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Checking Accounts and Bank Monitoring

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CHECKING ACCOUNTS AND BANK MONITORING

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CHECKING ACCOUNTS AND BANK MONITORING

Abstract

Do checking accounts help banks monitor borrowers? A borrower's checking account provides a bank with exclusive access to a continuous stream of borrower data, namely, the borrower's checking account balances at the bank. Using a unique set of data that includes monthly and annual information on small-business borrowers at an anonymous Canadian bank, we provide empirical evidence that checking account information helps the bank to monitor commercial borrowers. We show the direct mechanism through which banks can use this information in monitoring. Our results provide empirical support for the notion of Black (*Jrl of Fin Econ*, 1975) and Fama (*Jrl of Mon Econ*, 1985) that, because of their role in the payments system, banks are "special" monitors.

CHECKING ACCOUNTS AND BANK MONITORING

1. Introduction

Do checking accounts help banks monitor borrowers? If so, as Black (1975) and Fama (1985) have argued, banks are "special" monitors of borrowers because of their role in the payments mechanism. While several papers have presented striking evidence that banks are indeed special lenders, none that we know of shows the direct mechanism by which banks use their role in payments to monitor loans. In this paper we show how one bank uses information from checking accounts to ascertain whether operating loans are being used to finance normal operations — inventory and accounts receivable — rather than unanticipated cash shortfalls.

Some of the information in a checking account is clearly of use to a lender. For example, a borrower's canceled checks and banking statements allow a lender to verify the usual information accompanying a loan application; these are particularly useful in the absence of an independent auditor's report. However, a bank does not have a monopoly over this kind of evidence — the borrower can provide it to any lender.

On the other hand, a bank can have exclusive access to a continuous stream of borrower data on the most timely basis possible, provided the borrower uses the bank as its exclusive depository. These data are the flows into and out of the borrower's checking account at the bank. This timely access is useful in monitoring an existing loan to detect and control moral hazard problems associated with a rising probability of bankruptcy.

We analyze a unique set of data that includes monthly and annual information on bank balances, accounts receivable, and inventories for small-business borrowers at a Canadian bank that wishes to remain anonymous. In particular, we test the hypothesis that the lender uses information from borrower checking accounts to ascertain that operating loans are being used for normal operating purposes rather than to finance abnormal losses.

We establish that the bank account provides useful information to the lender and characterize how the lender responds to the information. Specifically, we find first that monthly changes in accounts receivable are quite transparently perceivable in movements in the checking account, when the borrower has an exclusive banking relationship with the lender. This transparency diminishes for borrowers who have relationships with more than one bank. Our second finding is that borrowings not accounted for by inventory and accounts receivable are clear predictors of credit downgrades and loan writedowns, and the bank uses such information promptly. Our third finding is that the bank intensifies monitoring as loans deteriorate — loan reviews become lengthier and are more frequent.

Taken together, these findings establish a set of links showing that banks can, and do, use checking accounts to monitor accounts receivable and inventories; and we show exactly how this one bank does so. Our finding on the transparency of changes in accounts receivable and banking accounts cover more than 1200 firm-months of data. Even though our data come from a particular bank, the bank does not control these cash flow movements (most obviously for healthy borrowers). Thus, we consider the results based on this data set as broadly representative of bank monitoring of small-business borrowers in general.

To our knowledge, this paper is the first direct empirical test of the usefulness of checking account information in monitoring commercial borrowers. Previous empirical research has documented the value of lending relationships to firms by examining loan rates (e.g., Petersen and Rajan, 1994; Berger and Udell, 1995; and Berlin and Mester, 1998). Other studies have documented a positive abnormal stock-price reaction to announcements of new or continuing bank loan agreements or loan commitments (e.g., Lummer and McConnell, 1989; Billet, Flannery, and Garfinkel, 1995; and Preece and Mullineaux, 1996). Berlin and Mester (1999) present empirical evidence for an explicit link between banks' liability structure and their distinctive lending behavior. Yet none of these previous papers directly examines the mechanism through which a bank is able to gain an information advantage over other types of lenders. And this is the

focus of our paper.

Recent papers by Kashyap, Rajan, and Stein (2002) and Diamond and Rajan (2001) offer alternative, complementary theoretical rationales for combining deposits and lending under a single roof. Kashyap, Rajan, and Stein argue that taking deposits and offering lines of credit are forms of liquidity provision that are optimally bundled together as long as they are not perfectly correlated. With such bundling, a bank is better able to hedge the risk of withdrawal. Diamond and Rajan argue that by taking deposits, banks commit themselves to bearing withdrawal risk. This commitment is beneficial, since it commits the bank to using its skill to collect from borrowers to repay depositors. (If a lender did not try to collect payment from borrowers, a run would be precipitated and the bank would fail.) This commitment means that deposits that are withdrawn from the bank to meet unforeseen liquidity needs can be replaced by new deposits, since new depositors are confident the bank will work to collect from borrowers to repay depositors. At the same time, borrowers are insulated from unforeseen liquidity needs of direct investors.

In this paper, we explore detailed micro data that show checking account information at banks is indeed relatively transparent for monitoring borrowers' collateral and that such monitoring is useful in detecting problems with loans.

2. The Mechanics of Bank Loan Monitoring

When a borrower suffers unexpected losses, its probability of bankruptcy rises and, by a familiar moral hazard mechanism, its incentives to invest optimally fall (Myers and Majluf, 1984). A lender who monitors the borrower's account and is able to detect such losses may be able to create incentives for the borrower to take actions that improve expected return (Nakamura, 1993a). In particular, the lender may strive to ensure that the operating loan extended by the bank finances operations and does not finance unexpected equity losses. It is thus an important advantage to a lender to be able to detect changes in normal seasonal borrowing needs, i.e., flows of inventory and accounts receivable.

Although much of the literature cites a bank's ability to monitor borrowers as one of its special talents, the literature rarely describes what gives the bank its monitoring advantage over other types of lenders. We argue that a bank loan officer has access to fine-grained information about a borrower's activities through its operating account, as he or she can observe checks on an item-by-item basis and compare them to the borrower's pro forma business plan. The continuing operation of a business demands that the business be able to meet its financial requirements, which means that the business must have enough cash to pay its employees, suppliers, and others. The cash flows of the business are recorded in its bank account. The bank account information is likely to be one of the timeliest sources of information available to the bank and will not be as readily available to other lenders. Moreover, as Nakamura (1993a,b) has argued, checking account information is relatively more transparent and complete for a small-business borrower whose banking relationship is exclusive to a single lender.

The flow of information about accounts receivable and inventory at our bank is provided for contractually. A representative loan contract for the bank we study included the following language:

> "Total outstandings are not to exceed 75% of good accounts receivable, excluding accounts over 90 days and inter-company accounts plus 50% of inventory, up to a maximum of $5 million dollars, including raw material, work in process and finished products, less priority claims."
>
> "The Borrower will deliver to the Banks such financial information as the Bank may reasonably request including but not limited to the following:
>
> a) audited annual financial statements of the Borrower, within 90 days after the fiscal year end;
> b) in house monthly financial statements of the Borrower within 20 days after the end of the month;
> c) monthly aged listing of accounts receivable and inventory reports within 20 days after the end of month."

This loan contract restricts the amount of the loan to a certain percentage of accounts receivable and inventory. It also requires the borrower to report shipments to customers that constitute new accounts receivable, as well as customer payments on accounts receivable. A borrower whose business is floundering may be tempted to submit false statements, particularly if these reports lie within the bounds of plausible error. For example, an account that has already been paid may be included among receivables. Or an order that has not yet been shipped may be called a receivable. However, by observing the detailed flow of checks received, the bank loan officer can verify that each receivable is followed, within 90 days, by a payment. In fact, every month, the loan officer can do an item-by-item reconciliation of the account receivables: beginning of month receivables + sales (operating revenues) – cash inflows (checks) = end of month receivables. This is a check not just on the veracity of the borrower but on how careful the business is in managing accounts receivables, itself a telling sign.

A nonbank lender — or a bank lender who did not have the borrower's checking account business — would not have the same timely access to this verification. While it is true that a nonbank financial institution can arrange to become the receiver of the accounts receivable, this adds additional cost, and may restrict the borrower's flexibility. There are two other reasons this might be a costly solution. First, the borrower may not wish to reveal to buyers that it is having financial difficulties. Second, the borrower is likely to be in a better position than the bank to judge how best to collect receivables, and the borrower will be deprived of information on the timeliness of payments, which helps it conduct its business. As a result, a nonbank lender is usually not able to easily discern that a troubled borrower is continuing to post accounts receivable after they have been collected. While any information possessed by the borrower may be in principle transmitted to any lender, such forward transmission may come at a cost, including loss of privacy and loss of timeliness and detail, as well as any direct cost of sending and receiving. The bank lender's access to this information is, by contrast, a necessary byproduct of the checking account

technology.[1]

Before continuing, it may be worthwhile mentioning that in the Canadian bank being studied, an operating loan is supplied as a negative-balance checking account, a typical practice in English banking. In the U.S., by contrast, the operating loan and the checking account are separated, with the checking account balance, at least in principle, required to be positive. Thus, the operating loan balance plus the checking account balance in the U.S. would be equal to the operating loan balance in this Canadian bank.

U.S.-style Bank Account		**English-style Bank Account (used by our Canadian bank)**	
Assets	Liabilities	Assets	Liabilities
Checking Balance = C_t	Loan = L_t		Bank Account = B_t

A nonbank lender in either the U.S. or Canada would observe only the loan balance. This would consist of a series of debits and credits between the firm's checking account at the firm's bank and the loan account at the firm's nonbank lender. In general, the nonbank lender does not see the individual checks the firm writes on its bank checking account that pay suppliers, workers, and other creditors, nor those that are paid into the account by clients. A bank lender, on the other hand, using the English-style account, observes B_t, the checks between the borrower and the rest of the world, but there is no separate loan account. In contrast, a bank lender using the system prevalent in the U.S. observes C_t and L_t. Thus, the U.S.-style bank lender observes both the checks between the borrower and the rest of the world, and between the loan account and the checking account. The U.S. bank accounting system provides somewhat more information than this Canadian bank's system, and it is possible that drawdowns of the operating loan may represent signals the bank can interpret. Thus, if anything, the results found using our Canadian data should indicate the lower bound on the information available in U.S.-style banking systems. On the

[1]The importance of proprietary information and banking, using the example of R&D contests, is explored in Bhattacharya and Chiesa (1995).

other hand, the gross liability of the bank to the borrower and vice versa are greater under the U.S.-style banking practice, because the checking account and loan account are not netted.

3. A Monthly Model of an Operating Loan

A simple accounting model shows the relationship between changes in accounts receivable, inventories, and bank account balance. In month t, the borrowing firm makes expenditures x_t to make products that increase the firm's inventories. It also makes shipments, y_t, which reduce inventories and increase accounts receivable. Then if the firm sells its products at a constant markup of m, shipments will increase accounts receivable by $y_t(1+m)$. At time t, the firm will also receive some payments z_t on past shipments, which decrease accounts receivable. Net operating outlays are then $x_t - z_t$. Let all other net outlays be w_t; these will include liquidity declines caused by unanticipated operating losses or expenditures.

Let the firm's bank balance (i.e., what it owes the bank, on net) be B_t, and let the monthly interest rate on the loan (assumed constant over time) be r. Then $B_t = B_{t-1}(1+r) + x_t - z_t + w_t$. Similarly, let R_t be accounts receivable and S_t be inventories. Then $R_t = R_{t-1} + y_t(1+m) - z_t$ and $S_t = S_{t-1} + x_t - y_t$.

The changes in bank balances, accounts receivable, and inventories are:

$$\Delta B_t = B_{t-1}r + x_t - z_t + w_t, \quad (1)$$

$$\Delta R_t = y_t(1+m) - z_t, \quad (2)$$

$$\Delta S_t = x_t - y_t. \quad (3)$$

The sum of changes in accounts receivable and inventories will approximately equal changes in bank balance, depending on the relative size of interest accruals (which depend on r), markup (m), and net other outlays (w_t). The size of interest accruals are, of course, known to the lender, as is the expected markup. Thus, if the lender knows the changes in inventories and accounts receivable, then knowledge of the bank balance is equivalent to knowledge of other net outlays.

The reverse is true too. If movements in w_t are infrequent, the bank balance can generally be used to monitor changes in inventory and accounts receivable.

The individual payments a borrower makes would be available to the borrower's bank lender. However, our data set does not include checking account or accounts receivable information detailed enough to verify individual payments in this manner. But it does allow us to demonstrate that the account balance provides a relatively transparent window on accounts receivable and inventory. In the empirical work described below, we use correlations between inventory, accounts receivable, and bank balance to judge how easily the bank balance can be used to monitor operations. We then show how this bank uses unexpected movements in the operating loan relative to inventory and accounts receivable to determine credit risk, intensify monitoring, and declare a loan troubled. We now describe our data set more fully and then turn to our empirical implementation and results.

4. The Data Set

The data contain information on 100 small-business borrowers who are customers of the Canadian bank. A small business is defined as one with authorized credit between C$500,000 and C$10,000,000 and whose shareholders are managers of the firm. The average sum actually borrowed on the credit in our sample is about C$1,500,000. The selected firms have been active for at least three years; public utilities, management firms, and financial companies are excluded. Fifty of these loans were declared troubled by the bank and the rest were healthy loans over the period studied. Declaring a loan troubled is a highly consequential act for the lender, as it is the point when the bank acknowledges a high probability of loss on the loans.

Table 1 shows the outcomes for the troubled loans. For the vast majority (72 percent) of these

loans, the borrowing firms ended up going into bankruptcy or were privately liquidated.[2] Of the other loans, nine remained troubled, four were repaid, and one was upgraded.

The troubled loans here are substantially all the troubled loans during this period that meet our criterion. Then for each troubled loan, we found a loan that remained healthy over the period studied and matched the troubled loan by industry, level of annual sales, credit rating at the start of the three year period, and loan amount.

Most of these troubled loans were so classified between 1990 and 1992 (only three loans were classified as troubled before 1990); healthy loans were last reviewed by the bank at some date in 1991 or 1992. Six industrial sectors are represented in the data (see Table 2).

For each loan, we have both annual and monthly data. For a troubled loan, the annual data pertain to the firm's three fiscal years prior to the loan's being declared troubled, and the monthly data pertain to the three calendar years prior to the firm's being declared troubled. (The data are not necessarily complete for each loan.) For the matched healthy loan, we have comparable information, with the reference date being the last time the firm's credit file was reviewed by the bank. For example, consider a firm whose loan was declared troubled in April 1991 and whose fiscal year runs from October to September. Our annual data on this firm would cover the firm's fiscal years FY1988, FY1989, and FY1990, and the monthly data would run from January 1988 through December 1990.[3]

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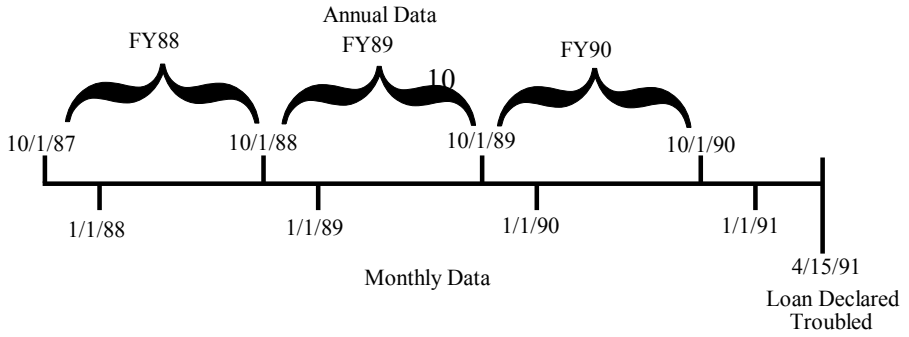
[2]A private liquidation is a cooperative sell-off of assets without a court settlement. When the owner has signed a personal guarantee as a part of the loan agreement, such a private liquidation is likely to be efficient, as the owner is strongly motivated to maximize liquidation value of the firm and minimize his personal liability. Of course, if there are other claimants liquidation may be complicated and bankruptcy entered into.

[3]Because the reference dates for a matched troubled loan and healthy loan differ, the data on two matched loans could potentially cover substantially different time periods, with significantly different macroeconomic conditions. But this does not seem to pose a large problem here, since the difference in reference dates was under two years in all but four cases, and the maximum difference was three and a half years for one loan pair.



An important variable included in our data set is whether the firm has an *exclusive* banking arrangement with the bank. This variable allows us to segment the loans into "exclusive" and "nonexclusive" categories, providing a metric against which we can measure certain effects. If a borrower has a nonexclusive relationship with our bank, it is not clear whose customer the borrower really is. In some cases, the borrower will have a primary customer relationship with the bank we are studying, in which case the borrower's operating balance is likely to remain quite informative. In other cases, the borrower's primary relationship will be with another bank, and the bank we are studying is partially dependent on the other bank for information on the borrower's creditworthiness. Thus, if checking account information is valuable, we would expect it to be more valuable for exclusive loans, since the bank's account balance data on the firm would reflect its entire checking account activity. However, in our empirical tests that use accounts receivable and inventories, almost all the "nonexclusive" borrowers have primary customer relationships with the bank under study. To that extent, the differences between exclusive and nonexclusive borrowers may be attenuated.

In our data, of the 50 troubled loans, 33 of the borrowers have an exclusive relationship with the bank; of the 50 healthy loans, 26 have an exclusive relationship. There appears to be a definite correlation between the completeness of our data and whether the bank serves as the firm's exclusive bank. Of the 59 firms with exclusive relationships, we have complete data on 19, i.e., 32 percent, while of the 41 firms with nonexclusive relationships, we have complete data on only four, i.e., less than 10 percent.

4.1 Annual data

The annual data contain information typically found on a firm's financial statement, e.g., balance-sheet data, such as the book value of accounts receivable and inventories; income-statement data; some items from the statement of changes in financial position; and information in the firm's credit file. Our data set also contains some information from the outside auditor's report on the firm, e.g., whether there were any qualifications in the auditor's report and the date of the audit. These data would be available to any lender the firm approached for a loan. Nonexclusive borrowers generally tend to have larger sales and often represent borrowers who are being accommodated by our bank because they have a plant or subsidiary outside their primary bank's territory.[4]

The credit file contains annual information about the firm's sales, the level of authorized credit the firm has gotten from the bank for an operating loan, additional credit for seasonal loans, and other temporary loans. In addition, there is information on whether the loan has covenants. A crucial datum in each annual credit review is the credit rating assigned to the loan by the bank's credit department upon completion of the review. This credit rating is arranged on a scale of one through eight, with one being the best, and six through eight being different degrees of "trouble."

Tables 3A, 3B, and 4 show some of the annual data on our borrowers. The first three columns in the top panel of Table 3A show the average loan sizes (measured by the average amount actually borrowed) for all the loans and for the healthy and troubled loan subsamples over the entire three-year period covered by the data and over each year individually, where the years are measured relative to the reference date (i.e., for a troubled loan, the three fiscal years prior to the loan being declared troubled; and

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[4]One such borrower with unusually large sales of over $300 million distorts the data on "nonexclusive-troubled" borrowers. When that borrower is omitted, average sales for all three years falls to $14.5 million for troubled loans, to $18.8 million for nonexclusive loans, and to $24.5 million for nonexclusive-troubled loans. This borrower's data, fortunately, does not materially affect any of our other results. Indeed, when this borrower is omitted, the results of our statistical tests, are, on average, slightly more favorable to our hypotheses.

for a healthy loan, the three fiscal years prior to the firm's last credit review by the bank). It is evident that the bank does not use its information about troubled borrowers to substantially reduce its exposure to loss; rather, if anything, troubled loans rise in average size. The top panel of Table 3B shows the average annual business sales for all firms and for the healthy and troubled loan subsamples. Note that troubled borrowers do not generally have obviously declining average sales compared to healthy ones.

The bottom panels of Tables 3A and 3B show the average loan amounts and average annual business sales, respectively, over time for exclusive and nonexclusive loans, and for these categories separated into healthy and troubled loan subcategories. As might be expected, firms that are larger, as measured by sales, tend to deal with more than one bank and so do not have an exclusive relationship with the bank under study.

Table 4 shows the evolution of the borrowers' credit ratings over time. At the dates when the loans were matched (i.e., at $t-3$), there are 19 loans rated superior or standard in the group of loans that do not become classified as troubled loans and 31 such loans with substandard credit ratings. At the final rating period ($t-1$), there are 23 loans rated superior or standard. Remember that healthy loans in the sample were chosen to be approximately as creditworthy as the troubled loans at the beginning of our data period. So one way to think about these loans is that rather than their starting out as good loans and remaining good over time, these loans start out with some qualifications, but then improve over time. By contrast, although 18 of the troubled loans are rated superior or standard in the initial period, only one is so rated two reviews later. These credit ratings are effective on the date the credit department signs off on the credit review. This sign-off date is typically later than the planned credit review date, as the loan officer doing the review may ask the borrower for additional information. In addition, the interval between planned credit reviews is not always one year, but may be shorter or longer.

4.2 Monthly data

The monthly data contain information on the value that the bank assigns to the firm's accounts receivable and inventories, as well as the end-of-month balance in the firm's bank account, as well as the minimum, maximum, and average balance over the month. The bank's *valuation* of accounts receivable and inventories are important ingredients in determining how much the bank is willing to lend to a commercial borrower. To restrict the use of the operating loan to purely operational ends and to ensure that the borrower has adequate collateral for the loan, the bank verifies on a monthly basis that the amount borrowed does not exceed the estimated value of the firm's operating assets that serve as collateral.

The bank's valuations include subjective discounts (haircuts) from book value (note, we do not have monthly information on these book values). These haircuts provide a comfort level for the lender; they also reflect the liquidity and quality of accounts receivable and inventories. For example, as accounts receivable remain uncollected, their quality (i.e., the probability they will ultimately be collected) may deteriorate. Also, the state to which the inventory is processed reflects its liquidity — works-in-progress inventory is the least valuable, since it is the most difficult to convert to other uses and, therefore, to sell to other producers. In general, our data indicate that this bank values accounts receivable at two-thirds to three-quarters of book value, while it values inventories at between one-quarter and two-fifths of book value. Credit rating does not seem to have much impact on the size of haircut, although borrowers with a credit rating in the "troubled" range may receive a bigger haircut on their accounts receivable than do other borrowers. This presumably reflects the aging of some proportion of the accounts receivable.[5]

[5]The mean haircut on accounts receivable was 0.29 for borrowers rated superior or standard and 0.36 for borrowers rated as troubled (with one of the three worst credit ratings). The mean haircut on inventories was 0.62 for borrowers rated superior or standard and 0.66 for borrowers rated as troubled.

5. Feasibility of Using Bank Account Information for Monitoring Borrowers: The Relationship Between Loan Balances and the Bank's Valuation of Accounts Receivable

Next, we turn to the transparency of the bank balance in providing information on accounts receivable. If we had complete data on loan balances, accounts receivable, and inventories, then, under the hypothesis of transparency, almost all the movements in bank balances would be accounted for by movements in accounts receivable and inventories. However, in our data, it appears that there is a limit on the amount the bank is willing to lend against inventory. That is, there is a binding ceiling on the bank's inventory valuation, so that changes in inventory are typically not reflected in our inventory valuations data. For this reason, we focus on the relationship between loan balances and accounts receivable. As indicated in section 3, to the extent that there is a high correlation between bank account balances and changes in accounts receivable and inventories, changes in the firm's bank account balance can be used to monitor a firm's operations. But how high can we expect this correlation to be? Obviously, this will depend on the distribution of the underlying variables defined in section 3, x_t, y_t, z_t, and w_t, i.e., expenditures, shipments, payments on past shipments, and other net outlays, respectively. When inventory is shipped, the borrower writes down its finished goods inventory but the loan balance is unaffected. Loan balances change only in response to payments, which represent only half of the changes in accounts receivable. This suggests that the correlation between accounts receivable and loan balances should be negative, and roughly one-half. In the appendix, we formalize this conjecture. Note that a similar calculation can be performed for the correlation between the change in bank account balance and the change in inventories.

To see whether bank account balance gives the bank useful information for monitoring the firm's operations, we examined the correlations between changes from the beginning to the end of each month in the firm's checking account balance, and the bank's valuations of the firm's accounts receivable and inventories. As discussed in section 3, we hypothesize that the correlation would be stronger for firms that

have an exclusive relationship with the bank than for firms that do not. So we repeat the correlation analysis for the exclusive and nonexclusive subsamples, and we also divide these subsamples into their healthy and troubled loan subgroups, to control for any loan performance effect. Thus, we perform the analysis for seven groups: all loans, exclusive, nonexclusive, exclusive-healthy, nonexclusive-healthy, exclusive-troubled, nonexclusive-troubled. In this analysis we normalize the variables by the firm's annual sales to control for heteroscedasticity.[6]

As shown in the first row of Table 5, the correlation between changes in bank balances and changes in accounts receivable is 0.45 for all loans, and is higher for exclusive loans than for nonexclusive loans. Thus, our data are showing about as high a level of correlation as one should expect. We also see that the correlations are stronger for firms that deal exclusively with the bank than for firms that have multiple banking relationships, even when we control for loan performance. This suggests there is more information to be gleaned about a firm's operations from the account balances for firms that deal exclusively with the bank than for those that have other banking relationships.[7] It appears that simply having a continuous record of the borrower's operating balance in an exclusive client relationship provides the lender with a substantial amount of information. Of course, the loan officer has access to even better information, as the loan officer can examine individual checks and deposits.[8]

The correlations between changes in inventories and changes in either bank balances or accounts

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[6]To normalize, we use the earliest annual sales figure available for each firm. For troubled loans, this is sales in the fiscal year three years prior to the loans' being declared troubled, and for healthy loans, this is sales in the fiscal year three years prior to the last credit file review.

[7]Not only would the bank have less data on nonexclusive firms, but the value of any information it had might be lower, since the firm would be less under the bank's control.

[8]Note that we also find a stronger correlation for healthy loans than for troubled loans, holding exclusivity constant. This may reflect the fact that when loans become troubled, the bank may lower its valuations and the loan limits may become binding on the firm. (It also suggests that the bank's control is not perfect.) This would disrupt the normal relationship between checking account balances and bank valuations of accounts receivable.

receivable are much smaller than the correlations between changes in bank balances and accounts receivable. This is because there is generally much less variation in changes in inventory valuations than in the other variables, as shown in the bottom panel of Table 5. Indeed, roughly 20 percent of the monthly observations of the bank's valuation of inventories appear to be at an upper limit. These are cases where there are more than two observations of the same valuation and that valuation is greater than others for that borrower.

This analysis suggests that changes in accounts receivable potentially contain useful information about firm operations, while changes in inventories are likely to contain less information. The empirical analysis in the next sections attempts to determine whether indeed there is useful information and how the bank uses such information.

6. Information Available from the Monthly Valuations: The Relationship Between Signals of Firm Trouble, Credit Downgrades, and Troubled Firms

The monthly data allow the lender to detect two signals of potential trouble at the firm. The first signal is when the bank's loan balance exceeds the bank's valuation of collateral, i.e., valuations of account receivables and inventory. The second signal is whether the borrower is consistently borrowing an amount close to or exceeding the credit line authorized at the beginning of the credit year. These two signals differ sharply on what kinds of lenders can use them. The first type of signal is available only to bank lenders, since only a bank lender can track the high frequency movements in collateral valuations and thus can create a reliable signal based on them. Monthly monitoring and valuation of accounts receivable and inventories are likely to be very difficult for a nonbank lender who does not have access to the checking account data we have documented as providing useful information. On the other hand, a signal based just on information on the firm's account balance would be available to both bank and nonbank lenders. Presumably any lender will know the extent to which the borrower is using or even exceeding the

authorized credit line. We compare the informativeness of these two types of signals and are specifically interested in what *additional* information is provided by the bank's valuations of collateral.

Our measures of these two types of signals are *exceed* and *utilization*. *Exceed* is the amount the firm has borrowed less the firm's collateral (as measured by the bank's valuation of the firm's accounts receivable and inventories and other guarantees posted by the firm), as a percent of the firm's authorized credit line. *Utilization* is the firm's borrowing as a percent of its authorized credit line. Exceed is a signal of trouble available to only a bank lender, while utilization is available to any lender. Troubled firms are likely to have higher, and possibly positive, values of *exceed* and higher values of *utilization*, since they are likely to have borrowed more, had the bank lower its valuations of accounts receivable and inventory, and had the bank also lower the firm's credit line.

Both *exceed* and *utilization* are computed using the monthly data on the firm, and thus, they are likely to be better signs of trouble for exclusive borrowers than for nonexclusive borrowers, since the bank has more accurate monthly data on exclusive borrowers. As expected, we found higher mean values of *exceed* and *utilization* for exclusive-troubled firms than for exclusive-healthy firms.

When *exceed* turns positive, the bank is at risk, in that the borrower's ability to relatively quickly pay off the loan has become stretched. This is a warning signal to the loan officer and to the bank. How useful is this signal? We define a variable, *violations*, which equals the number of months for which *exceed* is positive over the three years prior to our reference date (either the date when a loan was declared troubled or the date of a healthy loan's last credit review). We also define *violations_i*, i=1,2,3, which is the number of months *exceed* is positive in the i^{th} year before the reference date. Similarly, we define *nonviolations* and *nonviolations_i*, i=1,2,3, which are the number of months for which *exceed* is negative.[9]

[9]Months for which our data are incomplete do not count as positive or negative *exceed* and, therefore, do not increase either *violations* or *nonviolations*. To the extent that data are missing and to the extent that the firm is just borrowing an amount equal to the bank's valuation of its collateral, the sum of *violations* and *nonviolations* will differ from 36.

We are interested in two nested types of outcomes: downgrades of a loan's credit rating and, among these, downgrades to "troubled." The declaration that a borrower is troubled requires an immediate write down of the loan and is also tantamount to failure of the borrower; in almost all cases, the ultimate outcome is bankruptcy (see Table 1). Failure of the borrower is a more clearly objective event than a credit downgrade, which is explicitly subjective, and need not have immediate consequences. Thus we expect that signals of trouble will have quick and full impacts on credit downgrades — and that is what we find.

6.1 Usefulness of the bank balance data for monitoring borrowers

We ran OLS regressions and logit regressions of whether a loan was eventually declared troubled on *violations*, *nonviolations*, and *utilization*. The OLS results are shown in Table 6.[10] First note that the coefficients have the expected signs: the coefficients on *violations* and *utilization* are significantly positive and that on *nonviolations* is significantly negative. Taking all loans, including those on which we have no information on violations or nonviolations, we find that the additional information on violations and nonviolations adds 13 percentage points to the ability to separate troubled loans from untroubled loans. (While the level of the adjusted R^2 suggests there is still much to be explained, the adjusted R^2 increases from 0.11 to 0.24 when *violations* and *nonviolations* are included in the OLS regression equation.) Note that this information is useful for both exclusive clients and nonexclusive clients — it seems generally true that the nonexclusive clients about which the bank collects this type of information are clients with whom the bank has a strong relationship. On the other hand, the results are little changed if we exclude those borrowers for which the bank lacks information about violations.

6.2 Speed with which the lender acts on signals from the bank balance

How quickly is this information used? Two pieces of evidence suggest that the information is used relatively soon after it is available. Most of the information that determines whether a loan is

[10]The logit results are qualitatively the same and are available upon request from the authors.

declared troubled is in violations in the most recent fiscal year before a declaration of trouble, as shown in Table 7. Here we use our disaggregated measures of violations, *violations_1*, *violations_2*, and *violations_3*, which give separate counts of the number of violations according to how far in advance they took place before the loan was declared troubled (or before the final fiscal year for healthy borrowers). The first column of Table 7 shows the regression results for the sample of loans excluding those for which there was no information on violations during the third year prior to declaration. The third column excludes loans where there is no information on violations in any of the three years. In both cases, the bulk of the information is derived from the latest year: there is little difference in the adjusted R^2 when only the number of violations in the year prior to declaration is included in the regression compared to when violations in each of the three years prior are included.

Now consider downgrades of loans at the second review date, i.e., at least a year prior to when the loan was declared troubled.[11] Here we would expect that the most important information would be violations that occurred in the second year prior to the declaration that the loan is troubled, i.e., in the year prior to downgrade. Table 8 shows that is indeed the case. Almost all the information provided by violations in explaining downgrades in the second year is contained in violations that occurred in the year prior to the downgrade. The adjusted R^2 increases from 0.12 to 0.19 when the second-year violations are included. Here the information content of the second-year violations is somewhat lower when only information on violations in the second year is included, but the information remains significant both statistically and economically.

[11]Since the results for downgrades at the final review date are virtually identical to the results for declarations of "trouble," we omit them here for brevity; they are available upon request from the authors.

7. Information Available from the Monthly Valuations: How the Lender Reacts to Signs of Trouble Gleaned from Checking Account Information

The last two tables show that the lender intensifies its monitoring of risky loans by spending more time in loan review and by reducing the time between loan reviews. We examined the date on which a credit review was completed relative to the date the review was planned to be completed and changes in the frequency of planned reviews.

We expect that for loans that remain healthy, the completion of the credit review should be closer to the planned completion date than for loans that have deteriorated in quality, since for healthy loans the reviewer is less likely to find troublesome information that takes longer to evaluate. A credit review is typically prolonged by the bank's requests for additional information, such as more complete financial statements and more detail about projected future disbursements from the bank account. Higher ranking and presumably more experienced credit officers may become involved in the review, as the bank puts more resources into monitoring. The bank may negotiate changes in the terms of the loan (for example, asking for personal guarantees, such as the pledge of property), and such negotiations may take time. Thus a lengthy delay between the expected loan review date and the sign-off by the loan officer is a strong sign that monitoring has been intensified. Similarly, we expect that as a loan's quality deteriorates, a bank would want to examine the loan more frequently. Clearly, more frequent loan reviews are signs of more intensive monitoring, as they require more data collection and analysis per unit of time.

7.1 Delayed completion of loan reviews

At the beginning of our data (t−3), healthy loans were chosen to be approximately as creditworthy as the troubled loans. Over time, the healthy loans, on average, improve in apparent quality, while the troubled loans, by definition, deteriorate. Table 9 shows that among healthy loans, delays in loan reviews decrease compared to planned dates. This suggests that for loans that improve in quality, loan officers are able to sign off on them closer to the review date, while for troubled loans, a delay remains. For example,

in the third year prior to our reference date, 90 percent of healthy loans have a delayed review while in the first year prior, only 69 percent do. Moreover the length of delay is cut by three-fourths — from about 120 days to 38 days, on average. In contrast, for loans that remain troubled, there is little lessening in the number of delayed reviews or average length of delay.

7.2 Frequency of loan reviews

The lower part of Table 9 shows that over time, as the troubled loans worsen, the time planned between credit reviews shortens on average, while for loans that improve in health, the time between reviews increases. For example, for troubled loans, on average, the time between planned reviews decreases by about 48 days over the three years, whereas for healthy loans, on average, planned reviews become less frequent by about 18 days. Similarly, the number of troubled loans with fewer than 340 days between planned reviews increases from 10 to 19 over the three years, while the number of healthy loans with more than 390 days between planned reviews increases from 5 to 14.[12]

Table 10 replicates Table 9, but rather than sort the loans by whether they eventually are declared troubled or not, we sort them on the number of *violations* they eventually have — in particular, we divide the loans into two groups, those with *violations* less than or equal to the median level of *violations* over the sample of loans and those with *violations* greater than the median level. (The median level is 2.5 *violations.*) This is information that the bank can discern from a firm's checking account. In general, we see results similar to those shown in Table 9, albeit a bit weaker. First, loans with greater numbers of *violations* do have their credit reviews delayed relative to loans that have fewer *violations*: for example, in the third year prior to our reference date, 90 percent of loans with fewer *violations* have a delayed review while in the first year prior, only 69 percent do; the length of delay declines from 118 days, on average, to 48 days. For loans with a greater number of *violations*, there is little decline in the number of delayed

[12]The modal number of days between planned reviews is about 365, a year. The 340- and 390-day cutoffs were chosen to represent periods significantly less and significantly more than a year.

reviews and a much smaller decline in the average length of delay, compared to loans with fewer *violations*. The bottom panel shows that all loans have an increase in the frequency of their planned reviews over the three years, but loans with a greater number of *violations* have a larger decline in the number of days between planned reviews than do loans with a lower number of *violations* (approximately 17 days vs. 10 days).[13,14]

Overall, we see that borrowers whose borrowing needs exceed the bank's valuations of accounts receivable and inventories have their credit ratings downgraded at the next credit review. We have also shown that, together with downgrading of credit, scrutiny appears to become stronger, with the credit review itself dragging on and the time between reviews sometimes becoming shorter.

8. Conclusion

How are banks special? This paper has described the efforts of one Canadian bank to use information in checking accounts to scrutinize the activities of small business borrowers. It is clear from the evidence that the bank does use instances where borrowings exceed the bank's own valuation of a firm's accounts receivable and inventories as a signal of deterioration in credit. Moreover, movements in checking account balances are closely related to movements in the bank's valuation of accounts receivable and inventories, suggesting strongly that the checking account provides a relatively transparent window on these aspects of a firm's activity. Although our results pertain to only one bank, we believe that these results taken together provide detailed micro-level evidence that banks' handling of business transactions

[13]The right side of the bottom panel of Table 10 indicates there is little change over the three years in the number of high-violation loans whose planned reviews are significantly more than a year apart and there is little change in those whose planned reviews are less than a year apart. However, over the three years, the number of low-violation loans whose reviews are significantly more than a year apart increases. This increase is about the same as the increase in the number of low-violation loans whose reviews are significantly less than a year apart.

[14]Similar results are obtained if instead of dividing the loans into two groups, we divide them into three groups: $violations = 0$; $1 \leq violations \leq 10$; and $violations \geq 10$.

enables them to be special lenders to firms.

Table 1. Outcomes of the Troubled Loans

	Number of loans	Percent of Loans
Bankruptcy of the firm	10	20%
Private liquidation of the firm	26	52%
Loan remained troubled	9	18%
Loan repaid	4	8%
Loan upgraded to healthy	1	2%

Table 2. Distribution of Loans by Industry

	% of sample† (100 loans)	% of exclusive loans†† (59 loans)	% of nonexclusive loans††† (41 loans)
Manufacturing	42.0%	44.1%	39.0%
Wholesale Trade	20.0%	25.4%	12.2%
Services	20.0%	15.3%	26.8%
Retail Trade	10.0%	8.5%	12.2%
Construction	6.0%	5.1%	7.3%
Primary (Mining, Agriculture, Fishing, Forestry)	2.0%	1.7%	2.4%

†These percentages also represent the percentages for healthy loans and for troubled loans, since the pairs were matched on industry category.

††Exclusive loans are loans made to firms that have an exclusive banking relationship with the bank. Column does not sum to 100% due to rounding.

†††Nonexclusive loans are loans made to firms that have relationships with other banks. Column does not sum to 100% due to rounding.

Table 3A. Average Loan Size (in thousands C$)†

	All Loans	Healthy Loans	Troubled Loans
All three years	$1496.3 (2485.8)	$1269.9 (2828.8)	$1741.1 (2024.3)
Three years prior to reference date	1250.8 (2216.9)	1126.4 (2546.4)	1400.8 (1730.1)
Two years prior to reference date	1500.9 (2388.7)	1231.5 (2608.3)	1783.7 (2099.8)
One year prior to reference date	1679.4 (2745.7)	1426.2 (3229.3)	1938.5 (2113.2)

	Exclusive Loans	Nonexclusive Loans	Exclusive, Healthy Loans	Nonexclusive, Healthy Loans	Exclusive, Troubled Loans	Nonexclusive, Troubled Loans
All three years	$1365.8 (1994.6)	$1745.3 (3207.9)	$883.4 (1612.5)	$1849.9 (3945.6)	$1802.5 (2197.5)	$1585.9 (1491.1)
Three years prior to reference date	1088.5 (1682.3)	1593.0 (3028.2)	797.3 (1494.6)	1705.7 (3674.8)	1396.6 (1813.2)	1412.2 (1495.1)
Two years prior to reference date	1364.9 (2096.2)	1762.3 (2853.8)	836.7 (1686.6)	1843.7 (3516.8)	1839.7 (2307.0)	1646.6 (1472.2)
One year prior to reference date	1592.1 (2095.8)	1832.9 (3613.7)	1014.2 (1635.3)	1953.8 (4462.9)	2056.4 (2302.1)	1642.8 (1508.6)

†Loan size in thousands of Canadian dollars averaged over months and firms and standard deviation of loan size in parentheses. For healthy loans, the reference date is the last time the firm's credit file was reviewed by the bank. For troubled loans, the reference date is the date when the loan was declared troubled.

Table 3B. Average Business Sales (in thousands C$)†

	All Loans	Healthy Loans	Troubled Loans
All three years	$16,898.0 (36,811.3)	$12,805.2 (16,445.5)	$20,990.8 (49,327.0)
Three years prior to reference date	15,885.3 (38,803.3)	10,846.5 (10,836.6)	20,924.0 (53,599.2)
Two years prior to reference date	18,112.0 (42,688.4)	14,028.5 (23,514.0)	22,195.4 (55,631.4)
One year prior to reference date	16,696.9 (30,621.6)	13,540.6 (17,004.6)	19,853.1 (39,812.2)

	Exclusive Loans	Nonexclusive Loans	Exclusive, Healthy Loans	Nonexclusive, Healthy Loans	Exclusive, Troubled Loans	Nonexclusive, Troubled Loans
All three years	$10,108.8 (9,379.2)	$26,667.9 (55,321.0)	$10,742.0 (10,363.2)	$15,040.4 (21,199.6)	$9,609.8 (8,657.9)	$43,083.4 (80,721.0)
Three years prior to reference date	9,746.7 (10,120.9)	24,718.8 (58,672.9)	10,405.2 (10,448.1)	11,324.6 (11,448.5)	9,227.8 (9,987.4)	43,628.2 (88,141.0)
Two years prior to reference date	9,934.8 (9,497.2)	29,879.1 (64,333.9)	10,855.6 (10,958.3)	17,465.9 (31,995.2)	9,209.3 (8,272.5)	47,403.6 (91,203.8)
One year prior to reference date	10,644.8 (10,173.4)	25,406.0 (45,154.4)	10,965.2 (9,796.3)	16,330.6 (22,273.3)	10,392.3 (10,605.1)	38,218.2 (63,923.3)

†Annual business sales in thousands of Canadian dollars averaged over firms and standard deviation of business sales in parentheses. For healthy loans, the reference date is the last time the firm's credit file was reviewed by the bank. For troubled loans, the reference date is the date when the loan was declared troubled.

Table 4. Number of Loans with a Given Credit Rating Over Time

Credit Ratings for Loans Not Declared Troubled within Sample

			Reservations		
	Superior	Standard	Mild	Average	Strong
Time	1	2	3	4	5
No. of Loans at t−3	4	15	23	0	8
No. of Loans at t−2	3	17	23	0	7
No. of Loans at t−1	4	19	18	0	9

Credit Ratings for Loans Declared Troubled at Time t

			Reservations			Troubled		
	Superior	Standard	Mild	Average	Strong	Standard	Severe	Very Severe
Time	1	2	3	4	5	6	7	8
No. of Loans at t−3	3	15	28	0	4	0	0	0
No. of Loans at t−2	1	2	14	1	31	0	0	0
No. of Loans at t−1	0	1	2	1	6	29	5	6

Table 5. Correlations and Variances of Monthly Changes in Bank Account Balances, Bank's Valuation of Accounts Receivable and Inventories†

Correlations between changes in:	Total	Exclusive Loans	Nonexclusive Loans	Exclusive, Healthy Loans	Nonexclusive, Healthy Loans	Exclusive, Troubled Loans	Nonexclusive, Troubled Loans
Bank Account Balances and Accounts Receivable	0.44*	0.49*	0.31*	0.54*	0.34*	0.44*	0.28*
Bank Account Balances and Inventories	0.19*	0.13*	0.28*	0.18*	0.36*	0.11*	0.19*
Inventories and Accounts Receivable	−0.08*	−0.10*	−0.06	−0.10*	0.07	−0.10*	−0.20*
No. of Observations	1327	1024	303	514	142	510	161

Variances of changes in:	Total	Exclusive Loans	Nonexclusive Loans	Exclusive, Healthy Loans	Nonexclusive, Healthy Loans	Exclusive, Troubled Loans	Nonexclusive, Troubled Loans
Bank Account Balances	0.00233	0.00209	0.00315	0.00207	0.00367	0.00211	0.00270
Accounts Receivable	0.00200	0.00204	0.00178	0.00226	0.00202	0.00182	0.00180
Inventories	0.00053	0.00040	0.00098	0.00023	0.00112	0.00057	0.00085

†Here, a positive bank account balance corresponds to a firm's borrowings exceeding its deposits; a negative bank account balance corresponds to a firm's deposits exceeding its borrowings. Thus, positive bank account balances indicate the firm is borrowing, on net. All data are monthly changes, scaled by dividing by annual sales. For troubled loans, this is sales in the fiscal year three years prior to the loans' being declared troubled, and for healthy loans, this is sales in the fiscal year three years prior to the last credit file review.

*Significantly different from zero at the 5% level.

Table 6. Regression Results of Troubled Loans on Signs of Trouble in All Three Years Prior: Evidence that Warning Signs of Trouble Forecast "Troubled" Loans

	All Loans	Exclusive Clients	Nonexclusive Clients	All Loans with Information On Violations or Nonviolations		
Intercept	0.330* (0.134)	0.366 (0.231)	0.397* (0.160)	0.151 (0.195)	0.388* (0.174)	0.278* (0.0684)
Violations	0.0158* (0.007)	0.0137 (0.0094)	0.0239 (0.0147)	0.017* (0.0083)	0.0215* (0.00798)	0.0285* (0.0065)
Nonviolations	−0.010* (0.0046)	−0.0078 (0.0074)	−0.0128* (0.0062)	−0.0071 (0.0060)	−0.00745 (0.0059)	
Credit Utilization	0.236* (0.080)	0.389* (0.143)	0.164* (0.098)	0.353* (0.123)		
Exclusive Client Dummy	Yes	No	No	Yes	Yes	No
No. of Observations	86	56	30	78	81	81
Adjusted R^2	0.24	0.24	0.21	0.26	0.19	0.19
Adj. R^2 w/o credit utilization	0.17	0.14	0.16	0.19		
Adj. R^2 w/o violations or nonviolations	0.11	0.15	0.07	0.15		

Standard errors in parentheses.
*Significantly different from zero at the 5% level.

Table 7. Regression Results of Troubled Loans on Signs of Trouble in Each of Three Prior Years: Evidence that Almost All the Useful Information Is in Recent Warning Signs of Trouble

	All Loans with Information On Violations or Nonviolations in the 3rd year		All Loans with Information On Violations or Nonviolations
Intercept	0.0753 (0.0990)	0.198* (0.0749)	0.0819 (0.0843)
Violations, 1 year prior to declaration of "troubled"	0.0831* (0.0196)	0.0879* (0.0183)	0.0852* (0.0149)
Violations, 2 years prior to declaration of "troubled"	−0.0217 (0.0207)	−0.0218 (0.0210)	−0.0216 (0.0192)
Violations, 3 years prior to declaration of "troubled"	0.0201 (0.0215)	0.0199 (0.0218)	0.0163 (0.0197)
Credit Utilization	0.2273** (0.1257)		0.238* (0.113)
No. of Observations	60	61	78
Adjusted R^2	0.34	0.32	0.39
Adj. R^2 when only the violations 1 year prior to declaration of "troubled" and credit utilization are included	0.32	0.33	0.37
Adj. R^2 when none of the violations variables is included	0.10		0.11

Standard errors in parentheses.
*Significantly different from zero at the 5% level.
**Significantly different from zero at the 10% level.

Table 8. Regression Results of Credit Downgrades in the 2nd Year Before Classification on Signs of Trouble in Each of the Three Prior Years: Evidence that Warning Signs of Trouble Are Used Immediately

	All Loans with Information on Violations or Nonviolations in the 3rd Year	All Loans with Information on Violations or Nonviolations in the 2nd Year
Intercept	0.1109 (0.0751)	0.2561* (0.0665)
Violations, 1 year prior to classification	0.0375* (0.0184)	
Violations, 2 years prior to classification	0.051* (0.021)	0.0386* (0.0167)
Violations, 3 years prior to classification	−0.0293 (0.0219)	
No. of Observations	61	75
Adjusted R^2	0.19	0.06
Adj. R^2 when violations 1 year prior to classification is excluded	0.15	
Adj. R^2 when violations 2 years prior to classification is excluded	0.12	

Standard errors in parentheses.
*Significantly different from zero at the 5% level.

Table 9. Evidence of More Intensive Monitoring as Loans Deteriorate

Delayed Completion of Review

	% of Delayed Reviews			Average Number of Days Delayed			Median Number of Days Delayed		
	3rd year prior	2nd year prior	year prior	3rd year prior	2nd year prior	year prior	3rd year prior	2nd year prior	year prior
Healthy Loans	90%	84%	69%	119.6	89.0	37.8	118.0	99.0	24.0
Troubled Loans	84%	85%	79%	123.2	121.6	115.0	111.0	117.0	92.0

Times Between Planned Reviews

	Average Number of Days Between Planned Reviews		Average Change in Number of Days Between Planned Reviews	Number of Loans Whose Days Between Planned Reviews Are:			
				> 390	< 340	> 390	< 340
	3rd year prior to 2nd year prior	2nd year prior to year prior	Between 3rd year prior to 2nd year prior and 2nd year prior to year prior	3rd year prior to 2nd year prior		2nd year prior to year prior	
Healthy Loans	365.0	383.3	Number of days between planned reviews increases, on average, by 18.37 days	5	7	14	6
Troubled Loans	365.8	318.1	Number of days between planned reviews decreases, on average, by 47.96 days	10	10	9	19

Table 10. Evidence of More Intensive Monitoring in Response to Violations Based on the Monthly Bank Account Information†

Delayed Completion of Review

	% of Delayed Reviews			Average Number of Days Delayed			Median Number of Days Delayed		
	3rd year prior	2nd year prior	year prior	3rd year prior	2nd year prior	year prior	3rd year prior	2nd year prior	year prior
Loans with ≤ Median No. of Violations	90%	80%	69%	118.1	98.9	48.1	118.0	99.0	51.0
Loans with > Median No. of Violations	85%	90%	79%	124.7	111.5	104.5	111.0	105.0	83.0

Times Between Planned Reviews

	Average Number of Days Between Planned Reviews		Average Change in Number of Days Between Planned Reviews	Number of Loans Whose Days Between Planned Reviews Are:			
				> 390	**< 340**	**>390**	**< 340**
	3rd year prior to 2nd year prior	2nd year prior to year prior	Between 3rd year prior to 2nd year prior and 2nd year prior to year prior	3rd year prior to 2nd year prior		2nd year prior to year prior	
Loans with ≤ Median No. of Violations	367.1	354.6	Number of days between planned reviews decreases, on average, by 9.94 days	5	6	10	12
Loans with > Median No. of Violations	363.6	347.7	Number of days between planned reviews decreases, on average, by 16.98 days	10	11	13	13

†The median number of violations is 2.5.

Appendix. The correlation between changes in the loan balance and the bank's valuation of accounts receivable

To the extent that there is a high correlation between bank account balances and changes in accounts receivable and inventories, changes in the firm's bank account balance can be used to monitor a firm's operations.

We can derive approximate values of the correlations under certain simplifying assumptions. For example, suppose the bank values the collateral represented by the accounts receivable at vR. (It applies a haircut, since there is some chance the accounts receivable will not be collected.) Then, using equation (2) in the text, the change in the bank's valuation of accounts receivable is $\Delta vR_t \equiv vR_t - vR_{t-1} = v[y_t(1+m) - z_t]$. If m is small, then

$$\Delta vR_t \doteq v(y_t - z_t). \tag{A.1}$$

The correlation between the change in the firm's bank account balance and the change in the bank's valuation of the firm's accounts receivable is

$$\text{corr}(\Delta B_t, \Delta vR_t) = \text{covariance}(\Delta B_t, \Delta vR_t) / [\text{variance}(\Delta B_t)^{1/2}\text{variance}(\Delta vR_t)^{1/2}].$$

Using equations (1) in the text and (A.1), and assuming r is small, then

$$\begin{aligned}
&\text{corr}(\Delta B_t, \Delta vR_t) \\
&\quad \doteq \text{cov}(x_t - z_t + w_t, v(y_t - z_t)) / [\text{var}(x_t - z_t + w_t)^{1/2}\text{var}(v(y_t - z_t))^{1/2}] \\
&\quad = [v\,\text{cov}(x_t,y_t) - v\,\text{cov}(x_t,z_t) - v\,\text{cov}(z_t,y_t) + v\,\text{var}(z_t) + v\,\text{cov}(w_t,y_t) - v\,\text{cov}(w_t,z_t)]/ \\
&\qquad [\text{var}(x_t) + \text{var}(z_t) + \text{var}(w_t) - 2\text{cov}(x_t,z_t) - 2\text{cov}(z_t,w_t) + 2\text{cov}(x_t,w_t)]^{1/2} \times \\
&\qquad [v^2\,\text{var}(y_t) + v^2\,\text{var}(z_t) - 2\,v^2\text{cov}(y_t,z_t)]^{1/2}.
\end{aligned}$$

As an approximation, assume x_t, y_t, z_t, w_t are independent. Then,

$$\text{corr}(\Delta B_t, \Delta vR_t) \doteq [\text{var}(z_t)] / [\text{var}(x_t) + \text{var}(z_t) + \text{var}(w_t)]^{1/2}\,[\text{var}(y_t) + \text{var}(z_t)]^{1/2}.$$

If other payments are not variable, i.e., $\text{var}(w_t) = 0$ and the variance in goods purchased, goods sold, and payments received are similar, i.e., $\text{var}(x_t) = \text{var}(y_t) = \text{var}(z_t)$, then

$$\mathrm{corr}(\Delta B_t, \Delta vR_t) \doteq [\mathrm{var}(z_t)] / [2\mathrm{var}(z_t)]^{1/2} [2\mathrm{var}(z_t)]^{1/2} = 1/2.$$

A similar calculation can be performed for the correlation between the change in bank account balance and the change in inventories.

Obviously, this is a rough approximation, based on a number of simplifying assumptions. But it gives an idea of the magnitude of the correlation we would need to find to anticipate that the bank account balance might be a useful indicator of firm operations.

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