture is very similar although high-MVC firms tend to draw more on deposits and less on bank finance compared to the cash holdings-split and investment now is more cash-flow sensitive for the low-MVC firms.[27]

Generally, we find that firms with low MVC operate with a financing mix that relies heavily on internal funds on the margin. High-MVC firms, in contrast, operate with a marginal financing mix that relies more on external funding (esp. bank loans but also trade credit). This reveals differences in the marginal cost curves of each financing source for the firms. Accumulated cash is more valuable for a high-MVC firm on the margin, therefore, it uses only little cash to make up for a cash flow shortfall—if the firms buffer-stock of cash is low, it is associated with large costs to draw it down considerably: It may affect future investment adversely or the risk of financial distress may increase. The marginal cost curve for bank loans is relatively flatter for high-MVC firms, therefore it makes up for a cash flow

[26] For high-MVC firms: (18.19+5.48)/4.03=5.87. For low-MVC firms: 44.24/(5.63-4.39)=35.68.

[27] Notice that the estimated cash flow sensitivity of dividend payments is not zero for the high-MVC group (with 0 dividends for the given year) in the dividend-split because we are estimating the covariation between *firm demeaned* EBITDA and dividends. A firm that pays zero dividends in one year will pay below its average level in that year and if this occurs in years where EBITDA is also below average, the cash flow sensitivity of dividends will be positive.

shortfall by borrowing more. For low-MVC firms, the intuition is the reverse: They may draw down their cash reserves aggressively without affecting the value of the firm much; i.e., the marginal value of cash does not change much even with relatively large movements in cash holdings. The firm is situated on the flat segment of the marginal value of cash-curve; confer Figure 2.

Our finding that the cash flow sensitivity of cash is considerably larger for firms with large cash holdings and, therefore, a lower marginal value of cash, is extremely robust. It appears in all the regression specifications we use. A similar difference holds for the payment of dividends.

6.3 Transmission of bank shocks

So far, the estimated cash flow sensitivities tell us little about potential credit constraints that firms face. Credit constraints affect cash-flow sensitivities but the sensitivities are also correlated with firms' investment opportunities, the stochastic process governing firms' cash flows, etc., and expectations of these. We may, however, deduce the effect of credit constraints by examining how the cash flow sensitivities *change* with exogenous shocks to the supply of external finance. Because we have information about the main bank from which each firm borrows, we can examine how shocks to a firm's main bank affect the financing trade-offs made by the firm.[28] In particular, we look at the reaction of the firm's cash flow sensitivities in years where its main bank makes relatively large loan loss provisions. Specifically, our measure of the shock to bank j in year t is the difference between provisions made in year j and the bank's average provisions over the sample. Loan loss provisions lower the equity in the bank and make it harder for banks to expand their balance sheet though lending and they are therefore likely to respond to high provisions by

[28]We can observe all the banks a firm borrows from, but the vast majority of the firms in the sample borrow from just one bank and do not change bank relationship over the sample.

reducing lending and/or increasing the costs of borrowing.[29]

In Table 6 we provide summary statistics about the size distribution of the banks in our sample. Norway has a quite heterogenous bank population with 5-10 nationwide banks, several of which have been acquired by or merged with foreign banks. The largest of these banks has a market share of about 30 percent at the end of our sample. In addition, there is a group of very small, locally-oriented, savings banks and, in between, a large number of regionally-oriented banks. As can be seen from the table, the bulk of our observations consists of firms that bank with large or medium sized banks; naturally, the banks that cover the largest geographical areas are over-represented in this sense. Firms that bank with small banks make up less than 7 percent of the observations. Importantly, the total amount of loans to the firms in our sample constitute only a very small fraction (below 5 percent) of their main bank's loan portfolio. This alleviates concerns one may have about reverse causality in the bank shock regressions. Loans to households, including mortgage loans, constitute a large fraction of the loan portfolio for all banks, whereas it is mainly the largest banks that lend abroad. The table also shows the value of the bank shocks used in the regressions. On average, it is the largest banks that make above-average provisions during our sample period, that is, most of the negative shocks to loan supply are found in this group, whereas the smaller banks have generally made below-average provisions. Considering the size of the bank shock, not surprisingly, when a small bank experiences a negative shock, the shock tends to be larger relative to the bank's loan portfolio.

In the regressions, we include terms where EBITDA is interacted with the measure of bank shocks, allowing for the shock to provisions to work over two years; that is, we include measures of bank provisions in year t and year $t-1$ which we interact in all combinations with EBITDA_t and EBITDA_{t-1}. We include these lags because investment, as shown, reacts to cash flows with a lag.

[29]The costs of borowing should be understood to include all terms of the loan, not just the interest rate. For example, costs will increase if the bank tightens covenants or collateral requirements.

In Table 7, we show four sets of results: We split the sample according to firms' cash holdings respectively dividend payout and present OLS-estimates in the top panel and IV-estimates in the bottom panel. In order to limit the number of regressors in the table, we average some regressors, such that $\text{EBITDA}_{t/t-1} \equiv (\text{EBITDA}_t + \text{EBITDA}_{t-1})/2$, and (for provisions) $\text{PROV}_{t/t-1} \equiv (\text{PROV}_t + \text{PROV}_{t-1})/2$.[30] The averaging is done for variables that exert an effect over two periods based on preliminary regressions. The previously discussed results revealed that, especially, investment adjusts to cash flows over two periods but also the cash flow sensitivity of loan repayments tends to adjust to loan loss provisions over two periods, and this is the reason for focusing on the interaction variable $\text{EBITDA}_t \times \text{PROV}_{t/t-1}$. (For completeness, we display regressions without averaging in Appendix A). Our regressions include time fixed effects so the results are not driven by any particular time period or nationwide credit contraction.

First we consider the effect of provisions on the *level* of borrowing. High provisions lead to less net borrowing (higher net repayment) in the following period: The coefficient to lagged provisions is 0.71 (OLS) and 1.26 (IV) for the high-MVC group—both are significant at the 5 percent level while loan-loss provisions have no effect on the low-MVC group. The interpretation of a coefficient of 0.71 is that if a bank increases loan loss provisions (relative to total loans) by 1 percentage point, firms decrease the level of loans by an amount corresponding to 0.71 percent of their total assets. To get a sense of the economic size of this coefficient, we need to look at the size of a typical bank shock. Figure 3 plots the distribution of the (absolute value of) bank shocks observed during our sample period (these shocks are not cleaned of time fixed effects and therefore they differ from the shocks reported in Table 6). Most shocks are of a size below 1 percent of the bank's loan portfolio; hence, the economic effect of a typical shock on firms' repayment of loans is small. When banks receive a larger shock of, say, 5 percent it is associated with a almost 4 percent reduction in the loans-to-asset ratio of the borrowing firms. Considering that the typical

[30] The variables have firm-, bank-, and time-averages subtracted as explained in the previous section.

high-MVC firm operates with a loans-to-asset ratio of around 43 percent (Table 4), this is of significant, but modest, economic size.

Surprisingly, we find a positive relation between contemporaneous net repayment and provisions—this holds also for the IV-estimations wherefore it is not due to reverse causality. Possibly this occurs because firms draw on lines of credit but we cannot verify this; however, such cash hoarding has been documented during the 2008 financial crisis by Ivashina and Scharfstein (2009). Firms limit dividend pay-out in the same period as higher loan-loss provisions are observed at their respective main banks.

Turning to cash-flow sensitivities, Table 7 reveals that bank shocks affect the cash flow sensitivity of loan repayments and investment for high-MVC firms whereas there is no effect for low-MVC firms. The latter tend to have fewer loans and are therefore less likely to face significantly increased cost of lending and they can draw on cash and dividends although that seems not to happen to a large extent. The results are consistent with banks tightening standards relatively more for borrowers with a larger amount of outstanding loans.

The cash flow sensitivity of loan repayments interacted with loan-loss provisions averaged over two years ($\text{EBITDA}_t \times \text{PROV}_{\mathrm{t/t-1}}$) is –8.77 for the high-MVC group but –1.62 (and insignificantly different from 0) for the low-MVC firms. The economic interpretation of the coefficient of –8.77, is that if a bank makes loan loss provisions in the order of 1 percentage point of loans (deviation from the bank average and averaged of the current and previous period) then the net repayment of loans will decline by 8.77 dollars out of a 100 dollars cash flow increase or—maybe more relevant—the firm will draw 8.77 percent less on loans in the case of a cash flow shortfall. That is, a 1 percentage point increase in provisions causes an approximately 10 percent reduction in firms' use of bank finance on the margin. This is obviously an economic effect of considerable size. The changes in cash flow sensitivities are significant at the five percent level and they are significantly different from the corresponding estimates in the low-MVC group at the one and five percent level in the IV regressions (although the difference is not quite significant at conventional levels in the OLS regressions).

Interpreting the results in the light of Figure 1, higher loan-loss provisions steepens the marginal cost curve of loans for firms with large amounts of loans outstanding and, as a result, the MVC shifts up significantly for high-MVC firms leading to a higher investment sensitivity of cash flows. It is natural to expect that firms that face an increase in the cost of bank finance switch to other sources of finance, for example, internal funds. This, however, is not what we observe in our sample—there is no effect of bank shocks on the cash flow sensitivity of cash because high-MVC firms already economize on cash. Rather, it is the firms' investments that give. The correlation of investment with firms' (idiosyncratic) cash flow goes up and in this sense investment becomes more procyclical. The point estimate is around 10 for OLS with the interpretation that a 1 percentage point increase in provisions causes a 10 percent reduction in investment-to-assets in the case of a cash flow shortfall. The IV estimate is even larger at 27 and is significant but less precisely estimated.

In the IV-specification of Table 7, the marginal cost of trade credit and, to a lesser extent, the marginal utility of dividends increase in response to bank shocks (the estimated cash flow sensitivities fall) making firms more reluctant to draw on, especially, trade credit in bad times. One interpretation could be that in the face of uncertainty over future access to bank finance, firms prefer not to borrow from expensive non-bank sources fearing potential difficulties with repayment; alternatively trade credit may become more cyclical because the firms scale of operation have to follow cash flows more closely. These cash flow sensitivities are not significant in the OLS-estimation so we hesitate to stress them.

The second part of Table 7 presents OLS- and IV-regressions with the sample split according to whether firms pay dividends in a given year. The results are in line with the cash holdings-split, albeit the differences between the high and low-MVC groups are less significant. The results, however, indicate that bank shocks affect both the cash flow sensitivities and the level of net loan repayments and investment: Bank finance becomes more expensive so firms use it less, and as a result, investment falls. Overall, the results are very robust to the type of different sample split used.[31]

6.4 Robustness

Lastly, we check if our results are robust to dynamic panel effects. The lagged levels of the main variables are included in our regressions and they are correlated with the error terms through the estimated firm fixed effects when the time dimension is small.

We re-estimate the specifications in Table 7 using the Arellano-Bond Generalized Method of Moments (GMM) dynamic panel estimator.[32] The results (for our variables of interest) are presented in Table 8. They are quantitatively and qualitatively similar to those in Table 7—hence, our results do not appear to be significantly biased by the presence of dynamic panel effects.

7 Conclusion

We study the cash-flow sensitivities of dividends, borrowing, cash-holding, and investment for non-listed, closely-held, Norwegian firms. Our firms are heavily bank dependent and by using data that link individual firms to their main bank, we examine how these sensitivities are affected by external bank shocks.

Our results reveal how firms substitute between internal and external financing sources and how this substitution is related for firms' real investment and dividend payouts to owners. Firms' marginal value of cash (MVC) is a key determinant of firms' marginal financing choices and we show that cash-flow sensitivities reveal how quickly the marginal cost of the different sources of finance changes as the firm draws on them. By comparing estimated cash flow sensitivities for firms with a high MVC to those of firms with a low

[31] We present the "full" regression specification, without averaging, in Appendix A, Table A-1. Those results clearly show that the effect of loan provisions on the cash flow sensitivity of loan repayments is spread out over two periods, as the coefficient on both $\text{EBITDA}_t \times \text{PROV}_t$ and $\text{EBITDA}_t \times \text{PROV}_{t-1}$ are negative. The two coefficients are jointly significant. For that reason, we prefer to average the effects and use the regressor $\text{EBITDA}_t \times \text{PROV}_{t/t-1}$ in the main tables.

[32] The procedure is available for Stata as xtabond2, written by Roodman (2006).

MVC, we find substantial differences: high-MVC firms rely five-fold more on external (mostly bank) finance to absorb fluctuations in cash flow whereas low-MVC firms rely eight-fold more on internal finance (cash) than bank finance. Firms with high-MVC display significantly lower sensitivities of cash implying that the contrasting finding of Almeida, Campello, and Weisbach (2004) is specific for listed firms.

While recognizing that firms' level of cash balances is determined endogenously, we study how firms' financing choices are affected by exogenous shocks to the availability of external finance. Low-MVC firms are not affected by shocks to their main bank but high-MVC firms switch away from bank finance, reflecting that bank finance becomes more expensive. High-MVC firms, however, do not substitute internal funding for bank loans in the face of bank loan shocks; rather, investment becomes more dependent on firms' cash flows.

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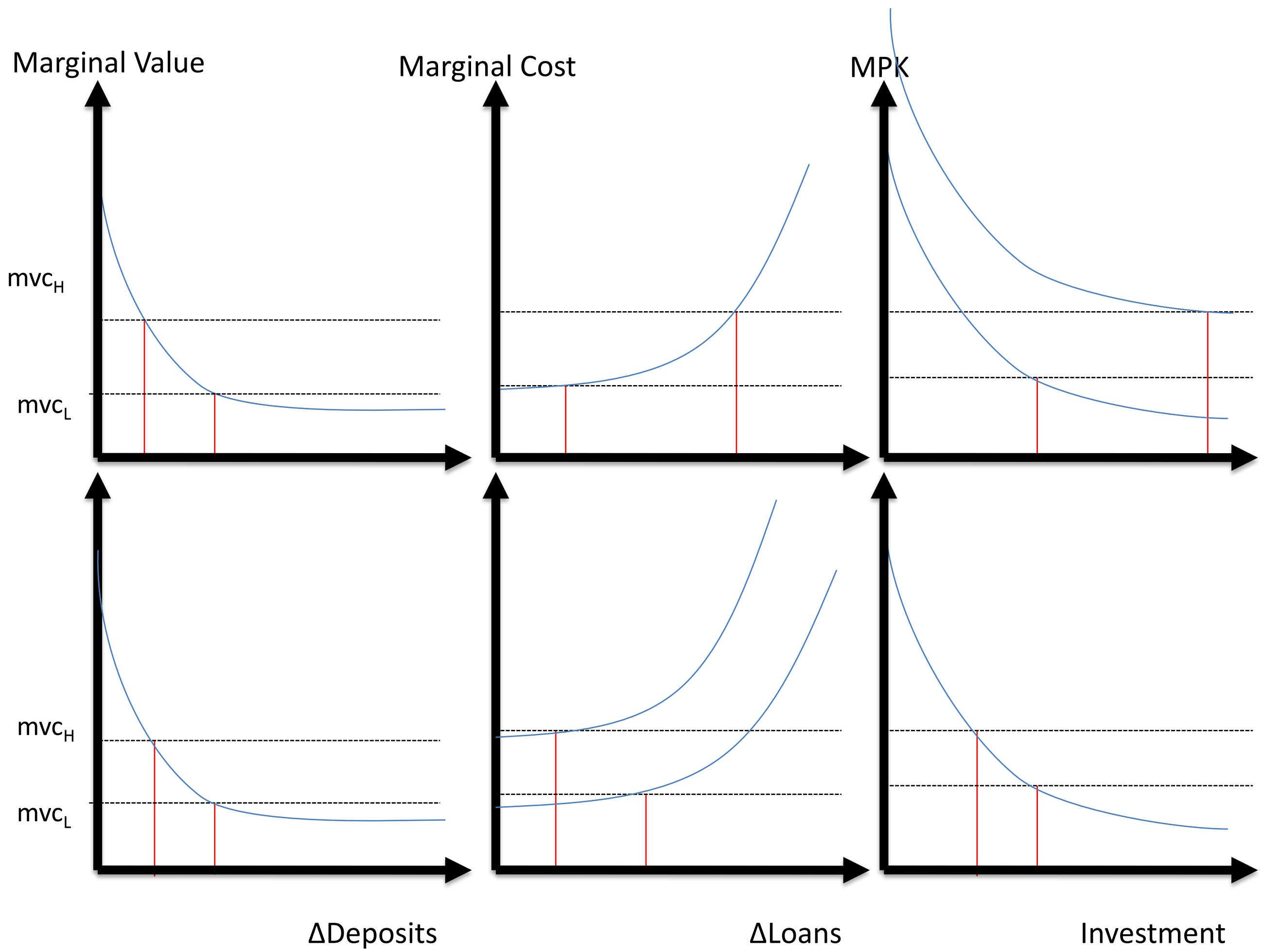
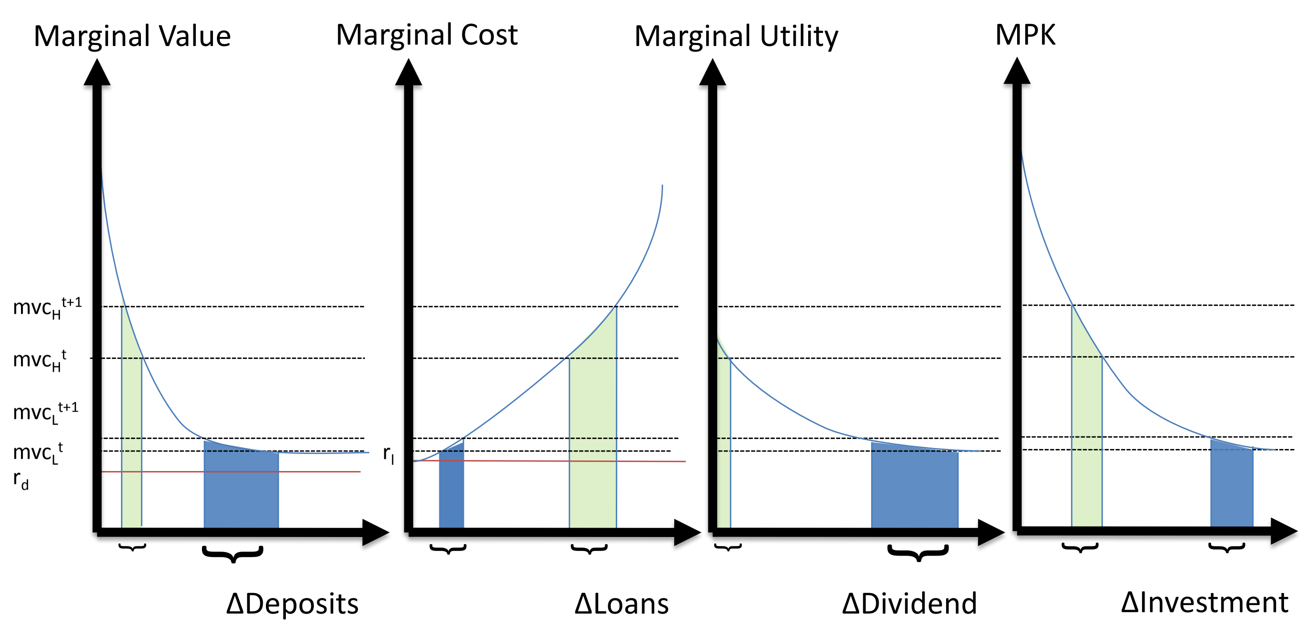
Figure 1: High-MVC vs. Low-MVC Firms



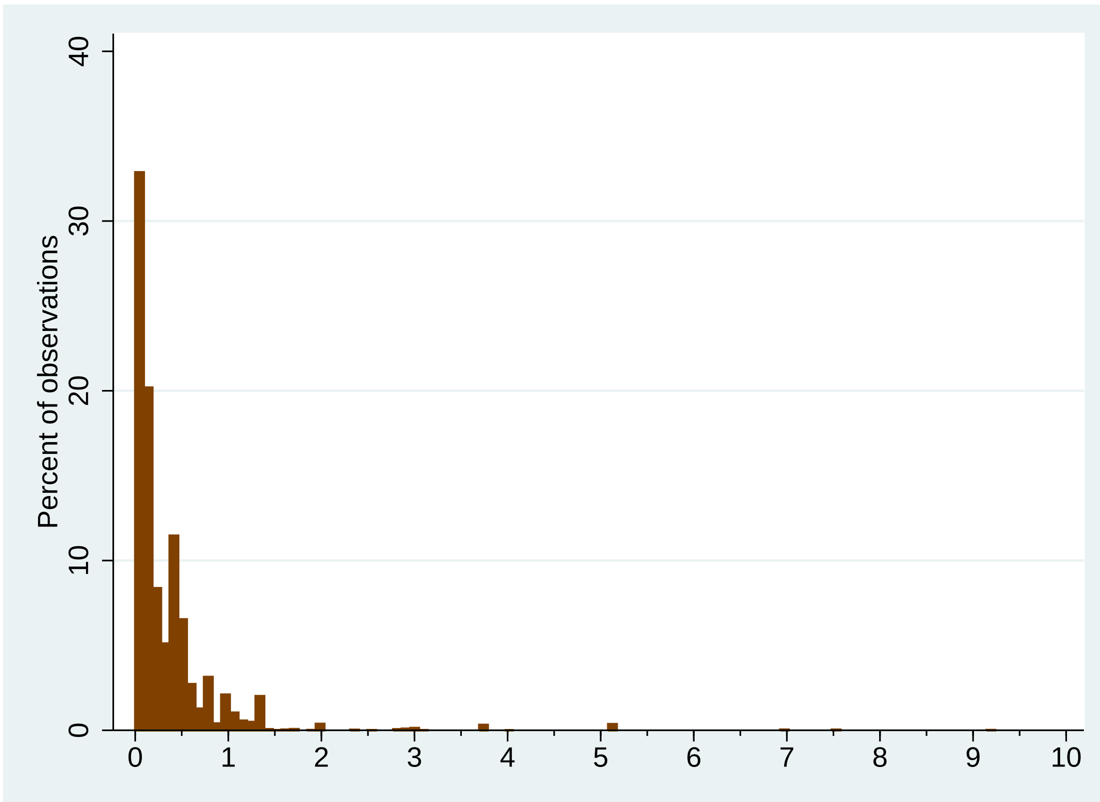
The figure illustrates two reasons why firms may have a high marginal value of cash. The top panels illustrate the case where a firm's investment opportunities improve and the MPK-curve shifts up and the firm's value of cash increases as it economizes on cash holdings and the cost of borrowing increases as the firm draws more on bank loans to finance physical investment. The bottom panel illustrates the case where the firm's access to credit deteriorates (the borrowing interest curve shifts up) making the firm cut back on physical investment and economize on cash holdings in order to borrow less.

Figure 2: Effect of a Cash Flow Shortfall on High-MVC vs. Low-MVC Firms



The figure illustrates the effect of a cash flow shortfall on the firm's demand for cash balances (deposits), bank loans, dividend payouts, and investment as estimated in Table 5. The initial marginal shadow value of cash for high-MVC and low-MVC firms is MVC_H^t and MVC_L^t, respectively. A cash shortfall causes the marginal value to increase to MVC_H^{t+1} resp. MVC_L^{t+1}, as firms adjust their deposit holdings, bank borrowing and investment accordingly. High-MVC firms that operate on the steep segment of the Marginal Value of Cash curve adjust deposits only a little (light/green shaded area) and similarly adjust dividends little, whereas low-MVC firm, operating on a flatter segment, draw down their cash balances to a larger extent (dark/blue shaded area). Similarly, the adjustment in bank loans is larger for high-MVC firms and smaller for low-MVC firms.

Figure 3: Distribution of Shocks to Loan Loss Provisions



The figure illustrates the distribution of bank shocks defined as the absolute deviation from a bank's average loan loss provisions.

Table 1:
Descriptive Statistics: Firm Characteristics

	Regression sample		
Firm-year obs.		119,682	
Firm obs.		21,206	
Percent	Mean	Median	Std
Firm age (years)	11	7	2
Largest Owner Share	65	62	6
Turnover (Sales) (thousand kr.)	11,406	6,226	2,616
Total Assets (thousand kr.)	5,520	3,002	1,381
Fixed Assets	37	31	13
Investment in Fixed Assets	7	4	10
Gross Investment	9	7	16
Deposits	14	9	8
Accounts Receivable	20	16	9
Equity	16	17	11
Liabilities	90	88	25
Bank Debt	28	22	12
Accounts Payable	21	16	9
EBITDA	5	4	11
ROA	6	6	10
Dividend	4	2	5
Dividend-Payout	39	24	48
Dividend/EBITDA	27	10	59

The table displays descriptive statistics for the firms in the regression sample. All values, unless indicated otherwise, are standardized by average firm size (total assets) over the period 1995-2005, reported in percent, and winsorized at the 1 and 99 percent level. Total assets and turnover are reported in thousands of Norwegian Kroner (NOK). Firm age is the number of years since the firm's incorporation. Largest owner is the ownership percent of the largest owner. Turnover (Sales) is total sales. Total Assets is book value of assets. Fixed Assets is the book value of fixed assets. Investment in Fixed Assets the change in fixed assets. Gross Investment is the change in fixed assets and inventories plus depreciation. Deposits is the balance outstanding on accounts in deposit-giving institutions. Accounts Receivable is short-term credit given to customers (trade credit extended). Equity is book value of equity. Liabilities is the sum of nonfinancial and financial debt. Bank Debt is loans from commercial and saving banks. Accounts Payable is short-term debt to creditors (trade credit received). EBITDA is earnings before interest, taxes, depreciation, and amortization. ROA is the return of total assets. Dividend is the value of dividends to be paid to shareholders. Dividend Payout is dividend-payments scaled by net income. Dividend/EBITDA is dividend-payments scaled by EBITDA.

Table 2:

Descriptive Statistics: Norwegian Sample Compared to the 2003 Survey of Small Business Finance

	Regression sample			SSBF S-corporations			SSBF C-corporations		
Firm-year obs.		119,682			736			480	
Firm obs.		21,206			736			480	
	Mean	Median	Std	Mean	Median	Std	Mean	Median	Std
Firm age	11	7	2	17	15	13	23	22	14
Largest owner	65	62	6	70	60	26	65	51	27
Turnover (sales) (thousands US$)	1,530	900	340	9,623	2,169	20,300	11,800	4,878	19,500
Total assets (thousands US$)	730	400	180	4,705	863	13,600	5,774	1,977	15,000
Deposits	13	9	6	20	9	39	17	8	29
Equity	14	16	10	54	56	30	54	55	27
Liabilities	84	84	10	49	38	58	43	36	40
Bank debt	26	21	10	18	3	32	16	4	26
Accounts payable	19	15	7	12	6	16	13	10	14

The table compares key descriptive statistics from the sample of firms analyzed in this paper to the sample of S-corporations and C-corporations from the 2003 Survey of Small Business Finances (SSBF) conducted by the Federal Reserve. We do not include sole proprietorships and limited liability companies as the Norwegian firms in our sample are all limited liability corporations. All values unless otherwise indicated are standardized by total assets and winsorized at the 1 and 99 percent level. Firm specific values are divided by firm specific total assets for each calender year before they are aggregated per firm. Conversion of Norwegian kroner to (U.S.) dollars is performed using the average kroner/dollar-exchange rate over the period 1995-2005. Firm age is the number of years since the firm's incorporation. Largest owner is the ownership percent of the largest owner. Turnover (Sales) is total sales. Total Assets is book value of assets.

Deposits is the balance outstanding on accounts in deposit-giving institutions. Equity is book value of equity. Liabilities is the sum of nonfinancial and financial debt. Bank Debt is loans from commercial and saving banks. Accounts Payable is short-term debt to creditors (trade credit received).

Table 3:
Decomposition of Cash Flow Identity: Sensitivity to Cash Flow and Effect of Stock Levels

	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Extension of Trade Credit (net)	Invest-ments (gross)	Accrued Taxes	Interest Paid (net)	Increase in stock of Securi-ties	Reduction in Paid-in Equity
$EBITDA_t$	19.92	24.09	12.69	0.39	21.30	6.18	19.62	-0.83	0.24	0.62
	(0.26)	(0.35)	(0.43)	(0.37)	(0.43)	(0.60)	(0.14)	(0.03)	(0.04)	(0.11)
$EBITDA_{t-1}$	0.82	-0.22	-4.17	-0.90	-0.77	10.67	0.75	-0.29	-0.13	0.45
	(0.21)	(0.31)	(0.46)	(0.38)	(0.40)	(0.58)	(0.10)	(0.03)	(0.04)	(0.13)
Outstanding $Deposits_{t-1}$	5.93	-69.84	0.39	-0.35	10.31	14.37	2.32	-1.58	0.57	-0.49
	(0.31)	(0.62)	(0.57)	(0.48)	(0.55)	(0.78)	(0.11)	(0.05)	(0.07)	(0.17)
Outstanding $Loans_{t-1}$	-4.86	-3.72	51.53	1.06	-3.56	-2.92	-1.78	4.54	-0.27	-0.76
	(0.17)	(0.29)	(0.56)	(0.36)	(0.37)	(0.64)	(0.09)	(0.05)	(0.05)	(0.13)
Accounts $Payable_{t-1}$	-3.65	-7.18	-7.47	72.60	-0.20	-8.12	-1.05	0.98	-0.25	-1.10
	(0.23)	(0.39)	(0.60)	(0.71)	(0.57)	(0.76)	(0.11)	(0.05)	(0.05)	(0.17)
Accounts $Receivable_{t-1}$	4.46	11.16	1.08	-6.16	-64.64	14.81	1.80	-0.15	0.22	-0.37
	(0.23)	(0.37)	(0.55)	(0.53)	(0.67)	(0.67)	(0.10)	(0.05)	(0.04)	(0.15)
Capital $Stock_{t-1}$	4.76	4.45	-12.61	-4.41	6.75	-26.35	2.12	0.93	0.20	0.62
	(0.15)	(0.25)	(0.45)	(0.32)	(0.32)	(0.57)	(0.08)	(0.04)	(0.04)	(0.12)
R-squared	0.26	0.39	0.22	0.32	0.34	0.12	0.57	0.49	0.00	0.02
No. Firms	23,057	23,057	23,057	23,057	23,057	23,057	23,057	23,057	23,057	23,057
No. Obs.	119,682	119,682	119,682	119,682	119,682	119,682	119,682	119,682	119,682	119,682

The table shows the coefficients from a panel OLS regression of the variable indicated in the column heading on the variables in column one. The regressions are performed on the same sample of firms in each column. EBITDA is earnings before interest, taxes, depreciation and amortization. Loans and deposit holdings by firms are outstanding balances on accounts held in deposit-taking (loan-giving) financial institutions. Repayment of Loans (net) is the net reduction in outstanding (bank and non-bank) loans, i.e. the net cash outflow due to repayment of loans. Repayment of Trade Credit (net) is the decrease in accounts payable. Extension of Trade Credit (net) is the increase in accounts receivable. Gross Investment is net (after depreciation) investment in fixed assets and inventory plus depreciation. Accrued Taxes is accounting taxes in a given year. Interest Paid (net) is interest expenses minus interest income, i.e. the net cash outflow due to debt service. Reduction in Paid-in Equity is the net reduction in share capital, i.e. the cash outflow due to write-downs. Capital Stock is the stock of fixed assets and inventory. Regressions include firms from all industries except financial and real estate-related services. All regressions are run with firm and time fixed effects. No. Firms is the number of unique firms in the regression and No. Obs. denotes the number of firm-year observations. All variables are annual, measured in millions Norwegian kroner, standardized by firm average size, and winsorized at the 1st and 99th percentiles. Firm clustered standard errors are reported in parentheses. Sample: 1995–2005.

Table 4:

Descriptive Statistics by Subgroup of Firms:
Split by High-MVC vs. Low-MVC Firms

percent	Firm-Year Obs. in Group	Total Assets (mill.)	Dividend Ratio	Deposit Ratio	Loan Ratio	Trade Credit Ratio	Capital Stock Ratio	Invest-ment Ratio	Sales Growth Ratio
AVERAGE CASH HOLDINGS									
High-MVC	32,522	6.27***	2.03***	2.78***	43.1***	21.4***	75.6***	8.42*	2.16***
Low-MVC	25,896	4.83	7.59	28.6	24.1	17.3	53.3	8.14	3.64
DIVIDENDS									
High-MVC	39,983	5.31***	0.00***	8.62***	41.6***	21.5***	69.7***	8.48***	2.50***
Low-MVC	63,504	5.77	13.1	18.7	25.0	16.8	63.0	8.83	3.35

The table shows the average value of key variables by subgroup according to two sample splits performed on the regression sample in Table 3. In the split by average cash holdings, firms are split into the High-MVC (Low-MVC) group according to their average of cash holdings, scaled by average firm size, over the sample. In the split by dividends, firm-year observations are split into the High-MVC (Low-MVC) group according to dividends scaled by average firm size. The High-MVC group is the lower 30% percentile of the distribution for the cash split and all firm-years with 0 dividends (more than 30% of the observations) for the dividend split. Firm-Year Observations in Group indicates the number of firm-year observations in each subgroup. Total Assets is measured in millions of Norwegian 1998-kroner. Dividend Ratio is the value of dividends paid out scaled by average firm size. Deposit Ratio is the outstanding amount of deposits scaled by average firm size. Loan Ratio is the outstanding amount of loans scaled by average firm size. Trade Credit Ratio is accounts payable scaled by average firm size. Capital Stock Ratio is the value of fixed assets and inventory scaled by average firm size. Investment Ratio is the change in fixed assets and inventory scaled by average firm size. Sales Growth Ratio is change in the log of sales scaled by average firm size. Sample: 1995–2005. ***, **, and * indicate significant difference at the 1, 5, and 10 percent level respectively in a two-sided t-test with unequal variances of difference between the group means.

Table 5:

Sensitivity to Current and Lagged Cash Flow:
Split by High-MVC vs. Low-MVC Firms

	High-MVC Firms					Low-MVC Firms				
	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Investments (gross)	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Investments (gross)
AVERAGE CASH HOLDINGS										
$EBITDA_t$	**11.74*****	**4.03*****	**18.19*****	**5.48*****	**8.75****	**28.48*****	**44.24*****	**5.63*****	**-4.39*****	**4.71*****
	(0.43)	(0.20)	(0.97)	(0.77)	(1.36)	(0.51)	(0.72)	(0.63)	(0.62)	(0.95)
$EBITDA_{t-1}$	**1.75*****	-0.30	**-6.12*****	-1.19	**12.59*****	-0.22***	-1.15	**-2.16*****	**-1.75**	**6.22*****
	(0.27)	(0.20)	(0.94)	(0.77)	(1.16)	(0.48)	(0.80)	(0.75)	(0.64)	(0.97)
DIVIDENDS										
$EBITDA_t$	**4.36*****	**17.20*****	**13.68*****	**3.29*****	**4.85*****	**34.32*****	**36.19*****	**5.48*****	**-6.24*****	**11.25*****
	(0.12)	(0.38)	(0.57)	(0.48)	(0.77)	(0.47)	(0.67)	(0.63)	(0.56)	(0.97)
$EBITDA_{t-1}$	**0.27****	0.57***	**-4.20**	**-1.28****	**10.77**	-0.98**	**-2.88*****	**-3.85**	0.40**	**10.12**
	(0.11)	(0.33)	(0.56)	(0.48)	(0.71)	(0.51)	(0.70)	(0.72)	(0.61)	(1.00)

The table shows the coefficients from panel OLS regressions of the column headings variables on the variables reported in Table 3 according to two sample splits. For brevity, the estimated coefficients on lagged stock levels are omitted from the table. In the split by average cash holdings, firms are split into the High-MVC (Low-MVC) group according to their average cash holdings over the sample. In the split by dividends, firm-year observations are split into the High-MVC (Low-MVC) group according to dividends scaled by average firm size. The High-MVC (Low-MVC) group is defined as the upper (lower) 30% percentile of the distribution. Sample period is 1995-2005. The number of observations in each regression is displayed in Table 4. Firm clustered standard errors are reported in parentheses. Estimated coefficients in bold script indicates significance at the 5 percent level. Firm clustered standard errors are reported in parentheses. ***, **, and * indicate significant difference between High-MVC and Low-MVC group coefficients at the 1, 5, and 10 percent level in a two-sided Wald test.

Table 6:
Descriptive Statistics by Bank Size Group

	Bank Size Group Assets		
	Below 1bn.	1bn – 50bn	Above 50bn
Firm-Year Obs.	7,027	56,276	41,273
Percent of Sample	6.7	53.8	39.5
Total Assets (mill.)	669	18,477	264,568
Ratio of Loans to Assets	86.9	88.5	80.9
Ratio of Loans in Sample to All Loans	4.4	3.1	1.5
Ratio of Loans to Households	82.0	67.7	50.7
Ratio of Loans to Foreign Sector	0.3	1.2	8.4
Loan Loss Provisions Shock	-0.07	-0.01	0.03
Maximum Shock in Group	2.28	2.35	0.85

The table shows the average (unless otherwise indicated) value of key variables in each bank size group (in billions of 1998 kroner). Firm-Year Obs. indicates the number of firm-year observations in each subgroup. Percent of Sample is the share of firm-year observations in percent of the sample. Total Assets is average bank size in million 1998-kroner. Ratio of Loans to Assets is the size of a bank's loan portfolio relative to its assets in percent. Ratio of Loans in Sample to All Loans is the volume of loans held by a bank against all firms in the sample in percent of its loan portfolio. Ratio of Loans to Households is the percent of banks' loan portfolio comprised of households loans (incl. mortgages). Ratio of Loans to Foreign Sector is the percent of banks' loan portfolio comprising loans to foreign financial institutions, public sector institutions, households and non-financial firms. Loan Loss Provisions Shock is the value of shocks to loan loss provisions used in the regressions. A shock is the deviation-from-average provisions measured in percent of a bank's loan portfolio. In the regressions, the shock is further demeaned each year across firms due to time fixed effects, that is, the table displayed the value of the shock across all firms that use a bank in the particular size group. Maximum Shock in Group is the maximum shock for the banks in each subgroup. Sample: 1995–2005.

Table 7:
Effect of Bank Shocks on Cash Flow Sensitivities for Firms with High vs. Low Marginal Value of Cash

	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)
	High-MVC Firms					Low-MVC Firms				
AVERAGE CASH HOLDINGS (OLS)										
$EBITDA_{t/t-1}$	**14.48*****	**3.91*****	**15.10*****	**5.62*****	**20.97*****	**33.19*****	**51.58*****	**7.13*****	**−6.51*****	**10.02*****
	(0.30)	(0.22)	(1.00)	(0.75)	(1.22)	(0.55)	(0.91)	(0.85)	(0.70)	(1.10)
$EBITDA_t \cdot Prov_{t/t-1}$	-0.92	0.24	**−8.77***	-1.97	**10.75**	0.80	-3.46	-1.62*	0.73	2.91
	(0.72)	(0.54)	(2.39)	(1.80)	(2.93)	(1.23)	(2.04)	(1.91)	(1.58)	(2.47)
$Prov_t$	**−0.12**	0.01	**−0.55***	-0.06	**0.54**	-0.19	-0.23	0.05*	0.02	0.08
	(0.06)	(0.05)	(0.22)	(0.16)	(0.26)	(0.13)	(0.22)	(0.20)	(0.17)	(0.26)
$Prov_{t-1}$	0.09	-0.02	**0.71****	0.13	**−0.61**	0.13	0.06	0.12**	0.01	-0.16
	(0.06)	(0.05)	(0.21)	(0.16)	(0.26)	(0.13)	(0.21)	(0.20)	(0.16)	(0.26)
$EBITDA_{t-1} \cdot Prov_{t-1}$	-0.49	-0.33	0.67	-1.41	-0.69†	1.01	-0.66	-2.48	-0.35	**5.98**†
	(0.64)	(0.48)	(2.15)	(1.62)	(2.64)	(1.14)	(1.89)	(1.77)	(1.46)	(2.28)
AVERAGE CASH HOLDINGS (IV)										
$EBITDA_{t/t-1}$	**13.13*****	**3.94*****	**16.21*****	**6.72*****	**18.45*****	**31.71*****	**51.17*****	**8.17*****	**−7.11*****	**9.43*****
	(0.63)	(0.35)	(1.81)	(1.44)	(2.32)	(1.01)	(1.56)	(1.46)	(1.23)	(2.04)
$EBITDA_t \cdot Prov_{t/t-1}$	**−6.58**	1.84*	**−21.76*****	**−13.31****	**27.16****	-3.58	-7.53*	-2.48***	-2.01**	5.25**
	(2.69)	(1.13)	(6.54)	(4.39)	(8.25)	(2.96)	(4.86)	(3.50)	(3.76)	(5.25)
$Prov_t$	**−0.24***	-0.01	**−1.26**	0.21	0.42	0.22*	-0.36	-0.56	0.08	0.67
	(0.11)	(0.09)	(0.44)	(0.31)	(0.52)	(0.25)	(0.42)	(0.37)	(0.32)	(0.51)
$Prov_{t-1}$	0.08	0.05	**1.26****	0.15	-0.71	-0.06	0.27	-0.08**	0.01	-0.03
	(0.15)	(0.10)	(0.46)	(0.35)	(0.52)	(0.25)	(0.40)	(0.33)	(0.31)	(0.43)
$EBITDA_{t-1} \cdot Prov_{t-1}$	-2.26**	1.14	-1.53	-2.41	5.80	4.70**	4.36	-0.81	-2.00	3.05
	(1.53)	(1.05)	(5.63)	(3.71)	(6.67)	(2.99)	(4.23)	(3.06)	(3.07)	(4.35)

The table shows the coefficients from regressions of the column headings variables on the variables reported in Equation (7) according to a sample split by average cash holdings. For brevity, the estimated coefficients on lagged stock levels are omitted from the table. The table reports results from a panel OLS and an instrumental variables panel OLS regression, respectively, where firms are split into the High-MVC (Low-MVC) group according to their average cash holdings over the sample. The High-MVC (Low-MVC) group is defined as the upper (lower) 30% percentile of the distribution. Sample period is 1995-2005. The number of firm-year observations in the High-MVC group for OLS and IV are 32,522 and 21,023, resp. The number of firm-year observations in the Low-MVC group for OLS and IV are 25,896 and 16,765, resp. Estimated coefficients in bold script indicate significance at the 5 percent level. Firm clustered standard errors are reported in parentheses. ***, **, *, and † indicate significant difference between High-MVC and Low-MVC group coefficients at the 1, 5, 10, and 15 percent level in a two-sided Wald test.

Table 7—*continued*

	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)
	High-MVC Firms					Low-MVC Firms				
DIVIDENDS (OLS)										
$\text{EBITDA}_{t/t-1}$	**4.98** ***	**18.41*****	**12.57*****	**2.80*****	**15.30*****	**38.42*****	**38.11*****	**5.11*****	**−6.52*****	**0.90*****
	(0.17)	(0.53)	(0.87)	(0.73)	(1.13)	(0.77)	(1.07)	(1.03)	(0.84)	(1.50)
$\text{EBITDA}_t \cdot \text{Prov}_{t/t-1}$	**−0.77**	-2.48	**−3.97**†	-2.03	**8.68****	-0.81	-0.99	0.14†	0.53	-0.21**
	(0.35)	(1.25)	(1.97)	(1.54)	(2.59)	(1.95)	(2.70)	(2.20)	(1.91)	(3.48)
Prov_t	0.00	-0.04	**−0.39**	-0.21**	**0.60**	0.00	0.01	-0.17	0.16**	0.25
	(0.03)	(0.08)	(0.17)	(0.12)	(0.21)	(0.13)	(0.17)	(0.19)	(0.14)	(0.26)
Prov_{t-1}	**0.06**	**−0.28**	**0.61****	0.21	**−0.45**	0.13	-0.04	0.13**	0.00	-0.20
	(0.03)	(0.09)	(0.17)	(0.12)	(0.20)	(0.13)	(0.15)	(0.18)	(0.14)	(0.24)
$\text{EBITDA}_{t-1} \cdot \text{Prov}_{t-1}$	0.33	-0.96	1.79	0.18	0.88	-0.71	-1.14	1.59	0.14	-2.08
	(0.28)	(0.97)	(1.76)	(1.26)	(2.12)	(1.49)	(1.94)	(1.91)	(1.57)	(2.80)
DIVIDENDS (IV)										
$\text{EBITDA}_{t/t-1}$	**4.21*****	**18.71*****	**12.83*****	**2.96*****	**14.83****	**38.62*****	**39.47*****	**5.46*****	**−7.13*****	**19.33****
	(0.20)	(0.65)	(1.07)	(0.89)	(1.38)	(0.96)	(1.32)	(1.34)	(1.02)	(1.88)
$\text{EBITDA}_t \cdot \text{Prov}_{t/t-1}$	**−1.69**	-1.56	**−6.00**	-5.55	**12.39**†	-5.77	-3.50	-2.93	-4.51	1.13†
	(0.61)	(2.17)	(3.45)	(2.69)	(4.57)	(3.46)	(4.68)	(4.06)	(3.31)	(6.15)
Prov_t	-0.03	0.08	**−0.84**	-0.22	0.74	0.12	-0.22	-0.64	0.24	0.48
	(0.05)	(0.16)	(0.32)	(0.24)	(0.39)	(0.24)	(0.31)	(0.36)	(0.25)	(0.46)
Prov_{t-1}	0.03	-0.17	**1.05**	0.23	-0.64	0.17	0.23	0.49	-0.13	-0.28
	(0.06)	(0.17)	(0.31)	(0.25)	(0.37)	(0.23)	(0.30)	(0.33)	(0.25)	(0.43)
$\text{EBITDA}_{t-1} \cdot \text{Prov}_{t-1}$	0.08*	-0.95**	0.71	2.79	2.79	4.53*	**7.02****	-0.71	2.08	-7.15
	(0.54)	(1.85)	(3.14)	(2.50)	(3.99)	(2.65)	(3.47)	(3.60)	(2.83)	(5.04)

The table shows the coefficients from regressions of the column headings variables on the variables reported in Equation (7) according to a sample split by dividend-payments. For brevity, the estimated coefficients on lagged stock levels are omitted from the table. The table reports results from a panel OLS and an instrumental variables-panel OLS regression, respectively, where firm-year observations are split into the High-MVC (Low-MVC) group according to the magnitude of dividends scaled by average firm size paid by firm i in year t. The High-MVC group is defined as the upper 30% percentile of the distribution while the Low-MVC groups comprises all firm-years with 0 dividends. Sample period is 1995-2005. The number of firm-year observations in the High-MVC group for and IV are 63,504 and 41,837, resp. The number of firm-year observations in the Low-MVC group for OLS and IV are 30,983 and 19,582, resp. Estimated coefficients in bold script indicate significance at the 5 percent level. Firm clustered standard errors are reported in parentheses. ***, **, *, and † indicate significant difference between High-MVC and Low-MVC group coefficients at the 1, 5, 10, and 15 percent level in a two-sided Wald test.

Table 8:
Effect of Bank Shocks on Cash Flow Sensitivities; Arellano-Bond Dynamic Panel GMM Estimator

	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)
	High-MVC Firms					Low-MVC Firms				
AVERAGE CASH HOLDINGS										
$\text{EBITDA}_{t/t-1}$	**13.15*****	**4.32*****	**13.77*****	**5.38*****	**25.66*****	**33.28*****	**50.37*****	**8.55*****	**−6.02*****	**13.11*****
	(0.46)	(0.30)	(1.46)	(1.11)	(1.80)	(0.92)	(1.39)	(1.27)	(1.08)	(1.69)
$\text{EBITDA}_t{\cdot}\text{Prov}_{t/t-1}$	-1.28†	0.25	**−8.33****	-2.32	**12.90***	1.55†	-1.08	-0.41**	0.14	4.10*
	(0.90)	(0.59)	(2.88)	(2.20)	(3.56)	(1.69)	(2.55)	(2.32)	(1.98)	(3.09)
Prov_t	-0.10	0.02	-0.01	-0.15	0.65	-0.24	-0.32	-0.10	-0.01	0.47
	(0.09)	(0.06)	(0.28)	(0.21)	(0.35)	(0.20)	(0.30)	(0.27)	(0.23)	(0.36)
Prov_{t-1}	0.14	-0.04	**0.66****	-0.02	-0.53	-0.17	-0.25	-0.10**	-0.31	-0.01
	(0.09)	(0.06)	(0.28)	(0.22)	(0.35)	(0.19)	(0.29)	(0.26)	(0.23)	(0.35)
$\text{EBITDA}_{t-1}{\cdot}\text{Prov}_{t-1}$	0.08	**−1.08****	0.81	-0.75	-1.12*	0.89	4.30**	-1.97	**−3.67**	**6.90***
	(0.79)	(0.52)	(2.53)	(1.93)	(3.13)	(1.47)	(2.22)	(2.03)	(1.73)	(2.70)
DIVIDENDS										
$\text{EBITDA}_{t/t-1}$	**5.71*****	**17.87*****	**14.04*****	**2.09*****	**20.54**	**42.76*****	**38.73*****	**7.68*****	**−5.93*****	**18.49**
	(0.32)	(0.49)	(0.97)	(0.75)	(1.21)	(0.93)	(1.16)	(1.34)	(1.06)	(1.74)
$\text{EBITDA}_t{\cdot}\text{Prov}_{t/t-1}$	-1.16	-0.85	**−5.23**†	-2.25	**9.91*****	0.77	0.69	-1.03†	1.68	0.13***
	(0.60)	(0.91)	(1.81)	(1.39)	(2.26)	(1.54)	(1.93)	(2.22)	(1.75)	(2.89)
Prov_t	0.05	-0.01	0.05*	**0.32****	**0.62**	-0.15	-0.24	**−0.53***	0.23**	0.55
	(0.07)	(0.11)	(0.21)	(0.16)	(0.26)	(0.16)	(0.20)	(0.22)	(0.18)	(0.29)
Prov_{t-1}	0.11	-0.16	**0.55***	0.13**	**−0.58**	0.10	-0.34	-0.03*	0.25**	-0.29
	(0.07)	(0.10)	(0.20)	(0.15)	(0.25)	(0.17)	(0.21)	(0.24)	(0.19)	(0.32)
$\text{EBITDA}_{t-1}{\cdot}\text{Prov}_{t-1}$	-0.65*	-0.01	1.65	-1.11†	0.87	1.98*	1.59	-1.50	-0.47†	-0.64
	(0.52)	(0.80)	(1.59)	(1.23)	(1.99)	(1.37)	(1.71)	(1.96)	(1.55)	(2.56)

The table shows the coefficients from the regressions reported in Table 7, estimated with the Arellano-Bond Dynamic Panel GMM estimator.

Table A-1:

Appendix A: Effect of Bank Loan Loss Provisions on Cash Flow Sensitivities: Full Specification

	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)	Dividend Paid to Owners	Increase in Deposits	Repayment of Loans (net)	Repayment of Trade Credit (net)	Invest-ments (gross)
	High-MVC Firms					Low-MVC Firms				
AVERAGE CASH HOLDINGS (OLS)										
$EBITDA_t$	**11.72*****	**3.89*****	**18.85*****	**5.83*****	**8.53****	**27.69*****	**44.01*****	**7.13*****	**−4.58*****	**4.74****
	(0.44)	(0.21)	(1.00)	(0.81)	(1.41)	(0.57)	(0.82)	(0.73)	(0.70)	(1.07)
$EBITDA_{t-1}$	**1.77*****	**−0.42**†	**−6.30*****	-0.87	**12.88*****	-0.19***	-1.82†	-1.83***	-1.24	**5.41*****
	(0.28)	(0.21)	(0.97)	(0.79)	(1.19)	(0.52)	(0.92)	(0.88)	(0.72)	(1.11)
$EBITDA_t \cdot Prov_t$	-1.96	0.03**	-3.14	-2.22	5.37	0.67	-4.76**	-1.44	1.23	0.42
	(1.13)	(0.60)	(3.08)	(1.99)	(3.98)	(1.48)	(2.38)	(1.85)	(1.90)	(2.79)
$EBITDA_t \cdot Prov_{t-1}$	-0.02	0.20	-5.59†	0.18	5.39	0.13	1.01	-0.24†	-0.42	2.40
	(1.16)	(0.59)	(3.03)	(1.98)	(4.02)	(1.42)	(2.39)	(1.92)	(1.80)	(2.75)
$EBITDA_{t-1} \cdot Prov_{t-1}$	-0.50	-0.25	1.49	-1.54	-0.78	1.82	1.21	-2.38	-0.24	5.74
	(0.95)	(0.48)	(3.10)	(1.97)	(3.74)	(1.47)	(2.35)	(1.89)	(1.85)	(2.68)
$Prov_t$	-0.11	0.01	**−0.52***	-0.05	0.53	-0.11	-0.08	0.08*	0.01	0.08
	(0.06)	(0.05)	(0.24)	(0.16)	(0.29)	(0.13)	(0.21)	(0.20)	(0.17)	(0.26)
$Prov_{t-1}$	0.08	-0.03	**0.67***	0.12	**−0.60**	0.09	-0.01	0.10*	0.02	-0.16
	(0.08)	(0.05)	(0.23)	(0.17)	(0.28)	(0.13)	(0.21)	(0.19)	(0.17)	(0.25)

The table shows the coefficients from panel regressions of the column headings variables on the variables reported in Equation (7) according to a sample split by average cash holdings. For brevity, the estimated coefficients on lagged stock levels are omitted from the table. The table reports results from a panel OLS regression where firms are split into the High-MVC (Low-MVC) group according to their average cash holdings over the sample. The High-MVC (Low-MVC) group is defined as the upper (lower) 30% percentile of the distribution. Sample period is 1995-2005. The number of firm-year observations in the High-MVC and Low-MVC group are 32,522 and 25,896, resp. Estimated coefficients in bold script indicate significance at the 5 percent level. Firm clustered standard errors are reported in parentheses. ***, **, and * indicate significant difference between High-MVC and Low-MVC group coefficients at the 1, 5, and 10 percent level in a two-sided Wald test.

Appendix B

Deriving the cash flow sensitivities

From the identities

$$s''\Delta \mathrm{DEP_t} = \frac{2\mathrm{dr^b}}{\mathrm{dL}}\Delta \mathrm{L_t} = \mathrm{f''_t I_t} = \frac{\mathrm{U''_t}}{\beta \mathrm{U'_{t+1}}}\Delta \mathrm{DIV_t} \ ,$$

we relate the cash flow components to dividends. This delivers an intuitive interpretation although one could relate to, say, deposits in a similar fashion in the case of zero dividends. We have $\beta U'_{t+1} s'' \Delta \mathrm{DEP_t} = \mathrm{U''_t}\Delta \mathrm{DIV_t}$. The right-hand side is the change in marginal utility of dividends associated with a change in dividends of ΔDIV while the left-hand side is the change in marginal value of cash associated with a change in deposits of $\Delta \mathrm{DEP_t}$—this change is proportional to s'' which captures how fast the marginal value of cash changes with deposit balances and, because deposits transfer funds to the next period, it is further proportional to the discounted marginal utility of dividends in period $t+1$. The marginal utility of dividends will be equal to the marginal value of cash before the allocation of cash flows and the marginal utility will equal MVC also after allocation of cash flows, which is why the change in the marginal values need to be equal. U'' is negative and so is s'', implying that dividends and deposits will both increase or both decrease as illustrated in Figure 2. For loans $2\beta U'_{t+1}\, r^{b'} \Delta \mathrm{L_t} = \mathrm{U''_t}\Delta \mathrm{DIV}$, implying that the change in marginal utility will equal two times the change in borrowing rate times the change in the stock of loans times $\beta U'_{t+1}$.[33] The borrowing rate will increase with borrowing, so $r^{b'} > 0$, and net lending will change in the opposite direction of dividends as can also be seen from Figure 2. Finally, investment (the change in the physical capital stock) will satisfy $\beta U'_{t+1} f'' I_t = U''_t \Delta \mathrm{DIV_t}$, with a similar interpretation. Because the marginal product of capital, f', is declining, f'' is negative and the change in the capital stock is of the same sign as the change in dividends.

[33]The factor 2 occurs because there is an effect on the marginal borrowing rate and because the stock of loans change. A similar pattern would occur for deposits if there was a change in the deposit rate but this is not our preferred interpretation of the s function.

Dividends, deposits, loans, and investments sum (in our approximation) to total cash flows ("CF") and expressing all components in terms of dividends using the relations just discussed, we obtain

$$\Delta\mathrm{DIV}_t + \frac{U''_t}{\beta U'_{t+1} s''}\Delta\mathrm{DIV} + \frac{U''_t}{2\beta U'_{t+1}\, r^{b\prime}}\Delta\mathrm{DIV} + \frac{U''_t}{\beta U'_{t+1} f''}\Delta\mathrm{DIV}_t = \mathrm{CF}_t\ ,$$

from which

$$\Delta\mathrm{DIV}_t = \frac{1}{1 + U''_t/(\beta U'_{t+1} s'') + U''_t/(\beta U'_{t+1} 2r^{b\prime}) + U''_t/(\beta U'_{t+1} f'')}\,\mathrm{CF}_t\,.$$

We observe that the change in dividends paid out is inversely proportional to the second derivative of the utility function relative to the second derivatives of the costs or benefits of other sources and uses of funds. This is intuitive, because dividends will increase or decrease simultaneously with deposits, loans, and capital while keeping marginal utility equal to marginal product and interest rates. The faster marginal utility changes relative to those interest rates and marginal product, the less dividends will change while maintaining the identities. For deposits we obtain

$$\Delta\mathrm{DEP}_t = \frac{1}{(\beta U'_{t+1}\, s''/U''_t + 1 + s''/2r^{b\prime} + s''/f'')}\mathrm{CF}_t\ ,$$

which says that deposits adjust in an amount inversely proportional to the rate at which the marginal shadow interest rate on cash changes compared to the other derivatives.

Similarly, we have

$$\Delta\mathrm{L}_t = \frac{1}{\beta U'_{t+1}\, 2r^{b\prime}/U''_t + 2r^{b\prime}/s'' + 1 + 2r^{b\prime}/f''}\mathrm{CF}_t\,.$$

Again, the change in loan demand is inversely proportional to the (relative) speed at which the lending rate changes with loans demanded. Finally, we have that gross investment (the change in capital in our approximation which ignores depreciation) is

$$\mathrm{I}_t = \frac{1}{\beta U'_{t+1}\, f''/U''_t + f''/s'' + f''/2r^{b\prime} + 1}\mathrm{CF}_t\ .$$

Firms adjust capital in an amount inversely proportional to the rate of decline in the marginal product of capital.

The deterministic model with binding constraint on period t dividends

If the non-negativity constraint for dividends is binding, the Euler equations are replaced by inequalities. Consider for instance capital. If no dividends are paid out it must be because the value of the marginal dollar is higher when invested than paid out as dividends (disregarding the case where the firm utilize the full cash flows for loan repayment). Assuming dividends in period $t+1$ are non-zero, the "Euler equation" for capital becomes an inequality

$$U'(0) < \beta\, U'(\mathrm{DIV_{t+1}})(1 + \mathrm{f}'(\mathrm{K_t}))\ .$$

(To handle the possibility of zero dividends in period $t+1$ one needs the more general value function framework sketched in Section 2.) Intuitively, this situation will occur when the marginal product of capital is relatively high and the MV-curve for dividends is relatively flat. This may be a state when earnings are low and the firm has few funds (K low and $f'(\mathrm{K})$ is a decreasing function in K), or it may arise because the productivity of capital, $f'(\mathrm{K})$, is especially high caused by technological or particular market conditions.

Even if dividend payments are zero, the firm can, at the margin, trade off repayment of loans against investment and in optimum the marginal value of each use will have to be equal (assuming no non-negativity constraint binds for investments or loans) giving the equality

$$\beta U'(\mathrm{DIV_{t+1}})(1 + \mathrm{r^b} + \mathrm{L_t}\,\frac{\mathrm{dr^b}}{\mathrm{dL}}) = \beta \mathrm{U}'(\mathrm{DIV_{t+1}})(1 + \mathrm{f}'(\mathrm{K_{t+1}})\ .$$

Similarly, a firm can trade off cash holdings against loan repayment and in equilibrium (ignoring non-negativity constraints for loans) we would have:

$$\beta U'(\mathrm{DIV_{t+1}})(1 + \mathrm{r^b} + \mathrm{L_t}\frac{\mathrm{dr^b}}{\mathrm{dL}}) = \beta \mathrm{U}'(\mathrm{DIV_{t+1}})(1 + \mathrm{r^d} + \mathrm{s}'(\mathrm{DEP_t}))\ .$$

In this case a firm will have a high marginal value of cash in the sense that keeping the cash within the firm exceed the marginal value of dividend pay-outs and we have:

$$\text{MVC}_t \equiv \beta U'(\text{DIV}_{t+1})(1+r^d+s'(\text{DEP}_t)) = \beta U'(\text{DIV}_{t+1})(1+r^b+\text{L}_t\,\frac{dr^b(\text{L}_{t+1})}{d\text{L}}) = \beta(U'(\text{DIV}_{t+1})(1+f'(\text{K}_t)) \,.$$

In this setting, the marginal sensitivities of cash will satisfy relations similar to those derived above, with the difference that the period t marginal utility will not enter the relations.