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Dutch Corporate Liquidity Management: New Evidence on Aggregation

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Dutch Corporate Liquidity Management: New Evidence on Aggregation*

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Abstract
In this paper we investigate Dutch corporate liquidity management in general, and target adjustment behaviour in particular. To this purpose, we use a simple error correction model of corporate liquidity
holdings applied to firm-level data for the period 1977-1997. We confirm the existence of long-run liquidity targets at the firm level. We also find that changes in liquidity holdings are driven by short-run shocks as well as the urge to converge towards targeted liquidity levels. The rate of target convergence is higher when we include more firm-specific information in the target. This result supports the idea that the degree of error in defining liquidity targets associates negatively with the observed rate of target convergence. It also suggests that the slow speeds of adjustment obtained in many macro studies on money demand are artefacts of aggregation bias.

Keywords: Corporate liquidity demand; Precautionary liquidity

JEL classification: C33; C43; E41; G3

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1 Introduction

Macroeconomic studies on money demand using stock-adjustment models typically find extremely low rates of adjustment, with 10-20 percent rates of annual convergence towards target being the rule, rather than the exception (e.g. Goldfeld and Sichel (1990), Fase and Winder (1993)). One reading of this evidence is that firms do not manage liquidity holdings. Another reading of the evidence is that aggregate analysis of corporate liquidity management is inappropriate. In that regard, Swamy et al. (1982) already demonstrate that aggregation issues may be at the root of slow rates of observed adjustment in money demand studies.

One way out of this problem is to focus on firm-level liquidity holdings. On the firm level, an important precautionary motive for corporate liquidity holdings stems from informational problems between firms and capital markets, which vary across firms.[1] Consequently, the assumption in aggregate analyses that all firms are homogeneous in the liquidity targets that they pursue, is misleading. As a corollary, corporate liquidity targets and concomitant rates of target convergence should be analysed at the appropriate level of aggregation, i.e. the firm level.

In the present paper, we do exactly that. Specifically, using firm-level data for the Netherlands, we assume a simple error correction model of corporate liquidity holdings. In it, changes in liquidity holdings are driven by short-run shocks to earnings and expenses as well as by the adjustment of liquidity holdings towards the specified target. The ultimate goal of the paper is to accurately estimate the speed of adjustment of liquidity holdings towards targeted levels. In our view, this adjustment speed is the best indicator of the practical relevance of liquidity targets to firms. Our main result is that meaningful rates of convergence of corporate liquidity holdings towards targeted levels are obtained only when liquidity targets are specified accurately. Specifically, we demonstrate that the speed of adjustment is faster when we include more firm-specific information in the target. In addition, we show that convergence is faster on time-varying liquidity targets than on simple historical (sector) averages. This all indicates that inaccurately measured corporate liquidity targets correspond with downward biases in the

[1] Kim et al. (1998) focus on the cost of external finance; Opler et al. (1999) emphasize asymmetric information in a broad sense; Pinkowitz and Williamson (2001) examine the influence of a bank-based versus a market-based economic environment; and Dittmar et al. (2003) analyse corporate governance issues.

observed speed of target convergence. It also strongly suggests that the slow observed speeds of adjustment in macro studies on money demand are artefacts of aggregation bias.[2]

The plan of the paper is as follows. Section 2 provides a theoretical exposition of the determinants of firm-level liquidity holdings. Informational problems between firms and capital markets feature prominently in this discussion. Section 3 presents the data and illustrates the development over time and the dispersion across firms and sectors of corporate liquidity holdings. In section 4 we analyse liquidity adjustment in two steps. In the first step we construct the liquidity targets and in the second step we examine the rate of convergence towards these targets from out-of-equilibrium positions. Section 5 concludes.

2 The determinants of corporate liquidity

We start with an outline of what drives firm-level liquidity holdings. In this respect, we first discuss the determinants of optimal corporate holdings of liquid assets, being transaction costs, opportunity costs and informational asymmetries. Together these factors yield an optimum liquidity level or ratio, which we label the static trade off level, following Opler et al. (1999). Subsequently, we turn to another branch of the literature, where liquidity holdings are assumed to take the back seat when other financial decisions are taken in the firm. Such passive adjustment of corporate liquidity holdings may reflect pecking order behaviour in finance and the absence of any actively pursued liquidity target, but also it may reflect the buffer stock property of liquidity in the short-run only and a longer-term return to a target.

Transaction and opportunity costs

The presence of positive transaction costs alone is sufficient to create a positive demand for liquidity. With zero opportunity costs, optimal holdings of corporate liquidity are unbounded. When opportunity costs are positive, however, firms will economize on liquidity holdings. Transaction and opportunity costs together then determine a positive and finite optimal amount of corporate liquidity holdings. In applied work, often used variables to capture the transaction

[2] As such our lesson in aggregation corroborates with the case made in for instance the inventory investment literature. See for example Bivin (1994) for a theoretical model and Seitz (1993) for supportive evidence on German micro-data in this regard.

motive are sales (in an inventory approach) or assets (in a Keynesian or portfolio framework). A benchmark interest rate then is generally assumed to account for the opportunity cost of holding liquid assets. More generally, all relevant substitutes for liquidity like for instance net working capital and minority holdings in other firms may need to be taken into account.

In addition, a precautionary demand for money may exist. One argument is the expectation of future investment opportunities. A second argument concerns uncertainty regarding future cash inflows and outflows. In particular, firms characterised by a more volatile cash flow history will desire a larger precautionary stock of liquidity. Third, firms with large amounts of short term debt possibly face a larger degree of refinancing uncertainty (Holmström and Tirole (2000)). This last factor is closely related to the informational motives for holding liquidity. The relation stems from the fact that refinancing becomes more uncertain when there is a possibility that future debt rollovers are denied. We turn to this issue now.

Informational problems

According to Holmström and Tirole (1998), asymmetric information problems between firms and financial markets raise the difficulty and cost of obtaining external finance and hence create a (precautionary) demand for corporate liquidity.[3] De Haan et al. (1992) find supportive evidence for this hypothesis examining Dutch corporate liquidity holdings through a survey questionnaire. We label this effect the informational cost of external finance. It can occur through firm specific characteristics, but also through sector and time specific factors.

An example of a firm-specific characteristic is the amount of leverage. In general, higher leverage increases moral hazard and thus the marginal cost of debt, see Freixas and Rochet (1997) and Hubbard (1998). With higher leverage, a firm then faces a higher degree of uncertainty regarding future access to debt financing and desires higher precautionary liquidity holdings.[4] This theoretical consideration is in line with empirical findings of De Haan (1997) and Van Ees et al. (1998) who, for a sample of Dutch firms, find that a debt-constraint augmented model of investment outperforms a neo-classical specification. Another example is the

[3] Firms with the most severe information problems may also face greater problems acquiring long-term debt and instead need to rely on less favourable short-term debt à la Diamond (1991a), which by itself stimulates a higher precautionary demand for liquidity (Holmström and Tirole (2000)).

[4] Myers and Rajan (1998) on the other hand suggest that higher liquidity may worsen the information problem rather than cure it. In that case, the cost of external finance may increase in liquidity holdings.

informational sensitivity of a firm's activities. Investment in research and development (R&D), for instance, is likely to be subject to stronger asymmetries in information than investment in manufacturing plants and equipment (e.g. Opler et al. (1999)).

Sector and time specific factors may add to this. Investments in the ICT sector may be more sensitive to asymmetric information than investments in the manufacturing sector (cf. Chirinko and Schaller (1995); Weigand and Audretsch (1999)). Similarly, investments in recessions may exhibit a higher informational sensitivity compared to investments in booms (cf. Calomiris et al. (1994)).

Another form of informational asymmetries potentially affecting liquidity holdings arises from the existence of agency problems between management and owners of a firm (cf. Grossman and Hart (1983)). Managers may value corporate liquidity more than owners and thus desire higher liquidity targets for a number of reasons. First, management may be overly concerned with liquidation risk, whereas shareholders can more easily diversify and so reduce the impact of a single bankruptcy on their portfolio return. Shareholders therefore likely put more emphasis on profits and hence prefer lower levels of precautionary liquidity. Second, managers may be empire builders rather than profit maximisers. Empire builders value projects that add to the size of the firm without necessarily being profitable. As the market does not value such projects, empire builders prefer a precautionary amount of liquidity that allows them to exploit empire building investment opportunities.[5] Third, management may also value liquidity more than shareholders do simply because it can be freely spent on perquisites, see Jensen (1986). In line with this, Dittmar et al. (2003) empirically demonstrate that in economic environments with low power for the owners of the firm, the firm's management will hold more cash.

Corporate liquidity holdings will therefore generally increase with managerial discretion. The costs of managerial discretion will be lower, the more a firm is subject to monitoring and the disciplining forces of the (capital) markets. To the extent that relationships with financial intermediaries induce information production and monitoring activities (cf. Diamond (1984), (1991b)), managerial discretion is limited and corporate liquidity holdings will be reduced.[6] Thus we may expect that higher leverage leads to lower levels of liquidity through the monitoring

[5] See Freixas and Rochet (1997, particularly pp. 125-129).

[6] Other factors may impact on managerial discretion as well. Dispersed ownership, size of the firm and charter amendments may act as takeover deterrents. This lowers capital market discipline and therefore, all else equal, raises corporate liquidity holdings.

channel. Moreover, strong bank relations may cause a firm to feel comfortable with lower levels of precautionary liquidity simply because banks are critical providers of liquidity especially when the market develops unfavourably (e.g. Saidenberg and Strahan (1999)).[7] On the other hand, Macey and Miller (1997) hypothesize that banks may try to reduce corporate risk taking and desire the firm to hold high levels of precautionary liquidity. Hence a bank-based system – as is the Dutch one – may stimulate large holdings of corporate liquidity. Pinkowitz and Williamson (2001) document empirical support for this hypothesis in the case of Japan and to a lesser extent for Germany.

Passive adjustment and buffer stock liquidity

In contrast to the static trade off view on corporate liquidity demand is the view where liquidity is passively drifting along on the waves of fortune of the firm. In this passive adjustment view on corporate liquidity holdings, firms care little about the amount of liquidity that is reported in their balance sheets. Effectively, therefore, corporate liquidity holdings are in the back seat when the firms decides for instance on its optimal capital structure or its dividend payout rate. While such a view is not directly following from for example the strict pecking order theory – which focuses on the passive adjustment of capital structure in general and net debt in particular (e.g. Myers and Majluf (1984)) – it is consistent with such theory.[8] Pecking order behaviour in its most extreme form implies that firms extract all expenses (investment in fixed assets and working capital, debt repayments, dividend payments, and so on) in excess of revenues (cash flow, new debt, sale of fixed assets or working capital) from stocks of liquid assets before turning to external sources of funding.[9] De Haan and Hinloopen (2003) present evidence that suggests that

[7] This argument counteracts the earlier hypothesis that higher leverage leads to higher liquidity holdings due to refinancing uncertainty (cf. Holmström and Tirole (1997)). However, we note that the monitoring and information production effects stemming from long term debt are probably larger than those stemming from short maturities (e.g. Diamond (1991a); Freixas and Rochet (1997)) so that our earlier conjecture remains unambiguous when related to short-term debt.

[8] In theory, liquidity targets may also be absent if a firm has an optimal capital structure which is cast in the form of a net debt target, see Opler et al. (1999).

[9] Nevertheless, even among the supporters of the pecking order theory it is recognized that "*slack* [i.e. liquidity] *has value*" (Myers and Majluf (1984), p. 195). At the same time, the realization that slack has value does not imply that the basic pecking order story includes active management of corporate liquidity holdings. Specifically, Myers (1984) states that whenever internally-generated cash flow is less than investment outlays "*the firm first draws down its cash balance or marketable securities portfolio.* [When] *it is more, the firm first pays off debt or invests in cash or marketable securities*" (Myers (1984), p. 581). Thus liquidity holdings adjust passively to the discrepancy between cash inflows and (investment) expenditures.

pecking order arguments are relevant determinants of Dutch corporate capital structure adjustments.

Closely related to this concept is the theory of buffer stock liquidity (e.g. Carr and Darby (1981)). According to the latter, firms may initially choose to let their liquidity holdings absorb any shocks, while only in the longer term trying to return to an optimal level of corporate liquidity. Note that buffer stock liquidity does not necessarily assume that firms are unaware of the benefits and costs of corporate liquidity. A sufficient condition is that the firm stresses other financial targets more than it does liquidity holdings, at least in the short run. De Haan et al. (1994) find that for Dutch firms corporate liquidity holdings exhibit distinct elements of a buffer stock approach while at the same time elements of pecking order behaviour characterize capital structure adjustment.

Summarizing the above, we conclude that an exclusive focus on short-run liquidity adjustment to shocks only is insufficient to distinguish between the absence and presence of long-run liquidity targets. This problem arises due to the observational equivalence in the short-run between buffer stock adjustment on the one hand and pure passive liquidity adjustment on the other. Consequently, we first need a characterization of equilibrium liquidity holdings in the long run. Subsequently, we can assess the short-term adjustment processes towards the long-run targets.

3 Data and variable definition

Data structure

The data used for the empirical testing of our corporate liquidity holdings framework is derived from Statistics Netherlands' data on the Finances of Large Firms (SFGO) covering the period 1977-1997. The SFGO provides company specific financial information at the level of balance sheet and income statement items for all large Dutch non-financial firms.[10] On an annual basis, the data cover 80 to 90 percent of the population. Occasionally, firms do not report in a given

[10] The size requirement for inclusion in the SFGO is a balance sheet length of at least 20 million Dutch guilders. Furthermore, Statistics Netherlands removes from a firm's financial statements any impact that financial segments have. Unfortunately, the data do not record which firms contain such financial segments. Otherwise, we might have exploited this information as a proxy for the ease with which firms can exploit internal capital markets, mitigating the need for precautionary liquidity (e.g. Bruinshoofd et al. (2002)).

year so that missing data entries arise. We only include firms for which no missing data are observed.[11]

In the early years, the number of firms on which Statistics Netherlands reports is quite small. Moreover, data then only cover the manufacturing sector. Data on the services sector start becoming available in 1983 and coverage increases substantially in the first years after. Therefore, we construct one balanced panel that runs from 1986 to 1997 and contains 453 firms, of which 197 are manufacturing firms and 182 are services firms.[12] We refer to this panel as *Panel1*. Given the number of firms and their distribution over a wide variety of economic sectors, this panel is particularly suited to identify cross-sectional variation in corporate liquidity holdings. The expense lies in its relatively short time dimension, which might affect results obtained in the analysis of corporate liquidity dynamics, where the time series emphasis is strongest. To check the robustness of our results in that regard, we construct a second balanced panel that exploits fully the time dimension offered in the SFGO. It runs from 1977 to 1997 and contains 84 firms, all of which are in manufacturing sectors. We refer to this panel as *Panel2*.

Variable definition and descriptive statistics

Figure 1 shows the development of Dutch firm-level liquidity ratios across sectors and over time. A few features catch the eye. First, the median liquidity ratio in *Panel1* (figure 1(A)) falls steadily over time, from roughly 5.5 per cent in 1986 to about 3.5 percent in 1997. From figures 1(B) to 1(D) we note that manufacturing and miscellaneous firms contribute most to this decrease in liquidity holdings, while for services firms the ratio remains more or less constant

[11] In some cases, firms may leave due to financial distress raising the issue of survivorship bias or because they drop below the threshold level of assets. However, in many other cases firms don't leave but simply do not report their financial statements to SFGO in one or more years after which they return. We are unable to distinguish between these different cases. Survivorship bias does not appear to be the major reason though.

[12] Manufacturing firms are those in sectors II (Foods and goodies industries, SBI93 15, 16), III (Petrochemical industry, SBI93 23), IV (Chemical, rubber and synthetic materials producing industries, SBI93 24, 25), V (Metals, machines and transports producing industries, SBI93 27-35) and VI (Other industries, SBI93 17-22, 26, 36, 37). Services firms are those in sectors IX (Wholesale and retail trade, SBI93 50-52), X (Hotel and catering industry, SBI93 55), XI (Transportation, storage and communication, SBI93 60-64) and XII (Real estate, personal property and commercial services, SBI93 70-74). Miscellaneous firms are in sectors I (Agriculture, fishery and minerals, SBI93 1-14), VIII (Construction industry, SBI93 45) and XIII (Public services, education, health care and miscellaneous services, SBI93 75-93). Utilities firms (sector VII, SBI93 40, 41) are not included in the analysis.

over time.[13] In addition, we observe the high levels of liquidity holdings of the miscellaneous firms as well as the strong dispersion of liquidity holdings across firms in all the figures. Specifically this dispersion across firms is a feature of liquidity holdings that is unobservable in aggregated data. Second, the movement of the median liquidity ratio in *Panel2* (figure 1(E)) also exhibits the downward trend in the late eighties and nineties, but suggests that this may simply be a return to average following the substantial increase in corporate liquidity holdings in the early eighties up to 1987.[14] Figure 1(F) compares the median liquidity ratios from the figures 1(A)-(E).[15] It shows that the downward trend over the common sample period 1986-1997 is similar for *Panel1* and *Panel2*. In addition, the manufacturing firms in *Panel2* typically have higher median liquidity ratios than their counterparts in the shorter *Panel1*. Survivorship effects may account for this observation. Third, we see that the median Dutch corporate liquidity ratio fluctuates between 2 and 6 percent, whereas Opler et al. (1999) and Pinkowitz and Williamson (2001) report a median corporate liquidity ratio of 6 to 6.5 percent for US firms. This observation is slightly surprising because the Netherlands is a country with a predominantly bank-based financial system in combination with low shareholder rights. In the literature both features are associated with high liquidity holdings (see Pinkowitz and Williamson (2001) and Dittmar et al. (2003)). A potential explanation for our finding may be the fact that our sample consists of large firms only.

For the remainder of this analysis, *liquidity* refers to the log of holdings of liquid assets (cash, short term investments, term deposits and demand deposits) as a fraction of total assets less liquid assets. Table 1 provides descriptive statistics for *Panel1* on liquidity holdings, asset structure (*size*, *net working capital, near liquidity*), liability structure (*total debt* and *short debt*), flow of funds characteristics (*investment, return on assets*, *earnings uncertainty*[16]), and the opportunity cost of holding liquidity (*effective interest rate*). We refer to the table for the exact definition of the variables and to the next section for a discussion of their linkage with the

[13] A potential reason for the relatively high liquidity ratios of services firms is their stronger intangibility of assets. However, Chirinko and Schaller (1995) suggest that the specificity of manufacturing assets more than offsets their lower intangibility. This would lead us to expect manufacturing firms to have the higher liquidity ratios.
[14] Note that the national liquidity ratio had been on a rising trend since the early 1980s and was perceived as being excessively high in the late 1980s (e.g. Kuipers and Boertje (1988); De Haan et al. (1992), (1994)).
[15] Excluding the one for the 74 miscellaneous firms for expositional clarity.
[16] The construction of *earnings uncertainty* as a rolling five-year standard deviation results in a loss of data points (453 times the first 5 *return on assets* observations per firm equals 2265 data points). We have limited this loss by adding *return on assets* information for the years 1981-1986 when available, conserving 1558 data points.

theoretical arguments on corporate liquidity management. Note that throughout the paper variable names are in italics.

4 Estimation results

To integrate the long-run and short-run analysis of corporate liquidity holdings, we hypothesize an error-correction specification of liquidity. In such a specification, the dynamics of liquidity are determined by various short-run shocks in addition to attempts to drive the actual liquidity level to the desired long-run (static trade off) level. We start, therefore, with an empirical investigation of the long-run determinants of corporate liquidity to arrive at measures of long-run corporate liquidity targets. The two-step procedure also allows us to consider unobserved firm specific factors in these targets and their impact on restricted error correction. We need this measure of unobserved heterogeneity to illustrate the relevance of aggregation bias in the analysis of corporate liquidity holdings.

Computing firm-level corporate liquidity targets

Table 1 already contains statistical information about the long-run characteristics of the different series used. Specifically, in the last column of table 1 the order of integration of the variables is indicated. *Liquidity* is shown to be *I(1)*, implying that the long-run level of *liquidity* is nonstationary. Consequently, the long-run determinants of *liquidity* should be nonstationary as well. The table shows that *size*, *near liquidity*, *total debt*, *short debt*, *effective interest rate* and *earnings uncertainty* all obey this condition and therefore are potential long-run determinants of *liquidity*. In contrast, *net working capital*, *investment* and *return on assets*[17] are all *I(0)*.

Direct estimates of long-run liquidity targets result from equation (1) where *liquidity* (*y*) is regressed on determinants x_{it} and firm specific effects η_i. υ_{it} is white noise. x_{it} includes a constant, time and sector dummies and the potential long-run determinants listed above plus *return on assets*:[18]

[17] *Return on assets* is essentially a measure of cash flow. It differs from the cash flow variable in Opler et al. (1999), Pinkowitz and Williamson (2001) and Dittmar et al. (2003) in that it assesses earnings *after* depreciation, but *before* dividends.

[18] *Return on assets* is included despite its *I(0)* character both because of the limited power of unit root tests in short

(1) $$y_{it} = \beta_n^{'} x_{it} + \eta_i + \upsilon_{it} .$$

Based on equation (1) we distinguish three different types of targets. In the subsequent analysis we compare the rates of target adjustment across target definitions. First, we define as the 'sophisticated' liquidity targets the predicted values from the estimated equation (1), $\hat{y}_{it}^{sophisticated} = \hat{\beta}_n^{'} x_{it}$. We argue that the precision of the estimated sophisticated liquidity targets improves if more relevant information regarding firm-level liquidity targets is included in x_{it} . We therefore vary the extent to which sector-specific features of liquidity targets are controlled for. Specifically, we compute sophisticated targets at a high (no sector dummies in equation (1)), a medium (1-digit sector dummies included), or a low (2-digit sector dummies included) level of aggregation.

Our sophisticated liquidity targets may nevertheless leave considerable unobserved heterogeneity in long-run firm-level liquidity levels. Although our sophisticated targets computed at the medium and low levels of aggregation may pick up some of this otherwise unobserved heterogeneity through the inclusion of sector dummies, even they likely do not capture all the firm-specific considerations in the liquidity decision. Such firm-specific considerations may refer to elements in (precautionary) liquidity demand not captured by our explanatory variables. We do not control, for instance, for the ownership structure of the firm or the extent to which the firm has access to emergency lines of credit. Especially the part of liquidity targets that is motivated by firm-specific information problems may remain opaque.

Within the main theme of this paper, if we fail to provide accurate measures of corporate liquidity targets, we cannot hope to see firms converging rapidly towards these targets. Therefore, we construct a separate set of 'specific' targets that takes account of remaining unobserved heterogeneity in liquidity holdings. Hence we define the specific targets as

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panels (e.g. Baltagi and Kao (2000)) and because of its general presence in the literature as explanatory variable for liquidity holdings (e.g. Opler et al. (1999)). Alternatively, we have computed all the adjustment results while excluding *return on assets* as a long-run determinant of *liquidity*. Then short-run shocks to liquidity holdings follow from the level of *return on assets*. The results are qualitatively similar. *Net working capital* and *investment* were treated similarly, but lacked statistical significance in the long-run equation.

$\hat{y}_{it}^{specific} = \hat{y}_{it}^{sophisticated} + \hat{\eta}_i = \hat{\beta}_n' x_{it} + \hat{\eta}_i$. The role of $\hat{\eta}_i$ in the firm-specific target is to capture all firm-specific motives feeding into optimal cash targets not captured by the sophisticated target. Note the resemblance of our approach with the way that debt targets have been computed in the capital structure literature (e.g. Auerbach (1985), Shyam-Sunder and Myers (1999)). As with the sophisticated targets, we compute specific targets at the high, medium, and low level of aggregation.

Lastly, we use simple historical averages of liquidity ratios as benchmark targets. Again, we compute these historical targets at a high, medium, and low level of aggregation.

Estimation results

Now we turn to the estimation results of equation (1), as presented in panel A of table 2. The odd-numbered columns in the table capture specifications of equation (1) without the *return on assets* among the explanatory variables, while the even-numbered columns include this variable. Furthermore, the specifications vary in terms of the level of sectoral aggregation reflected by the included sector dummies. For example, in columns (1) and (2) estimates of equation (1) include no sector dummies at all (high level of aggregation), while in columns (5) and (6) a sector dummy is included for each 2-digit sector (low level of aggregation).

Panel B of the table provides important information on these long-run sophisticated liquidity targets. First, the order of integration of the predicted values is 1, implying that our sophisticated liquidity targets are nonstationary. Since the residuals are shown to be *I(0)* and – recall from table 1 – *liquidity* is *I(1)*, we have indirect evidence that *liquidity* is cointegrated with our sophisticated targets.[19] Hence the use of an error correction framework to characterize corporate liquidity dynamics is justified.

Second, the degree of unobserved heterogeneity in liquidity holdings strongly depends on the aggregation level at which the targets have been computed. For example the $\overline{R}^2$ of the specified model in column (2), with targets computed at a high level of aggregation, nearly doubles when targets are computed at a low level of aggregation (column (6)). But even when

[19] The evidence is indirect, because it disregards for instance the cointegrating relationships that may exist among the explanatory variables. Direct, multivariate tests on cointegration, however, typically require $T \to \infty$ for consistency (e.g. Baltagi and Kao (2000)). Unit root tests on the specific target and residual respectively lead to the same conclusion as for their sophisticated counterparts: nonstationarity cannot be rejected for the target, while it can for the residual.

we compare the $\overline{R}^2$ in column (6) with that in column (4), with targets computed at a medium level of aggregation, the explanatory power of the former is larger by 21 percent. Panel C of the table demonstrates that this observation applies to all sub-samples of *Panel1* as well as to *Panel2*.

We now briefly discuss the estimated coefficients of the long-run liquidity equation. The *effective interest rate* and *earnings uncertainty* probably capture the direct costs and benefits of liquid assets holdings best. The results indicate that firms hold lower levels of *liquidity* – all else equal – when this is more costly to do so, whereas stronger earnings variation feeds into higher (precautionary) liquidity balances. *Size* in this regard captures any scale effect in liquidity management.[20] The negative parameter estimate shows that *liquidity* tends to increase less than one for one with *size*. This scale effect seems to pick up sector-specific motives to hold *liquidity*, however, as it all but disappears when sector-dummies are included in the model (columns (3) and onwards). Estimates for the manufacturing, services, and miscellaneous firms separately – presented in appendix 2, table A1 – show that services firms are particularly sensitive to these direct motives to hold liquid assets.

Informational aspects of the corporate liquidity decision are empirically captured by *total debt* and *short debt*, representing the impact of leverage and debt maturity structure. Holding constant the effective cost of debt, larger *total debt* implies lower *liquidity*. This observation supports the theoretical argument that leverage captures creditors' monitoring efforts (cf. Diamond (1991b)) which may directly and indirectly reduce corporate liquidity holdings.[21] Through the direct channel, monitoring reduces managerial discretion and hence lowers *liquidity*. Indirectly, monitoring may reduce information asymmetries and hence lower the risk premium on external finance, which reduces the corporate demand for precautionary liquidity.[22] This leverage effect is conditional on the maturity structure, captured by the short term debt share in

[20] The long-run relevance of liquidity substitutes has been explored by including *near liquidity*. We find no statistical evidence that this variable explains variations in liquidity holdings. One explanation is that inventories are actively managed themselves (see Seitz (1993) for evidence for German firms). Then, inventories – which make up part of *near liquidity* – cannot accommodate long-run swings in liquidity holdings.

[21] The informational cost of external finance view predicts that higher leverage raises, rather than lowers, the risk premium on external finance since higher leverage implies that firms are closer to their debt capacities. This effect, if present, should be largely captured by the *effective interest rate* in our model.

[22] Two additional explanations suggest that higher leverage ratios indicate better historical access to debt and hence a reduced precautionary liquidity motive and/or self-restraining management that prefers not to concern its creditors with high levels of liquidity when leverage is high as well (cf. Myers and Rajan (1998)).

total debt (*short debt*). Its positive parameter estimate implies that for any given level of *total debt*, a lower average maturity (. higher *short debt*) increases *liquidity*. This effect lies probably closest to the refinancing uncertainty that we conjectured to impact on the informational cost of external finance.[23] The results in appendix 2, table A1 show that manufacturing firms are particularly sensitive to *total debt* (and the *effective interest rate*, for that matter) in specifying their optimal liquidity holdings, though the maturity structure seems to matter little. This conclusion applies to manufacturing firms in *Panel1* (panel A of table A1) as well as those in the longer *Panel2* (panel D of table A1).

Lastly, each specification of equation (1) is estimated both with and without *return on assets*. The estimation results demonstrate that *return on assets* is an important determinant of *liquidity* holdings, which corroborates with for example Opler et al. (1999), Pinkowitz and Williamson (2001), and Dittmar et al. (2003). In terms of economic importance, we observe from the estimation results in table 2 and the descriptive statistics in table 1 that an increase in *return on assets* from the 25th percentile to the 75th percentile boosts *liquidity* (evaluated at the median) by more than 1.5 percentage points.

Table 3 summarizes the differences in target variation and unexplained variation across the three types of targets and three levels of aggregation. Comparing the sophisticated targets with simple historical targets we observe from the table that the former exhibits larger variance in target levels and lower variance in the unexplained part ($\hat{\eta}_i + \hat{\varepsilon}_{it}$) of liquidity holdings. Hence our time-varying sophisticated targets are better equipped to capture cross-sectional variation in liquidity holdings than are historical targets. It also follows from table 3 that target variation strongly increases when moving from sophisticated targets towards specific targets. For the specific targets the unexplained variance now only consists of variance in $\hat{\varepsilon}_{it}$, whereas the variance of $\hat{\eta}_i$ is included in the target variance. Similarly, the lower the level of aggregation at which historical and sophisticated targets have been computed, the larger is the target variance and the smaller the unexplained variance. For specific targets this observation does not hold, as these targets essentially include firm-level effects at all levels of aggregation.

[23] Note that increases in the level of short and long term debt alike have a negative impact on liquidity holdings. For an increase in long term debt, through a higher *total debt* and lower *short debt*, this effect is unambiguous. For an increase in short term debt, via a negative effect through *total debt* and a positive effect through *short debt*, this result holds at sample means and given the parameter estimates in table 2.

Target adjustment

The practical importance of corporate liquidity targets ultimately follows from the speed of adjustment towards these targets from out-of-equilibrium positions. For the remainder of this section, we therefore shift attention to the short-run dynamics of corporate liquidity holdings.

Within our error correction specification, various short-run shocks affect liquidity holdings. When the net effect of these shocks is to push liquidity holdings away from targeted levels, firms have incentives to adjust liquidity back towards targets in subsequent years. Hence our dynamic liquidity equation looks as follows:

$$\Delta y_{it} = \beta_d^{'} x_{it}^d + \gamma_z \hat{a}_{i,t-1}^z + \upsilon_{it}^d , \tag{2}$$

where Δy_{it} denotes $y_{it} - y_{i,t-1}$ and y again represents *liquidity*. Short-run pressure on liquidity holdings is partly captured by the explained part $\beta_d^{'} x_{it}^d$, with x_{it}^d a vector of explanatory variables, containing for example changes in the long-run *liquidity* determinants as well as earnings and expenditure shocks. In addition, there is an unexplained part υ_{it}^d to liquidity shocks, which is white noise. Last but not least, $\hat{a}_{i,t-1}^z$ captures adjustment incentives in the form of start-of-year deviations from long-run targets. Here $z \in \{historical, sophisticated, specific\}$ indicates that the *historical*, *sophisticated*, or *specific* targets have been used to compute the adjustment incentive. The speed of adjustment towards the long-run target is represented by γ_z.[24]

Table 4 presents the estimation results.[25] Panel A of the table displays estimates of equation (2) for *Panel1*. In columns (1) – (3) the *historical*, *sophisticated*, and *specific* targets have been imposed alternately to compute the target deviations, but the level of aggregation in specifying the targets – defined as in table 3 – is kept constant at the high level. Columns (4) –

[24] Dynamic stability requires $\gamma_z < 0$.

[25] We discuss the restricted error correction estimates only. We have also estimated unrestricted versions of equation (2) where lags of all long-run determinants of liquidity targets are included separately. The implied long-run coefficients from unrestricted estimation are broadly similar to the direct estimates of long-run liquidity determinants as presented in table 2. Moreover, the resulting estimates on short-run dynamics are very similar to those obtained from the restricted estimation presented in table 4. Adding lagged liquidity also does not affect the results much.

(6) and (7) – (9) are similar, but the level of aggregation in specifying the targets is medium and low, respectively. Since the focus in the analysis of dynamic *liquidity* is on target adjustment, we will postpone the discussion on the x^d included in the model and turn to the estimated γ_z first.

Comparing the adjustment towards *historical* targets with the adjustment towards *sophisticated* targets, we note that at all levels of aggregation there is a somewhat faster rate of convergence on *sophisticated* targets. Furthermore, for *historical* and *sophisticated* targets we observe clear differences in the rate of convergence associated with the level of aggregation. Specifically, there is faster convergence towards targets that have been computed at lower levels of aggregation. Although these convergence differentials are statistically significant, they are not economically so. For any deviation from *sophisticated* targets about 58 percent persists for more than 2 years using the high level of aggregation in constructing the targets, while the comparable number using the low level of aggregation is 52 percent. In that regard the rate of convergence implied by these estimates is quite low. Two explanations of this result are possible. Assuming the long-run targets are measured accurately, the observed speed of adjustment suggests that these targets do not play a very important role in a firm's liquidity management. As a corollary, it suggests that actual liquidity developments over periods of several years may resemble the picture that would emerge under passive adjustment behaviour.[26] Alternatively, the targets may be measured inappropriately, for instance because the *historical* and *sophisticated* targets neglect the unspecified parts of firms' targets as captured by the firm specific effects. These are included in the *specific* targets to which we now turn.

Columns (3), (6), and (9) indeed show that the speed of adjustment increases considerably when we use *specific* liquidity targets. At all levels of aggregation, we now observe convergence at a rate of more than 60 percent per year. Similar results obtain in the subsamples of *Panel1* as well as in *Panel2* (refer to panel C of the table). The speed of adjustment implied by these estimates is quite fast, now only about 10 percent of a deviation persists for more than 2 years. In comparison with the *historical* and *sophisticated* target results, these findings stress the importance of micro-data analysis in the analysis of liquidity targets and especially target adjustment, since the error correction effort is likely to be seriously under-estimated when the data are analyzed at higher levels of aggregation. Here, the link with many macroeconomic

[26] Shyam-Sunder and Myers (1999) make a similar point for capital structure adjustment.

studies of money demand is easily made. There, an implausibly low speed of adjustment is often found as well, see for instance Goldfeld and Sichel (1990). Swamy et al. (1982) already suggest that aggregation problems may cause these results.

Of course, part of the unobserved heterogeneity in liquidity holdings, routinely included in the *specific* targets, may capture firms' structural inability to converge towards targets. This argument implies that our adjustment results using the deviations from *specific* targets are biased upwards. Putting it more strongly, if unobserved heterogeneity in liquidity holdings mainly captures inability to adjust, our convergence results are an artefact of the construction of the *specific* targets.

We do not think the bite of this argument is exactly that strong, though. First, given the inherent nature of liquidity, it is hard to motivate firm-specific deviations from optimal targets over a period of time of 12 years in *Panel1* by structural adjustment inability. A forteriori this argument holds for our *Panel2* results, which cover a period of 21 years. Second, we note that our *annual* liquidity adjustment results are qualitatively and quantitatively comparable to those obtained by Seitz (1993) for *quarterly* inventory investment adjustment. Since *liquidity* should be at least as easy to adjust as inventory investment, the absolute level of our annual adjustment speeds does not seem excessive. Even when we consider the speed of adjustment towards the *specific* targets as a strict upper bound, the differential with the adjustment speeds towards *historical* and *sophisticated* targets is sufficiently large to worry more about aggregation issues than the computation of the *specific* targets.

In addition to target adjustment, the dynamic specification allows for an investigation of the short-run driving forces of *liquidity*. The variables considered in this regard are *investment* as well as changes in *size*, *total debt*, *short debt*, *return on assets*, *earnings volatility*, *effective interest rate*, and *near liquidity*. The reported models result after removing insignificant coefficients. The collective significance of the omitted variables is summarized in the OV F-test statistics in panel B of table 4. For *Panel1* only changes in *return on assets*, *size* and the *effective interest rate* have a meaningful impact on *liquidity* dynamics. For *Panel2* this set additionally includes changes in *near liquidity* (see appendix 2, table A2).

Note first that by variable construction, the estimated impact of a change in *size* on the change in *liquidity* is an elasticity (all other estimated effects are semi-elasticities). The negative

parameter estimates in excess of unity indicate that changes in *size* cause more than proportional changes in *liquidity* in the opposite direction. This result implies scale economies in liquidity management and we know from the analysis of *liquidity* targets that it extends to the long run.

From the flow of funds variables, advocated as driving forces of *liquidity* dynamics by the passive adjustment and the buffer stock views, we find that changes in *return on assets* structurally incite changes in *liquidity*, but *investment* does not. Even for *return on assets* the absolute impact is only moderate when compared to its long-run effect. Using the estimation results in columns (3), (6), and (9), we obtain that a change in *return on assets* that equals the difference between the 25th and the 75th percentile increases liquidity holdings – evaluated at the median – by about 1.0 percentage point. Recall that the long-run effect of the same level shift in *return on assets* is to increase targets by more than 1.5 percentage points. Hence we do not find that firms are more passive in the short run in the sense that incoming funds are routinely stored in liquid form.

These results sharply contrast with the capital structure results obtained by Shyam-Sunder and Myers (1999). They find relatively slow target adjustment in combination with an almost one-to-one effect of flow-of-funds variables on changes in net or gross debt. Our results are just the opposite, with substantial target adjustment. The evidence thus suggests that liquidity and debt are far from perfect substitutes. Consequently, it throws doubt on the net debt hypothesis.

5 Conclusion

Macroeconomic studies on corporate money demand using stock-adjustment models typically find extremely low rates of adjustment of observed money holdings towards targeted levels. While this result may suggest that money holdings are not actively managed, it may also point towards aggregation problems. In this paper we argue that informational asymmetries between firms and financial markets motivate precautionary liquidity holdings that vary across firms. This makes the accurate measurement of corporate liquidity targets particularly troublesome in macroeconomic analyses. Within the main theme of this paper, if we fail to provide accurate measures of corporate liquidity targets, we cannot hope to see firms converging rapidly towards these targets. We therefore analyze liquidity management at the firm level and demonstrate that

meaningful rates of convergence of liquidity holdings towards targeted levels follow only when liquidity targets are specified accurately. Our findings are the following.

Our analysis confirms the existence of long-run liquidity targets at the corporate level. The targets are determined by a small set of economically plausible variables. The sign of the estimated coefficients is consistent with theory and earlier empirical literature.

Specifying liquidity targets as simple historical industrial sector averages associates with rates of annual target convergence that range from 20-24 percent. While this is faster than the adjustment speeds obtained from many macro-studies of money demand, it still suggests that the half-life time of a liquidity shock lies beyond 2 years. Nevertheless, aggregation effects are suggested by the observation that higher rates of target convergence are obtained when the historical average is constructed at higher-digit industrial sector levels.

Target convergence results improve to 24-28 percent annually when liquidity targets are constructed controlling for firm-level (financial) characteristics and well as year and industrial sector dummies. In this case, aggregation effects are suggested by the fact that rates of annual target convergence are highest when the industrial sector dummies are constructed at the highest-digit level available.

Alternatively, we take into account that a considerable part of the liquidity decision may remain opaque even after controlling for firm-level (financial) characteristics. Adjusting the liquidity targets accordingly to capture remaining unobservable heterogeneity across firms, we find plausibly high annual rates of target convergence exceeding 60 percent, well in excess of the 10-20 percent that is usually obtained in macro-studies. Our adjustment results thus lend credibility to the suspicion raised by Swamy et al. (1982) that aggregation issues are at the root of the implausibly slow adjustment observed from analyses using aggregated data. Hence we conclude – in contrast with the main results obtained from macroeconomic analyses – that corporate liquidity is an actively managed financial ratio that does not passively adjust to financial decisions taken elsewhere in the firm.

Since our results derive from a data set that includes only the largest Dutch firms, one may worry about their general applicability. There is some consensus that informational problems between firms and financial markets are at least as relevant for small firms as they are for large firms (e.g. van Ees et al. (1998)). Hence insofar as the accurate measurement of liquidity targets

in aggregated data is obscured by informational asymmetries, our conclusions apply likely to small firms at least with equal force.

Lastly, while we have focussed on the speed with which firms adjust liquidity holdings towards targeted levels and emphasized the role of the level of aggregation at which liquidity targets are computed therein, we did not consider the speed of adjustment as depending on whether firms are initially above or below their targets and/or whether the are initially close to or far removed from their targets. Nevertheless, such adjustment asymmetries raise yet another aggregation issue in corporate liquidity management. Namely at the aggregate level the adjustment of corporate liquidity holdings to shocks then depends on the initial distribution of the target deviations across firms and is possibly nonlinear as a result. We leave the analysis of adjustment asymmetries in corporate liquidity holdings as an area for future research.

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Appendix 1: The panel unit root test

For the assessment of the order of integration we evaluate the normalized least squares estimator of the autoregressive coefficient (φ) in $y_{it} = \varphi y_{i(t-1)} + \phi_{it}$. The error term, ϕ, may simply be white noise ($\phi = \varepsilon_{it}$), or it may contain firm-specific intercepts ($\phi^C = \alpha_i + \varepsilon_{it}$), possibly combined with a time trend ($\phi^{C,T} = \alpha_i + \delta_t + \varepsilon_{it}$). We test H_0: $\varphi = 1$ – at the 95% confidence level – versus the alternative H_a: $\varphi < 1$. Harris and Tzavalis (1999) demonstrate that:

for ϕ, $\quad \sqrt{N}\left(\hat{\varphi} - 1\right) \xrightarrow{w.c.} N\left(0, \frac{2}{T(T-1)}\right)$;

for ϕ^C, $\quad \sqrt{N}\left(\hat{\varphi} - 1 + \frac{3}{T+1}\right) \xrightarrow{w.c.} N\left(0, \frac{3(17T^2 - 20T + 17)}{5(T-1)(T+1)^3}\right)$;

for $\phi^{C,T}$, $\quad \sqrt{N}\left(\hat{\varphi} - 1 + \frac{15}{2(T+2)}\right) \xrightarrow{w.c.} N\left(0, \frac{15(193T^2 - 728T + 1147)}{112(T+2)^3(T-2)}\right)$;

where *w.c.* denotes weak convergence in distribution. The limiting distribution of this test is shown to be normal for $N > 100$ and T small relative to N, conditions satisfied by our data.[27]

In the analysis, when the unit root cannot be rejected while the test includes firm-specific intercepts and a time trend, we check for a unit root in the first-differenced series of the respective variable, excluding the time trend from the test. Similarly, when the unit root cannot be rejected while the test includes only firm-specific intercepts, we check for a unit root in the first-differenced series excluding also the firm-specific intercepts.

Appendix 2: Liquidity targets and target adjustment results for subsamples and *Panel2*

[INSERT TABLES A1 AND A2]

[27] We are aware of the debate in the literature regarding the validity of unit root computation for panel data. For elaboration on this issue, see for instance the survey by Baltagi and Kao (2000). We compute unit root test statistics using the Harris and Tzavalis (1999) technique; a choice that is motivated by the small *T* character of our panel.

Table 1
Descriptive statistics *Panel1*

Variable	# Obs.	25th percentile	Median	75th percentile	Standard deviation	Order of integration[1]
Liquidity ratio (%)	5436	0.88	4.42	15.80	28.77	$I(1)^{C,T}$
Liquidity	5436	-4.735	-3.120	-1.845	2.110	$I(1)^{C,T}$
Size	5436	10.839	11.532	12.529	1.343	$I(1)^{C,T}$
Net working capital	5436	-0.075	0.045	0.173	0.237	$I(0)^{C,T}$
Near liquidity	5436	0.328	0.503	0.653	0.228	$I(1)^{C,T}$
Total debt	5436	0.381	0.529	0.669	0.201	$I(1)^{C,T}$
Short debt	5436	0.625	0.845	0.999	0.229	$I(1)^{C,T}$
Investment	5436	0.028	0.058	0.105	0.073	$I(0)^{C,T}$
Return on assets	5436	0.021	0.054	0.096	0.099	$I(0)^{C,T}$
Earnings uncertainty	4729	0.018	0.030	0.050	0.035	$I(1)^{C,T}$
Effective interest rate	5436	0.018	0.041	0.064	0.115	$I(1)^{C,T}$

Notes: Liquidity ratio (%) is cash and marketable securities over net assets and *Liquidity* is its logarithm; net assets is total assets less cash and marketable securities; *Size* is the logarithm of net assets expressed in 1990 prices; *Net working capital* is the sum of short term claims, inventories and work in progress less short term debt to net assets; *Total debt* is defined as total debt over total assets; *Short debt* expresses short term debt as a fraction of the sum of short and long term debt; *Investment* is changes in tangible fixed assets due to purchase or production over net assets; *Return on assets* is earnings after depreciation, interest, taxes and extraordinary gains and losses, but before dividend payments to net assets; *Earnings uncertainty* is the firm-specific five-year rolling standard deviation of *Return on assets*; *Effective interest rate* is interest expenses as a fraction of total debt, excluding debts to subsidiary companies.

[1] We use I(0) and I(1) to signify that a series is integrated of order zero and one, respectively, using the Harris and Tzavalis (1999) test and a 95% level of confidence. The superscript C denotes that firm-specific intercepts have been included in the test; the superscript T denotes the inclusion of a common time trend. Also see appendix 1.

Table 2

Level estimates of corporate liquidity

PANEL A Estimation results *Panel1*						
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
Size	-0.056	-0.058	-0.011	-0.014	-0.018	-0.021
	(0.023)	(0.022)	(0.022)	(0.022)	(0.024)	(0.023)
Total debt	-1.772	-1.323	-2.089	-1.634	-2.161	-1.756
	(0.154)	(0.156)	(0.155)	(0.156)	(0.156)	(0.157)
Short debt	1.027	0.770	0.904	0.668	0.912	0.698
	(0.141)	(0.140)	(0.145)	(0.143)	(0.145)	(0.143)
Return on assets	-	4.455	-	4.389	-	4.108
		(0.345)		(0.333)		(0.330)
Effective interest rate	-1.706	-1.544	-1.481	-1.344	-1.313	-1.195
	(0.250)	(0.246)	(0.243)	(0.239)	(0.239)	(0.235)
Earnings uncertainty	3.727	2.184	3.746	2.206	2.874	1.341
	(0.864)	(0.858)	(0.857)	(0.850)	(0.855)	(0.851)
Constant term	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Sector dummies	NO	NO	1-digit	1-digit	2-digit	2-digit
PANEL B Summary statistics *Panel1*						
# firms	453	453	453	453	453	453
# observations	4729	4729	4729	4729	4729	4729
R^2-adjusted	0.083	0.115	0.153	0.183	0.196	0.221
Order of int. prediction[1]	$I(1)^{C,T}$	$I(1)^{C,T}$	$I(1)^{C,T}$	$I(1)^{C,T}$	$I(1)^{C,T}$	$I(1)^{C,T}$
St. dev. prediction	0.621	0.725	0.838	0.915	0.956	1.014
Order of int. residual[1]	$I(0)^{C}$	$I(0)^{C}$	$I(0)^{C}$	$I(0)^{C}$	$I(0)^{C}$	$I(0)^{C}$
St. dev. residual	2.018	1.984	1.938	1.904	1.883	1.853
PANEL C Summary results *Panel1* subsamples & *Panel2*						

Manufacturing firms						
# firms	197	197	197	197	197	197
R^2-adjusted	0.110	0.138	0.126	0.149	0.200	0.218
St. dev. prediction	0.755	0.823	0.812	0.877	1.024	1.066
St. dev. residual	2.080	2.054	2.059	2.032	1.962	1.940
Services firms						
# firms	182	182	182	182	182	182
R^2-adjusted	0.074	0.109	0.081	0.119	0.102	0.138
St. dev. prediction	0.559	0.671	0.586	0.701	0.658	0.756
St. dev. residual	1.875	1.838	1.867	1.827	1.843	1.805
Miscellaneous firms						
# firms	74	74	74	74	74	74
R^2-adjusted	0.226	0.254	0.284	0.316	0.312	0.337
St. dev. prediction	0.881	0.932	0.994	1.045	1.050	1.088
St. dev. residual	1.557	1.528	1.487	1.452	1.449	1.421
Panel2						
# firms	84	84	84	84	84	84
R^2-adjusted	0.105	0.166	0.167	0.212	0.253	0.300
St. dev. prediction	0.716	0.873	0.851	0.989	1.094	1.175
St. dev. residual	1.956	1.865	1.901	1.807	1.772	1.692

Notes: Fixed effects estimates of *Liquidity*. All variables are defined as before in table 1. Standard errors are robust to heteroskedasticity and reported in parentheses. The subsamples of *Panel1* (manufacturing, services and miscellaneous firms) are defined in footnote 12 of the text.

[1] We use I(0) and I(1) to signify that a series is integrated of order zero and one, respectively, using the Harris and Tzavalis (1999) test and a 95% level of confidence. The superscript C denotes that firm-specific intercepts have been included in the test; the superscript T denotes the inclusion of a common time trend. Also see appendix 1.

Table 3

Panel1 variance in targets and unexplained variance by target type and aggregation level

Level of aggregation		Type of target			# observations
		(1) Historical	(2) Sophisticated	(3) Specific	
High	Variance in targets	0.00	0.53	3.15	4729
	Unexplained variance	4.45	3.93	1.30	4729
Medium	Variance in targets	0.31	0.84	3.15	4729
	Unexplained variance	4.14	3.61	1.30	4729
Low	Variance in targets	0.55	1.03	3.15	4729
	Unexplained variance	3.90	3.42	1.30	4729

Notes: Historical targets are computed as the average observed liquidity holdings over the entire sample-period and the relevant level of aggregation. At the high level of aggregation, the historical target is sample average *liquidity*; at the medium level of aggregation it is average *liquidity* at the 1-digit sector level; at the low level of aggregation it is average *liquidity* at the 2-digit sector level. Sophisticated targets are the predicted values from the regressions reported in table 2, including *return on assets*. At the high level of aggregation, no sector dummies are included in the regression (column (2) of table 2); at the medium level of aggregation 1-digit sector dummies are included in the regression (column (4) of table 2); at the low level of aggregation 2-digit sector dummies are included in the regression (column (6) of table 2). Specific targets are constructed as sophisticated targets, but include the firm-specific error component.

Table 4

Target adjustment in corporate liquidity dynamics

PANEL A Estimation results *Panel1*									
Explanatory Variables	High level of aggregation			Medium level of aggregation			Low level of aggregation		
	(1) Historical	(2) Soph.	(3) Specific	(4) Historical	(5) Soph.	(6) Specific	(7) Historical	(8) Soph.	(9) Specific
Target deviation$_{t-1}$	-0.208	-0.237	-0.677	-0.225	-0.261	-0.678	-0.241	-0.276	-0.680
	(0.009)	(0.010)	(0.015)	(0.010)	(0.010)	(0.015)	(0.010)	(0.011)	(0.015)
ΔReturn on assets$_t$	1.654	2.145	2.768	1.640	2.178	2.771	1.637	2.182	2.699
	(0.247)	(0.245)	(0.214)	(0.246)	(0.244)	(0.213)	(0.245)	(0.242)	(0.213)
ΔSize$_t$	-1.371	-1.422	1.145	-1.363	-1.414	-1.147	-1.346	-1.405	-1.148
	(0.100)	(0.098)	(0.086)	(0.099)	(0.098)	(0.086)	(0.099)	(0.097)	(0.086)
ΔEffective interest rate$_t$	-0.329	-0.515	-0.737	-0.308	-0.479	-0.668	-0.302	-0.461	-0.618
	(0.219)	(0.218)	(0.189)	(0.218)	(0.216)	(0.189)	(0.217)	(0.215)	(0.188)
Constant term	YES	YES	YES	YES	YES	YES	YES	YES	YES
PANEL B Summary statistics *Panel1*									
# firms	453	453	453	453	453	453	453	453	453
# observations	4276	4276	4276	4276	4276	4276	4276	4276	4276
R^2-adjusted	0.161	0.175	0.379	0.170	0.188	0.380	0.177	0.195	0.381
OV F-test	1.52	0.89	1.08	1.76	1.15	1.17	1.88	1.23	1.22
PANEL C Summary results *Panel1* subsamples & *Panel2*									
Manufacturing									
Target deviation$_{t-1}$	-0.249	-0.282	-0.714	-0.259	-0.291	-0.715	-0.281	-0.316	-0.716
	(0.015)	(0.016)	(0.022)	(0.015)	(0.016)	(0.022)	(0.016)	(0.017)	(0.022)
# firms	197	197	197	197	197	197	197	197	197
R^2-adjusted	0.167	0.184	0.382	0.173	0.189	0.383	0.184	0.201	0.384
Services									
Target deviation$_{t-1}$	-0.198	-0.224	-0.649	-0.198	-0.225	-0.649	-0.201	-0.229	-0.650
	(0.015)	(0.016)	(0.023)	(0.015)	(0.016)	(0.023)	(0.015)	(0.016)	(0.023)
# firms	182	182	182	182	182	182	182	182	182
R^2-adjusted	0.180	0.193	0.388	0.180	0.194	0.389	0.182	0.196	0.390
Miscellaneous									
Target deviation$_{t-1}$	-0.167	-0.220	-0.588	-0.166	-0.234	-0.597	-0.190	-0.250	-0.604
	(0.022)	0.025	(0.034)	(0.022)	(0.025)	(0.034)	(0.023)	(0.026)	(0.034)
# firms	74	74	74	74	74	74	74	74	74
R^2-adjusted	0.151	0.178	0.363	0.151	0.184	0.370	0.163	0.194	0.372
Panel2									
Target deviation$_{t-1}$	-0.230	-0.272	-0.601	-0.250	-0.287	-0.606	-0.278	-0.329	-0.600
	(0.018)	(0.019)	(0.027)	(0.019)	(0.020)	(0.027)	(0.020)	(0.021)	(0.027)
# firms	84	84	84	84	84	84	84	84	84
R^2-adjusted	0.175	0.195	0.340	0.184	0.203	0.341	0.197	0.222	0.338

Notes: OLS estimates of Δ*Liquidity*, with Δ the first-difference operator. All specifications include a constant term. Standard errors are robust to heteroskedasticity and reported in parentheses. The subsamples of *Panel1* (manufacturing, services and miscellaneous firms) are defined in footnote 12 of the text. End-of-previous-period target deviations (*Target deviation*$_{t-1}$) are defined using the historical, sophisticated, or specific targets – including *Return on assets* – computed at the high, medium, or low level of aggregation. Target types and level of aggregation are defined as in table 3. All other variables are defined as before in table 1. The OV F-test evaluates the reported model against one that additionally includes *Investment*, *ΔTotal debt*, *ΔShort debt*, *ΔEarnings uncertainty*, and *ΔNear liquidity*. Significance at the 5 and 1 percent level is indicated by * and **, respectively.

Table A1

Level estimates of corporate liquidity for *Panel1* subsamples & *Panel2*

PANEL A Manufacturing firms						
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.051	0.040	0.083	0.071	0.128	0.118
	(0.033)	(0.033)	(0.034)	(0.033)	(0.035)	(0.035)
Total debt	-2.685	-2.274	-2.722	-2.298	-2.958	-2.572
	(0.286)	(0.288)	(0.285)	(0.287)	(0.277)	(0.279)
Short debt	0.047	-0.180	-0.064	-0.281	-0.184	-0.368
	(0.242)	(0.241)	(0.242)	(0.241)	(0.236)	(0.235)
Return on assets	-	3.857	-	3.926	-	3.579
		(0.528)		(0.524)		(0.509)
Effective interest rate	-4.549	-4.290	-4.175	-3.964	-3.786	-3.576
	(0.541)	(0.535)	(0.549)	(0.543)	(0.533)	(0.528)
Earnings uncertainty	3.481	2.264	2.581	1.202	0.906	-0.408
	(1.283)	(1.278)	(1.311)	(1.307)	(1.286)	(1.288)
Constant term	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Sector dummies	NO	NO	1-digit	1-digit	2-digit	2-digit
# firms	197	197	197	197	197	197
# observations	2135	2135	2135	2135	2135	2135
R^2-adjusted	0.110	0.138	0.126	0.126	0.200	0.218
PANEL B Services firms						
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
Size	-0.081	-0.076	-0.068	-0.061	-0.130	-0.122
	(0.037)	(0.036)	(0.037)	(0.036)	(0.038)	(0.037)
Total debt	-1.201	-0.778	-1.000	-0.527	-0.984	-0.548
	(0.214)	(0.216)	(0.219)	(0.221)	(0.225)	(0.226)
Short debt	0.886	0.715	1.226	1.104	1.466	1.326
	(0.198)	(0.195)	(0.216)	(0.212)	(0.218)	(0.214)
Return on assets	-	4.696	-	4.891	-	4.768
		(0.543)		(0.542)		(0.538)
Effective interest rate	-2.522	-2.242	-2.598	-2.320	-2.350	-2.095
	(0.612)	(0.601)	(0.613)	(0.601)	(0.608)	(0.596)
Earnings uncertainty	6.220	4.786	6.596	5.166	6.677	5.127
	(1.490)	(1.471)	(1.488)	(1.465)	(1.497)	(1.477)
Constant term	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Sector dummies	NO	NO	1-digit	1-digit	2-digit	2-digit
# firms	182	182	182	182	182	182
# observations	1856	1856	1856	1856	1856	1856
R^2-adjusted	0.074	0.109	0.081	0.119	0.102	0.138
PANEL C Miscellaneous firms						
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)

Size	-0.142	-0.125	-0.17	-0.154	-0.151	-0.146
	(0.054)	(0.053)	(0.054)	(0.053)	(0.059)	(0.058)
Total debt	-2.488	-2.249	-3.169	-2.926	-3.178	-3.001
	(0.324)	(0.322)	(0.340)	(0.335)	(0.354)	(0.349)
Short debt	2.103	1.723	1.725	1.211	1.489	1.087
	(0.299)	(0.302)	(0.313)	(0.318)	(0.325)	(0.328)
Return on assets	-	3.402	-	3.702	-	3.352
		(0.640)		(0.626)		(0.635)
Effective interest rate	-0.193	-0.164	-0.156	-0.151	-0.144	-0.142
	(0.254)	(0.249)	(0.246)	(0.240)	(0.242)	(0.237)
Earnings uncertainty	1.998	0.383	2.744	1.020	2.71	0.985
	(1.538)	(1.541)	(1.548)	(1.540)	(1.596)	(1.601)
Constant term	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Sector dummies	NO	NO	1-digit	1-digit	2-digit	2-digit
# firms	74	74	74	74	74	74
# observations	738	738	738	738	738	738
R^2-adjusted	0.226	0.254	0.284	0.316	0.312	0.337
PANEL D *Panel2*						
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)
Size	0.018	0.010	0.090	0.080	0.123	0.134
	(0.044)	(0.048)	(0.044)	(0.049)	(0.043)	(0.048)
Total debt	-3.253	-2.435	-3.303	-2.470	-3.824	-2.999
	(0.347)	(0.397)	(0.350)	(0.403)	(0.335)	(0.390)
Short debt	-0.115	-0.090	-0.516	-0.537	-0.314	-0.191
	(0.305)	(0.332)	(0.306)	(0.336)	(0.301)	(0.333)
Return on assets	-	4.461	-	4.537	-	3.973
		(0.665)		(0.652)		(0.636)
Effective interest rate	-3.231	-3.633	-2.364	-2.978	-1.621	-2.198
	(0.645)	(0.664)	(0.642)	(0.663)	(0.612)	(0.638)
Earnings uncertainty	-1.038	-1.759	-0.986	-2.242	-1.365	-2.567
	(1.615)	(1.707)	(1.657)	(1.777)	(1.596)	(1.714)
Constant term	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES
Sector dummies	NO	NO	1-digit	1-digit	2-digit	2-digit
# firms	84	84	84	84	84	84
# observations	1342	1342	1342	1342	1342	1342
R^2-adjusted	0.105	0.166	0.167	0.212	0.253	0.300

Notes: Fixed effects estimates of *Liquidity*. All variables are defined as before in table 1. Standard errors are robust to heteroskedasticity and reported in parentheses. The subsamples of *Panel1* (manufacturing, services and miscellaneous firms) are defined in footnote 12 of the text.

Table A2

Target adjustment in corporate liquidity dynamics for *Panel1* subsamples & *Panel2*

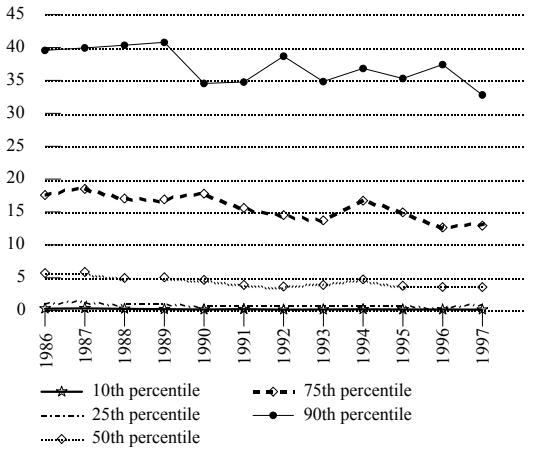
PANEL A Manufacturing firms									
Explanatory Variables	High level of aggregation			Medium level of aggregation			Low level of aggregation		
	(1) Historical	(2) Soph.	(3) Specific	(4) Historical	(5) Soph.	(6) Specific	(7) Historical	(8) Soph.	(9) Specific
Target deviation$_{t-1}$	-0.249	-0.282	-0.714	-0.259	-0.291	-0.715	-0.281	-0.316	-0.716
	(0.015)	(0.016)	(0.022)	(0.015)	(0.016)	(0.022)	(0.016)	(0.017)	(0.022)
ΔReturn on assets$_t$	1.939	2.534	3.247	1.935	2.546	3.324	1.938	2.567	3.132
	(0.418)	(0.415)	(0.362)	(0.416)	(0.413)	(0.362)	(0.414)	(0.410)	(0.361)
ΔSize$_t$	-1.228	-1.290	-0.855	-1.221	-1.291	-0.859	-1.190	-1.265	-0.867
	(0.168)	(0.166)	(0.146)	(0.168)	(0.166)	(0.146)	(0.167)	(0.165)	(0.146)
ΔEffective interest rate$_t$	-0.308	-0.482	-0.690	-0.302	-0.455	-0.616	-0.288	-0.426	-0.562
	(0.449)	(0.445)	(0.387)	(0.448)	(0.443)	(0.387)	(0.445)	(0.440)	(0.387)
Constant term	YES	YES	YES	YES	YES	YES	YES	YES	YES
# firms	197	197	197	197	197	197	197	197	197
# observations	1938	1938	1938	1938	1938	1938	1938	1938	1938
R^2-adjusted	0.167	0.184	0.382	0.173	0.189	0.383	0.184	0.201	0.384
OV F-test	1.83	1.35	0.33	1.85	1.28	0.33	2.04	1.37	0.39
PANEL B Services firms									
Explanatory Variables	High level of aggregation			Medium level of aggregation			Low level of aggregation		
	(1) Historical	(2) Soph.	(3) Specific	(4) Historical	(5) Soph.	(6) Specific	(7) Historical	(8) Soph.	(9) Specific
Target deviation$_{t-1}$	-0.198	-0.224	-0.649	-0.198	-0.225	-0.649	-0.201	-0.229	-0.650
	(0.015)	(0.016)	(0.023)	(0.015)	(0.016)	(0.023)	(0.015)	(0.016)	(0.023)
ΔReturn on assets$_t$	1,446	1.900	2.651	1.448	1.916	2.673	1.449	1.911	2.619
	(0.380)	(0.378)	(0.331)	(0.380)	(0.377)	(0.330)	(0.379)	(0.377)	(0.330)
ΔSize$_t$	-1.726	-1.754	-1.618	-1.725	-1.775	-1.622	-1.724	-1.765	-1.626
	(0.151)	(0.149)	(0.130)	(0.151)	(0.149)	(0.130)	(0.151)	(0.149)	(0.130)
ΔEffective interest rate$_t$	0.245	0.030	-0.449	0.245	0.050	-0.363	0.244	0.062	-0.308
	(0.504)	(0.500)	(0.436)	(0.504)	(0.500)	(0.436)	(0.503)	(0.499)	(0.435)
Constant term	YES	YES	YES	YES	YES	YES	YES	YES	YES
# firms	182	182	182	182	182	182	182	182	182
# observations	1674	1674	1674	1674	1674	1674	1674	1674	1674
R^2-adjusted	0.180	0.193	0.388	0.180	0.194	0.389	0.182	0.196	0.390
OV F-test	1.29	1.01	1.93	1.34	1.06	1.93	1.33	1.13	1.77
PANEL C Miscellaneous firms									
Explanatory Variables	High level of aggregation			Medium level of aggregation			Low level of aggregation		
	(1) Historical	(2) Soph.	(3) Specific	(4) Historical	(5) Soph.	(6) Specific	(7) Historical	(8) Soph.	(9) Specific
Target deviation$_{t-1}$	-0.167	-0.220	-0.588	-0.166	-0.234	-0.597	-0.190	-0.250	-0.604
	(0.022)	(0.025)	(0.034)	(0.022)	(0.025)	(0.034)	(0.023)	(0.026)	(0.034)
ΔReturn on assets$_t$	1.337	1.775	1.974	1.337	1.770	1.976	1.315	1.761	1.932
	(0.424)	(0.418)	(0.368)	(0.424)	(0.416)	(0.366)	(0.421)	(0.413)	(0.365)
ΔSize$_t$	-1.024	-1.085	-0.899	-1.036	-1.075	-0.890	-1.017	-1.062	-0.876
	(0.175)	(0.171)	(0.151)	(0.174)	(0.170)	(0.150)	(0.173)	(0.169)	(0.150)
ΔEffective interest rate$_t$	-0.487	-0.661	-0.802	-0.474	-0.622	-0.751	-0.469	-0.610	-0.712
	(0.487)	(0.229)	(0.202)	(0.232)	(0.228)	(0.200)	(0.230)	(0.226)	(0.200)
Constant term	YES	YES	YES	YES	YES	YES	YES	YES	YES
# firms	74	74	74	74	74	74	74	74	74
# observations	664	664	664	664	664	664	664	664	664
R^2-adjusted	0.151	0.178	0.363	0.151	0.184	0.370	0.163	0.194	0.372
OV F-test	1.64	1.69	1.48	1.65	1.73	1.52	1.58	1.74	1.77
PANEL D *Panel2*									

Explanatory Variables	High level of aggregation			Medium level of aggregation			Low level of aggregation		
	(1) Historical	(2) Soph.	(3) Specific	(4) Historical	(5) Soph.	(6) Specific	(7) Historical	(8) Soph.	(9) Specific
Target deviation$_{t-1}$	-0.230	-0.272	-0.601	-0.250	-0.287	-0.606	-0.278	-0.329	-0.600
	(0.018)	(0.019)	(0.027)	(0.019)	(0.020)	(0.027)	(0.020)	(0.021)	(0.027)
ΔReturn on assets$_t$	1.136	1.548	2.003	1.144	1.595	2.019	1.115	1.611	2.016
	(0.486)	(0.481)	(0.436)	(0.483)	(0.479)	(0.436)	(0.479)	(0.473)	(0.437)
ΔSize$_t$	-1.539	-1.577	-1.372	-1.519	-1.562	-1.331	-1.481	-1.508	-1.315
	(0.193)	(0.190)	(0.172)	(0.192)	(0.189)	(0.172)	(0.191)	(0.187)	(0.173)
ΔEffective interest rate$_t$	-0.679	-1.049	-1.578	-0.675	-0.975	-1.367	-0.678	-0.872	-1.116
	(0.450)	(0.445)	(0.404)	(0.448)	(0.443)	(0.403)	(0.444)	(0.437)	(0.404)
ΔNear liquidity$_t$	-1.164	-1.175	-1.187	-1.185	-1.235	-1.273	-1.185	-1.265	-1.290
	(0.491)	(0.484)	(0.439)	(0.488)	(0.482)	(0.438)	(0.484)	(0.477)	(0.440)
Constant term	YES	YES	YES	YES	YES	YES	YES	YES	YES
# firms	84	84	84	84	84	84	84	84	84
# observations	1258	1258	1258	1258	1258	1258	1258	1258	1258
R^2-adjusted	0.175	0.195	0.340	0.184	0.203	0.341	0.197	0.222	0.338
OV F-test	0.68	0.93	1.82	0.71	1.05	1.98	0.64	1.02	2.23

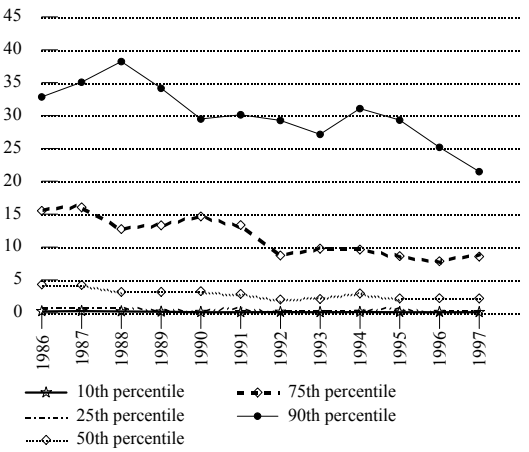
Notes: OLS estimates of Δ*Liquidity*, with Δ the first-difference operator. All specifications include a constant term. Standard errors are robust to heteroskedasticity and reported in parentheses. The subsamples of *Panel1* (manufacturing, services and miscellaneous firms) are defined in footnote 12 of the text. End-of-previous-period target deviations (*Target deviation*$_{t-1}$) are defined using the historical, sophisticated, or specific targets – including *Return on assets* – computed at the high, medium, or low level of aggregation. Target types and level of aggregation are defined as in table 3. All other variables are defined as before in table 1. The OV F-test evaluates the reported model against one that includes *Target deviation*$_{t-1}$, *ΔReturn on assets*$_t$, *Investment*$_t$, *ΔSize*$_t$, *ΔEffective interest rate*$_t$, *ΔTotal debt*$_t$, *ΔShort debt*$_t$, *ΔEarnings uncertainty*$_t$, and *ΔNear liquidity*$_t$. Significance at the 5 and 1 percent level is indicated by * and **, respectively.

Figure 1 Dutch corporate liquidity ratios (%)

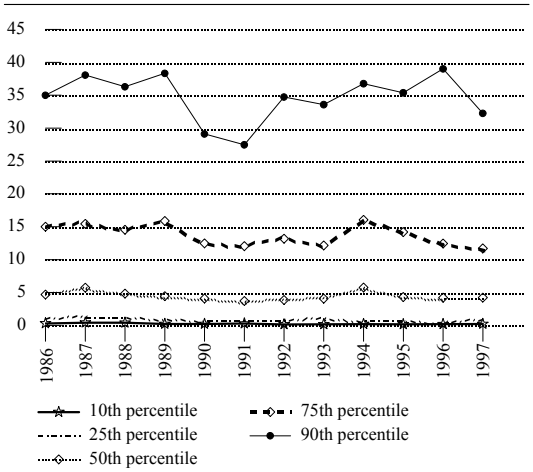
(A) *Panel 1*



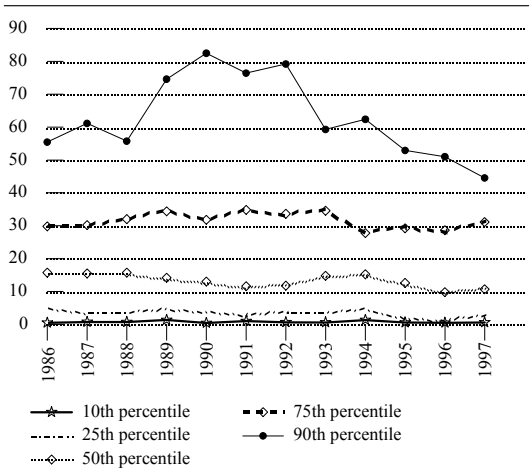
(B) *Panel 1*, manufacturing firms



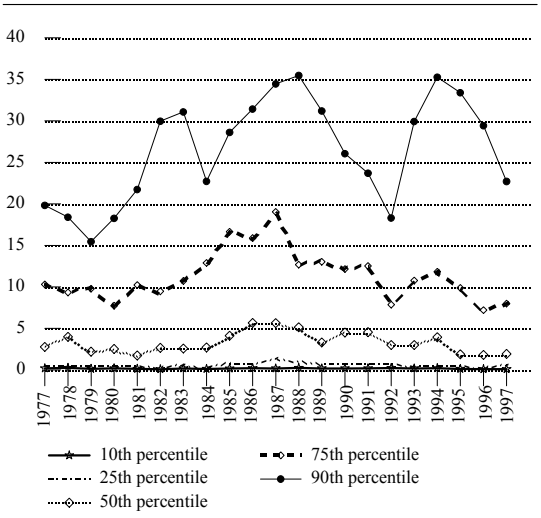
(C) *Panel 1*, services firms



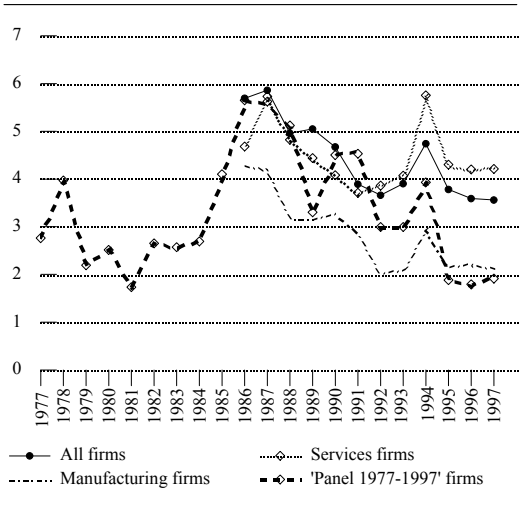
(D) *Panel 1*, miscellaneous firms



(E) *Panel 2*



(F) Median liquidity ratios compared



Note: The liquidity ratio is cash and marketable securities as a percentage of all assets less cash and marketable securities.