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Journal of Financial Markets 7 (2004) 97–116

Journal of FINANCIAL MARKETS

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Public disclosures and calendar-related movements in risk premiums: evidence from interbank lending ☆

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Abstract

This paper finds that risk premiums on overnight interbank loans increase dramatically at year-end. Further, cross-sectional variation in prices reflects, in part, differences in public disclosure requirements across institutions, suggesting a significant influence of window dressing on behavior in this market. © 2002 Elsevier B.V. All rights reserved.

JEL classification: G14; G21

Keywords: Pricing anomalies; January effect; Window dressing; Federal funds

1. Introduction

Extensive research has examined the behavior of financial markets around calendar events. This paper carries forward previous work by studying calendar-related changes to the pricing of federal funds transactions. These transactions represent unsecured overnight loans between financial institutions. Relative to other financial markets, the funds market offers two key advantages in understanding the impact of the calendar on financial market pricing. First, this market is an overnight

☆ The author would like to acknowledge helpful comments from Linda Allen, James Hamilton, colleagues at the Bank for International Settlements, Avanidhar Subrahmanyam (the editor), and an anonymous referee. The views expressed are those of the author and do not necessarily reflect the views of the Bank for International Settlements.

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PII: S1386-4181(02)00024-1

market.[1] Thus, any anomalous year-end effects, for example, would show up on a single day, December 31. Similarly, any quarter-end effects occur precisely at quarter-end. Second, the federal funds market contains institutions with notably different disclosure requirements regarding their federal funds market activity. This cross-sectional variation can be exploited to test whether window dressing plays a role in any calendar-related movement in risk premiums.

An examination of unique data identifying individual federal funds transactions delivers two main empirical results. The first is that the relationship between the rate paid on overnight borrowing and borrower risk changes dramatically at year-end and at quarter-end. More precisely, the spread between the rates paid by risky and safe institutions to borrow in the funds market is much higher at year-end than on a normal business day. Smaller, but still significant increases in risk premiums are found at quarter-end.

The second key finding exploits the fact that only branches and agencies of foreign banks are required to disclose even limited information regarding the composition of their federal funds portfolios. It is shown that lending by foreign banks to US commercial banks on disclosure dates is done at a notably lower rate of interest than foreign bank lending to other institutions. This suggests that foreign banks willingly accept a lower rate of interest in order to show a portfolio tilted towards US borrowers. That this change in risk premiums is associated with a flight from risk is confirmed by an analysis of the interbank loan portfolios of foreign and US banks around the year-end.

The rest of the paper is organized as follows. Section 2 briefly reviews the previous literature on calendar-related movements in financial markets. Section 3 discusses the federal funds market, particularly the role played by the Federal Reserve in determining prices. Section 4 demonstrates that risk premiums in the funds market rise at year-end and at quarter-end. Section 5 documents the relationship between disclosure requirements, the repricing of risk, and the time variation in the composition of interbank loan portfolios. Section 6 provides evidence suggesting that the year-end changes to risk premiums and interbank loan portfolios documented in Sections 4 and 5 cannot solely be driven by calendar-related increases to the level of risk. Section 7 concludes.

2. Previous research

Much of the interest in calendar anomalies stems from Keim (1983), who finds that stock returns of small firms outperform those of large firms in January, a finding that has become known as the "January effect". Although a complete understanding of Keim's finding has not yet been reached, two competing hypotheses have attracted the most attention in the literature: tax-loss selling and window dressing.[2]

[1] According to a Federal Reserve Bank of New York (1987) survey, 96% of federal funds loans were for an overnight maturity.

[2] A third possibility, suggested by Glosten and Milgrom (1985), is that above average returns in January represent compensation for the possibility that insider traders possess more non-public information at year-end. Seyhun (1988), however, does not find empirical support for this hypothesis.

The tax-loss selling hypothesis predicts that stocks with recent downturns will come under increased selling pressure in December that is subsequently reversed in January. This timing arises because individual investors subject to capital gains taxes have an incentive to sell losing stocks before the end of the calendar year and to use those realized losses to reduce their current year's tax burden. If the stock of small firms is more likely to have underperformed, then such tax-motivated trading could explain the January effect.

Many authors have lent empirical support to the tax-loss selling hypothesis. Givoly and Ovadia (1983) find that recent losers have a larger turn-of-the-year effect. Badrinath and Lewellen (1991) document an increase in loss-taking trades near the end of the year. Griffiths and White (1993) exploit the difference in the Canadian tax year-end and calendar year-end to argue that taxes drive the tendency for stocks to trade at the bid rather than the ask price.[3] Sias and Starks (1997) document that stocks with greater individual interest, and therefore a greater exposure to capital gains taxation, have a greater year-end effect.

Despite the evidence supporting a tax-related cause of the January effect, research has also persuasively argued that taxes cannot be the complete answer. In particular, Jones et al. (1987) show that the January effect existed in the US before capital gains taxation and Gultekin and Gultekin (1983) find a calendar-year effect in countries where the tax year-end is different from the calendar year-end.

A second hypothesis advanced to explain Keim's (1983) empirical regularity is window dressing. Because numerous types of institutional investors publicly disclose their portfolio holdings at year-end, such investors have an incentive to sell relatively risky or recently underperforming portfolio holdings before December 31. By doing so, the details of prior poor investment decisions or risky portfolio holdings are concealed from the public. If the stock of small firms has either underperformed or is considered to be riskier than the stock of large companies, then window dressing could also generate the January effect. Haugen and Lakonishok (1988) argue that these year-end portfolio adjustments are sufficiently important to depress the price of small company stocks in December and give these same stocks an added boost in January.

An obvious complication in determining the relative importance of the tax-loss selling and window dressing hypotheses in generating the year-end pricing anomaly documented by Keim (1983) is that both theories make similar predictions. That is, both hypotheses would lead to risky and underperforming stocks being sold in December, which in turn leads these same stocks to deliver abnormally high returns in January. To avoid this identification problem, other research has focussed on the behavior of prices in money and government bond markets since instruments traded in these markets are not subject to capital gains taxation. For instance, Park and Reinganum (1986) document that government bonds maturing across the end of the year trade at a substantial discount. That is, these instruments contain an additional premium in their yield that is related to the end of the calendar year. Because

[3] Clark et al. (1992) document a year-end pattern in bid–ask spreads, yet find no correlation between changes in spreads at year-end and January returns.

government bonds are subject only to income taxes, and because investors presumably wish to defer such taxes by buying bonds maturing in the following calendar year, Park and Reinganum present these results as a puzzle that requires theories unrelated to taxation for explanation.

Musto (1997) finds that commercial paper that matures across the year-end also contains a substantial risk premium that increases both with the maturity and with the credit risk of the instrument. These results provide convincing evidence that either the amount of risk or the price of bearing risk increases at year-end. Consistent with the latter explanation, Musto (1997) finds that intermediaries with predominantly December 31 fiscal year-ends show evidence of window dressing, lending support to the notion that commercial paper spreads around year-end are being driven by market participants shying away from holding riskier instruments at the time of mandatory public portfolio disclosures. In further work, Musto (1999) distinguishes between retail and wholesale money funds as a proxy for the ease with which the funds' investment decisions are observed. Consistent with window dressing, Musto (1999) finds that the degree to which funds shift their portfolio towards safer assets around disclosure dates is related to the degree to which such behavior can be observed by the funds' investors.

3. The federal funds rate and fed policy

This study examines pricing in the federal funds market. Before turning to the analysis directly, it is important to recognize a key difference between pricing in the federal funds market and pricing in other financial markets. In particular, interest rates in the funds market are, on average, largely determined by Federal Reserve policy because the federal funds rate is the tool through which the Fed implements monetary policy. To be more precise, when the Fed "lowers the federal funds rate to 5.50%", what is really happening is a change in what is known as the *target* federal funds rate. It is this target that signals the stance of monetary policy. As a practical matter, however, the Fed intervenes in the interbank market each day, adjusting the aggregate supply of reserves so that, conditional on realized reserve demand, its target is obtained in the market.

The Fed tracks the success of its daily reserve (open market) operations very closely. Each day, the central bank surveys a small number of federal funds brokers. The brokers report to the Fed the dollar volume of interbank loan transactions brokered at different rates of interest. Aggregating across brokers, the Fed calculates the *daily effective federal funds rate* as the volume-weighted average rate paid in transactions brokered by the surveyed firms. Because the Fed's forecasts of the level and elasticity of reserve demand are imprecise, the daily effective federal funds rate does not equal the target rate each day.

Perhaps more surprising is the finding that the deviations of the effective rate from the target rate are largely predictable. Predictable movement in the effective rate has spawned considerable research, most notably by Spindt and Hoffmeister (1988), who emphasize the role of reserve requirements, Hamilton (1996), who emphasizes line limits and other market frictions, and Furfine (2000), who demonstrates the importance of interbank payment flows. Underlying all this research, and modeled specifically by Feinman (1993), is the role of the central bank. In particular, it is understood that the Fed, if it desired, could eliminate any predictable movement in the effective rate by systematically adjusting reserves in such a way as to offset the predictable movement.

The persistence of predictable movements in the effective rate, therefore, reflects the policy choice of the central bank. By not smoothing all interday variation in the federal funds rate, the central bank encourages more sophisticated reserve management practices as banks try to optimize their reserve holdings subject both to minimum reserve requirements and to predictable variation in rates. Encouraging an improvement in bank reserve management practices has been a constant theme of Fed operational policy for several decades and has been emphasized recently (e.g., Federal Reserve Board of Governors, 1999).[4]

For the purposes of the current study, the Fed's role in the federal funds market carries an important implication. In particular, any calendar-related movements in the daily effective federal funds rate should not be interpreted as changes in risk premiums since the persistence of any such observation is entirely at the discretion of the Fed. Therefore, if one wants to examine the impact of market participants' calendar-related behavior on pricing in this market, one must not look at the daily effective funds rate, but focus instead on the cross-sectional variation in interest rates charged in this market. This is the approach taken in the remainder of the paper.

4. Calendar variation in the pricing of federal funds transactions

In this section, the pricing of individual federal funds transactions is explored to determine whether there are calendar-related changes in the pricing of risk in the federal funds market such as have been found in other financial markets. The data were constructed from a record of every Fedwire funds transfer payment made between November 17, 1997 and January 7, 2000. These data identify, among other items, the sending and receiving institution and the amount of every payment across the Fedwire system. Although all federal funds transactions are settled on Fedwire, relatively few of the over 200 million Fedwire payments are related to a federal funds market transaction. Stigum (1990) notes that federal funds transactions are typically in round lots over $1 million. Therefore, Fedwire payments whose amounts were greater than $1 million and ended in five zeros (seven including cents) were identified as candidates for federal funds being delivered. On average, 15,000 payments per day were identified as possible federal funds deliveries. For each of these possible deliveries, the following business day's payments were searched for a payment between the same two banks in the opposite direction in an amount that could reasonably be construed as the initial payment plus interest. Interest rates were allowed to fall

[4] For instance, allowing the effective rate to rise predictably on reserve settlement days was viewed as a way to encourage banks to maintain their required reserves early during the maintenance period.

between 50 basis points below the lowest and 50 basis points above the highest rate reported by the brokers surveyed each day by the Fed. When searching for loan repayments, special care was taken to account for the fact that interest charges accrue even when Fedwire does not operate (e.g. weekends and holidays). That is, the search algorithm adjusted for the number of calendar days between delivery and repayment of funds. For example, repayments of a loan made on a Friday will contain three days' worth of interest. Analogously, repayments of a loan made on December 31 will contain two days of interest since January 1 is always a holiday.

Pairs of payments on successive business days satisfying these search criteria were identified as a federal funds transaction. As a simple example, if the Fedwire data contained a payment from Bank A to Bank B for $10 million on Tuesday and also a payment from Bank B to Bank A for $10,001,527.78 on Wednesday, then this was identified as a federal funds loan of $10 million from Bank A to Bank B on Tuesday at an interest rate of 5.50%.[5] Overall, this process identified 1,626,735 transactions over the 538 business days.[6]

The sample of transactions was split into six groups: transactions occurring at one of the three year-ends, those occurring at one of the six (non-year-ending) quarter-ends, those occurring at one of the other 17 month-ends, those occurring on reserve settlement days not otherwise classified, high payment days not otherwise classified, and all other days (normal days).[7] High payment days and reserve settlement days were identified separately to control for the possibility that risk might be priced differently on these days since, as found by the earlier literature, these days are associated with predictable movement in the effective rate.

As this paper is interested in the calendar variation of risk premiums, one must calculate a measure of borrower risk. For each institution borrowing in the funds market, a volume-weighted average interest rate spread paid over the effective rate was calculated using all transactions that occurred on normal days. This spread was used to proxy for the borrowing bank's risk as it reflects its "normal" premium paid relative to the market as a whole. Institutions were then classified into three categories based upon the value of this "normal" premium. Low risk banks were defined as those that on average paid less than the effective rate for funds borrowed on a normal day. Medium risk banks were defined as those that on average paid between 0 and 25 basis points above the effective rate for funds borrowed on a normal day. The riskiest banks were defined as those that on average paid more than 25 basis points over the effective rate on a normal day. These categories identified 226, 488 and 159 institutions, respectively.[8]

We search for calendar-related movements in risk premiums in two ways. The first method is a simple variation of the Fama and MacBeth (1973) approach.

[5] Federal funds interest rates are quoted on a discount yield basis.

[6] As a first approximation, therefore, the data analyzed here represent the universe of federal funds transactions during the sample period. In that way, the data are similar to those analyzed by Grinblatt and Keloharju (2001), who analyze virtually the entire universe of Finnish equity trades.

[7] High payment days were defined to be days on which Fedwire volume was in its highest decile and where the day was not included in one of the other special categories.

[8] The results that follow are robust to changes in the definition of the risk categories.

Specifically, for each of the three categories of institutions and for each day of the sample, we calculate the volume-weighted average interest rate across all transactions. Two credit spreads are then calculated by subtracting the weighted average interest rate paid by the safest category of bank from the average rate paid by the middle and riskiest category institution, respectively. These two credit premiums serve as dependent variables in two separate regressions. The right hand side of each regression contains the aforementioned set of five calendar-related indicator variables.

More formally, Table 1 reports the parameter estimates from the two regression equations

$$spread_{ct} = \alpha_c + \sum_{j=1}^{5} \gamma_{cj} I_{jt} + \varepsilon_{ct}, \tag{1}$$

where, for example, the dependent variable *spread* in the first regression is the difference between the average rate paid across all banks in the middle risk category ($c = 2$) and the average rate paid by banks in the safest category. The second regression is analogous but replaces the dependent variable with the spread between the rates paid by banks in the riskiest category ($c = 3$) and the rate paid by those in the safest category. The indicator variable I_{jt} equals 1 when date t is a special day of type j, 0 otherwise, where $j = 1, \ldots, 5$ represents year-, quarter-, and month-end, settlement days, and high payment days, respectively. Because of the potential for serial correlation, we allow the error term, ε_{ct}, to be heteroskedastic and serial correlated up to lag length of ten business days with reported standard errors corrected using the method of Newey and West (1987). Note that the figures reported in the last five columns are expressed as differences from a normal day. Therefore, any insignificant coefficient reported in the last five columns means that the estimated interest rate premium on the given special day is no different than it is on a normal day.

The first column of Table 1 reports that, on average, the spread between the rate paid by banks in the second risk category and the rate paid by banks in the safest risk category is only 3.7 basis points on a normal day. This increases by nearly 38 basis points at year-end and by 10 basis points at quarter-end. For banks in the riskiest category, the year-end increase in risk premiums is even more dramatic. Although the premium on a normal day is just over 30 basis points, the premium increases to over 115 (85.1 + 30.4) basis points at year-end. The regression results do not indicate a statistically significant increase in the risk premium paid by the riskiest category of banks at quarter-end. The final three columns of Table 1 document that such a dramatic increase in risk premiums does not occur on month-ends, settlement days, or high payment days.

Although these results provide evidence of a calendar-related movement of risk premiums in the federal funds market, they do not exploit the cross-sectional richness of the data. We therefore conduct a more sophisticated regression analysis based on a pooling of the individual bank level borrowing information. In this framework, the dependent variable is an individual bank's average interest rate paid

Table 1
Time series evidence on calendar variation in the pricing of risk in the federal funds market

	Normal days	Coefficients represent differences from normal				
		Last day of year	Last day of quarter	Last day of month	Settlement days	High payment days
Dependent variable						
Spread between average rate paid by banks in the middle risk category and banks in the safest risk category	0.037 (0.003)[b]	0.377 (0.088)[b]	0.100 (0.045)[a]	0.021 (0.011)[a]	0.031 (0.009)[b]	0.024 (0.011)[a]
Spread between average rate paid by banks in the highest risk category and banks in the safest risk category	0.304 (0.013)[b]	0.851 (0.263)[b]	0.089 (0.089)	− 0.008 (0.025)	0.063 (0.020)[b]	0.033 (0.026)
Observations	422	3	6	17	54	36

Standard errors calculated using method of Newey and West (1987) shown in parentheses.
[a] Significant at 5% level;
[b] Significant at 1% level.
Note: This table presents the values of α_c, $c = 2, 3$ and γ_{cj}, $j = 1, \ldots, 5$ from two regressions (for $c = 2, 3$)

$$spread_{ct} = \alpha_c + \sum_{j=1}^{5} \gamma_{cj} I_{jt} + \varepsilon_{ct},$$

where $spread_{ct}$ measures the difference between the volume-weighted average interest rate paid for funds borrowed by banks in risk category c and volume-weighted average interest rates paid for funds borrowed by banks in risk category 1. The risk categories are defined as banks that on average borrow at a rate (1) below the effective rate, (2) between the effective rate and 25 basis points above the effective rate, and (3) more than 25 basis points above the effective rate. α_c is a constant term. I_{jt} equals 1 when date t is a special day of type j, 0 otherwise. $j = 1, \ldots, 5$ represents year-, quarter-, and month-end, settlement days, and high payment days. ε_{ct} is the error term, allowed to be heteroskedastic and serial correlated up to lag length of ten business days.

for borrowed funds on a given day, expressed as a spread over the given day's effective federal funds rate. This variable was regressed on the bank's risk category, and the risk category interacted with dummy variables indicating the five types of special days, i.e. year-end, quarter-end, month-end, settlement days, and high payment days. Note that since the dependent variable is a daily average rate for funds borrowed by a given bank, the number of observations in the regression is reduced to 124,635, reflecting averages taken across the 1,626,735 transactions. To isolate the cross-sectional variation in pricing, the regression also included a complete set of dummy variables for the 538 business days in the sample.

Specifically, the regression that lies behind Table 2 takes the form of

$$spread_{it} = \alpha + \lambda_t + \sum_{c=2}^{3} \beta_c \, riskcat_{ic} + \sum_{c=2}^{3} \sum_{j=1}^{5} \gamma_{cj} \; riskcat_{ic} \, I_{jt} + \varepsilon_{it}, \tag{2}$$

Table 2
Panel evidence on calendar variation in the pricing of risk in the federal funds market

	Normal days	Coefficients represent differences from normal				
		Last day of year	Last day of quarter	Last day of month	Settlement days	High payment days
Borrower risk category						
Safest	Baseline					
Middle	0.107	0.440	0.083	0.021	0.015	0.032
	(0.002)[b]	(0.020)[b]	(0.049)	(0.008)[a]	(0.008)	(0.009)[b]
Riskiest	0.349	0.603	0.146	− 0.021	0.015	0.040
	(0.009)[b]	(0.125)[b]	(0.071)[a]	(0.017)	(0.020)	(0.019)[a]
Observations	97,902	713	1,487	3,595	12,564	8,374

Standard errors calculated using method of Rogers (1993) shown in parentheses.
[a] Significant at 5% level;
[b] Significant at 1% level.
Note: This table presents the values of β_c and γ_{cj}, $c = 2, 3$, $j = 1,\ldots,5$ from the regression

$$spread_{it} = \alpha + \lambda_t + \sum_{c=2}^{3} \beta_c \; riskcat_{ic} + \sum_{c=2}^{3} \sum_{j=1}^{5} \gamma_{cj} \; riskcat_{ic} \, I_{jt} + \varepsilon_{it},$$

where $spread_{it}$ measures the difference between the volume-weighted average interest rate paid on funds borrowed by bank i on date t and the daily effective federal funds rate on date t. α is a constant term. λ_t represents a set of 538 dummies for each business day in the sample. $riskcat_{ic}$ equals 1 when bank i is in risk category c, where the risk categories are defined as banks that on average borrow at a rate (1) below the effective rate, (2) between the effective rate and 25 basis points above the effective rate, and (3) more than 25 basis points above the effective rate. I_{jt} equals 1 when date t is a special day of type j, 0 otherwise. $j = 1, \ldots, 5$ represents year-, quarter-, and month-end, settlement days, and high payment days. ε_{it} is the error term, allowed to be heteroskedastic and correlated across errors in the same cluster. A cluster is defined as all bank-date observations occurring within the same reserve maintenance period.

where now the dependent variable *spread* measures the difference between the volume-weighted average interest rate paid on funds borrowed by bank i on date t and the daily effective federal funds rate on date t. The notation λ_t represents the complete set of 538 dummies for each business day in the sample. The variable *riskcat* equals 1 when bank i is in risk category c. As before, the variable I_{jt} equals 1 when date t is a special day of type j, 0 otherwise where $j = 1, \ldots, 5$ represents year-, quarter-, and month-end, settlement days, and high payment days. Because it is likely that the observations of individual bank risk premiums are correlated on any given day and quite possible over time as well, the error term ε_{it} is allowed to be both heteroskedastic and correlated across errors in the same cluster of observations. The reported results define a cluster as all bank-date observations occurring within the same reserve maintenance period.[9] Standard errors in Table 2 are adjusted for potential clustering using the method of Rogers (1993).

[9] Both Hamilton (1996) and Furfine (2000) develop models that indicate that serial correlation in the daily effective federal funds rate would not extend across reserve maintenance periods. Thus, it seems natural to make this clustering assumption. For robustness, the regression was reestimated with a cluster defined as all bank-date observations ranging from the 16th of one month to the 15th of the next. With this alternative definition, standard errors are adjusted only slightly from those reported in Table 2.

The first column of Table 2 reports the coefficients on the borrowing institution's risk category. Given that risk categories were defined based upon observed risk premiums paid, it is no surprise that the coefficient estimates of 10.7 and 34.9 basis points in the first column show banks in the higher risk categories pay higher rates than banks in the safest category. The next five columns report the influence of a bank's "normal" risk category on the premium paid on special days. As before, the results in the last five columns of Table 2 report differences from normal. The second column of Table 2 indicates that risk premiums increase dramatically at year-end. Specifically, banks that typically pay a risk premium of 10.7 basis points pay a premium of 54.7 ($10.7 + 44.0$) basis points at year-end. The riskiest banks that normally pay a 34.9 basis point premium pay 95.2 basis points more than safe banks at year-end. Quarter-end days also witness an increase in risk premiums for banks in the riskiest category, although of a noticeably smaller magnitude than that seen at year-end. While a similar change of risk premiums is found on high payment days, the magnitude of the effect is much smaller than what is observed at year-end and quarter-end. Thus, the results of Table 2 further suggest a dramatic increase in risk premiums at year-end, with some evidence of a similar but smaller change at quarter-end.

5. Can window dressing explain the year-end increase in risk premiums?

The results of Section 4 document that riskier banks pay higher rates to borrow across the year-end than they do on other days. One possible explanation for this finding is that the price to bear risk increases at year-end. As mentioned before, such a systematic repricing may relate to the incentive to window dress around public disclosure dates. In particular, banks may wish to hold safer than average interbank loan portfolios on days when information regarding these portfolios is revealed to the public. Support for this hypothesis is provided in this section.

Musto (1997, 1999) argues that institutions must be paid an additional premium to bear risk at year-end, as these dates are typically associated with disclosure requirements. In other words, institutions actively adjust their balance sheet to disclose a preferred portfolio. Translated to the funds market, Musto's argument suggests that lending institutions would demand a premium for lending to borrowers that it would prefer not to reveal around disclosure dates. With this in mind, we discuss the various participants in the federal funds market and describe any public disclosure requirements regarding their funds market activity.

Although dominated by US commercial banks, the federal funds market has a variety of participants. Table 3 lists the major borrowers and lenders in the sample used in this paper. As the table indicates, US commercial banks are responsible for 78.2% of the funds borrowed and 70.0% of the funds lent. Branches and agencies of foreign banks are the only other substantial borrowers of overnight funds and these institutions lend over 10% of aggregate funds volume as well. The federal home loan banks and government-sponsored enterprises such as Freddie Mac are notable

Table 3
Major participants in the overnight federal funds market

	Share of aggregate funds borrowed	Share of aggregate funds lent
US commercial banks	78.2	70.0
Branches and agencies of foreign banks	17.3	10.9
Federal home loan banks	0.1	8.9
Government-sponsored enterprises	0.2	4.7
Savings and loans	0.2	0.5
Credit unions	0.0	2.0

lenders in the market, while other depository institutions such as savings and loans and credit unions participate to only a very limited degree.

However, as documented in Table 4, none of the participants in the funds market is required to explicitly disclose the risk of its federal funds loans. Each quarter, US commercial banks file what is known as a call report, which details each bank's income statement and various on- and off-balance sheet items. In particular, a call report requires that a bank disclose the total value of federal funds loans and securities purchased with an intent to resell that are outstanding at the end of each quarter and the average amount outstanding during the quarter.[10] Because only total quantities are revealed on the call report, the public does not learn about the risk of the bank's federal funds loans.

Federal home loan banks and government-sponsored enterprises are only required to release an annual report and they do so at year-end. Some of the home loan banks report quarterly "summaries", although these reports are not audited. These institutions generally report only the aggregate value of federal funds loans outstanding at year-end, although the information on federal funds loans is typically separated from information on reverse repurchase agreements.

Savings and loans file a quarterly financial statement that reports aggregate federal funds and repo transactions in the same way as US commercial banks, although thrifts do not also report quarterly average values. The National Credit Union Administration ceased collecting information on federal funds transactions in 1995, so that for the period of this study credit unions did not even publicly disclose aggregate totals of federal funds transactions.

Branches and agencies of foreign banks also disclose federal funds loans together with reverse repurchase agreements. However, unlike US commercial banks and thrifts, a foreign branch or agency must disaggregate this lending into three categories: loans to other branches and agencies of other foreign banks, loans to US commercial banks, and loans to all other institutions.

At first glance, therefore, one might suspect that window dressing could not lie behind the repricing of risk found in Section 4 because none of the lenders in the

[10] Using these call report data, Allen and Saunders (1992) find that banks use the federal funds and repo markets to increase or decrease the size of their balance sheet at quarter-end.

Table 4
Public disclosures of major lenders in the overnight federal funds market

	Disclosure mechanism	Year-end	Quarter-end
US commercial banks	Call report FFIEC 0031-0034	Total federal funds sold and securities purchased under agreement to resell. Year-ending total and quarterly average	Total federal funds sold and securities purchased under agreement to resell. Quarter-ending total and quarterly average
Branches and agencies of foreign banks	Call report FFIEC 002	Total federal funds sold and securities purchased under agreement to resell. Disaggregated into funds lent to US commercial banks, other branches and agencies of foreign banks, and all other institutions. Year-ending total	Total federal funds sold and securities purchased under agreement to resell. Disaggregated into funds lent to US commercial banks, other branches and agencies of foreign banks, and all other institutions. Quarter-ending total
Federal home loan banks	Annual report, quarterly summaries	Total federal funds sold	Total federal funds sold, unaudited. Inclusion in summary varies by bank
Government-sponsored enterprises	Annual report	Total federal funds sold	None
Savings and loans	Thrift financial report OTS 1313	Total federal funds sold and securities purchased under agreement to resell. Year-ending total	Total federal funds sold and securities purchased under agreement to resell. Quarter-ending total
Credit unions	Call report NCUA 5300	None	None

market publicly discloses information sufficient to clearly reveal the overall risk of its federal funds portfolio. It is possible, however, to suggest that window dressing is likely to be a factor driving a calendar-related repricing of risk by demonstrating that window dressing does affect pricing in this market. To do so, the remainder of this section will exploit the unique disclosure requirements of foreign banks relative to all other market participants to document the relationship between disclosure requirements, interest rates, and federal funds portfolios. As mentioned, foreign lenders in the funds market must disaggregate their overnight loans into three categories based upon the type of institution that is borrowing. Conceivably, foreign banks might want to shade their federal funds portfolio towards the category of institution (i.e. other foreign banks, US commercial banks, and other institutions) that they want to reveal on disclosure dates.

Which institutions would a foreign institution wish to lend to around disclosure dates? According to the Musto (1999) hypothesis, an institution would tilt its portfolio towards safer institutions. During the sample period, US commercial banks, foreign banks, and other institutions paid a volume-weighted premium of −0.5, 3.8, and 3.6 basis points, respectively, for money borrowed.[11] As interest rate premiums in the funds market are generally less than 50 basis points, the seemingly small 4.3 basis point higher spread typically paid by foreign banks relative to US banks is a nontrivial difference. Another way to see that this 4.3 basis point difference is economically significant is by comparing this differential in spreads with the results of Furfine (2001). Although he does not consider the borrowing bank's nationality, Furfine (2001) analyzes 17 other determinants of interest rates paid on individual federal funds transactions. Of all the variables considered, he finds that only bank size influences spreads in the funds market by more than 4.3 basis points.

Thus, institutions other than US commercial banks are generally viewed as riskier borrowers in the funds market. Hence, if foreign bank *lenders* wish to window dress their balance sheet around quarterly disclosure dates, we would expect to see a marked preference for lending to US commercial banks relative to other institutions. To explore this possibility, the raw transaction data were aggregated for each borrower according to the type of lending institution. That is, for each borrower and for each date, a weighted average interest rate was calculated separately depending on whether the lender was a US commercial bank, a foreign bank, or any other institution. Expressed as a difference from the Fed's effective rate, these daily interest rate spreads for each institution/lender type were regressed on the same variables as the previous regression. In addition, the regression included dummy variables interacting a foreign-bank-lender indicator with the three relevant types of borrower classes. Formally, Table 5 presents the parameter estimates from the regression given by

$$\begin{aligned} spread_{int} = \alpha + \lambda_t + \sum_{c=2}^{3} \beta_c \; riskcat_{ic} + \sum_{c=2}^{3} \sum_{j=1}^{5} \gamma_{cj} \; riskcat_{ic} \, I_{jt} \\ + \sum_{j=0}^{5} \sum_{n=1}^{3} \theta_{jn} I_{jnt} + \varepsilon_{int}, \end{aligned} \tag{3}$$

where the dependent variable *spread* now measures the difference between the volume-weighted average interest rate paid on funds borrowed by bank i on date t of classification n and the daily effective federal funds rate on date t. The different classifications $n = 0, \ldots, 3$ represent transactions when (0) a domestic bank lends to any counterparty, (1) a foreign bank lends to a US commercial bank, (2) a foreign bank lends to a foreign bank, and (3) a foreign bank lends to any other institution. Once again, the regression includes a set of 538 dummies for each business day in the sample and the interaction of bank risk categories and the five calendar-related indicator variables. Also as before, the method of Rogers (1993) is used to make the computed standard errors robust to heteroskedasticity and cross-sectional correlation in the error term, ε_{int}.

[11] The difference between the average rate paid by US commercial banks and that paid by each of the other two categories is statistically significant at the 5% level.

Table 5
Panel evidence on calendar variation in the pricing of risk in the federal funds market, by type of institution

	Normal days	Coefficients represent differences from normal				
		Last day of year	Last day of quarter	Last day of month	Settlement days	High payment days
Borrower risk category						
Safest	Baseline					
Middle	0.089	0.445	0.131	0.025	0.023	0.030
	(0.003)[b]	(0.073)[b]	(0.028)[b]	(0.011)[a]	(0.009)[b]	(0.008)[b]
Riskiest	0.335	0.670	0.217	− 0.016	0.034	0.025
	(0.009)[b]	(0.189)[b]	(0.056)[b]	(0.020)	(0.020)	(0.021)
Transaction type						
Domestic entity to any	Baseline	Baseline				
Foreign bank to US commercial bank	− 0.014	− 0.256	− 0.112	0.004	− 0.053	− 0.025
	(0.003)[b]	(0.066)[b]	(0.048)[a]	(0.006)	(0.015)[b]	(0.014)
Foreign bank to foreign bank	− 0.012	− 0.001	0.005	0.020	0.020	− 0.027
	(0.003)[b]	(0.093)	(0.071)	(0.015)	(0.010)	(0.014)
Foreign bank to other	− 0.012	0.149	0.243	0.020	0.065	− 0.011
	(0.004)[b]	(0.128)	(0.150)	(0.040)	(0.021)[b]	(0.012)
Observations	152,183	1,088	2,282	5,539	19,742	13,138

Robust standard errors in parentheses.
[a] Significant at 5% level;
[b] Significant at 1% level.

Note: This table presents the values of β_c, γ_{cj}, and θ_{jn}, $c = 2, 3$, $j = 1,\ldots,5$ and $n = 1,\ldots,3$ from the regression

$$spread_{int} = \alpha + \lambda_t + \sum_{c=2}^{3} \beta_c \; riskcat_{ic} + \sum_{c=2}^{3} \sum_{j=1}^{5} \gamma_{cj} \; riskcat_{ic} \; I_{jt} + \sum_{j=0}^{5} \sum_{n=1}^{3} \theta_{jn} I_{jnt} + \varepsilon_{int},$$

where $spread_{int}$ measures the difference between the volume-weighted average interest rate paid on funds borrowed by bank i on date t of classification n and the daily effective federal funds rate on date t. $n = 0,\ldots,3$ represents transaction classifications indicating transactions of (0) domestic bank lends, (1) foreign bank lends to US commercial bank, (2) foreign bank lends to foreign bank, and (3) foreign bank lends to other. α is a constant term. λ_t represents a set of 538 dummies for each business day in the sample. $riskcat_{ic}$ equals 1 when bank i is in risk category c, where the risk categories are defined as banks that on average borrow at a rate (1) below the effective rate, (2) between the effective rate and 25 basis points above the effective rate, and (3) more than 25 basis points above the effective rate. I_{jt} equals 1 when date t is a special day of type j, 0 otherwise. $j = 1,\ldots,5$ represents year-, quarter-, and month-end, settlement days, and high payment days. I_{jnt} equals 1 when date t is a special day of type j and r_{itc} refers to classification n, 0 otherwise. $j = 0$ represents normal days. ε_{int} is the error term, allowed to be heteroskedastic and correlated across errors in the same cluster. A cluster is defined as all bank-date observations occurring within the same reserve maintenance period.

As before, the regression results shown in Table 5 reveal the behavior of risk premiums across various types of days. The calendar-related repricing estimates shown at the top of Table 5 are similar to those reported in Table 2. The bottom rows of Table 5 report the estimated coefficients on transactions involving money lent from a foreign bank. The first column indicates that on normal days, the nationality of the borrower and lender influences the interest rate paid by no more than 2 basis points.[12] The results in the second and third columns reveal evidence of window-dressing-induced repricing. At year-end, lending by foreign banks to US commercial banks is done at a rate 25.6 basis points lower than domestic institutions lend, whereas other foreign lending is undertaken at a rate indistinguishable from domestic institution lending. At quarter-end, foreign banks accept 11.2 basis points less to lend to US commercial banks. These results suggest that foreign lenders are willing to accept a notably lower interest rate on their loans in order to hold a higher proportion of loans to institutions that are perceived to be safer, i.e. US commercial banks, on public disclosure dates.[13]

To confirm that the year-end reduction in premiums received by foreign banks that lend to US banks is related to portfolio rebalancing, the following time series regression is estimated:

$$spread_t = \alpha + \sum_{j=1}^{5} \phi_j I_{jt} + \beta_0 \ relative\ share_t + \sum_{j=1}^{5} \beta_j I_{jt} \ relative\ share_t + \varepsilon_t. \quad (4)$$

The dependent variable *spread* is defined to be the average rate (weighted by volume across all transactions on date t) received by foreign banks when they lend to a US bank less the average rate received by foreign banks when they lend to another foreign bank. Thus, the dependent variable is a measure of the *price* of lending to US banks relative to foreign banks. The variable *relative share* is the fraction of total foreign bank lending that was to US banks on date t. This variable, which is also interacted with the five calendar-related measures, is a measure of the *quantity* of foreign bank lending to US banks relative to foreign banks.

The coefficient estimates from this regression are shown in Table 6. Regressing proxies of price on proxies of quantity may not deliver statistically significant coefficient estimates due to the confounding effects of both supply and demand shifts. Thus, the estimate for β_0 of 0.001 is not surprising. It suggests that on normal days, spreads and portfolio shares are neither positively correlated (e.g. higher lending by foreign banks to US banks driven by an increase in the demand for such borrowing by US banks leading to a related increase in the price) nor negatively correlated (e.g. higher lending by foreign banks to US banks driven by an increase in the supply of such lending by foreign banks leading to a related decrease in the price). Rather, the evidence suggests that the normal relationship between spreads and shares is affected by both supply and demand considerations that, to a first approximation, cancel each other out.

[12] This conclusion reflects a non-weighted average of bank/transaction-type observations. Thus, this does not conflict with the earlier finding that on normal days, foreign banks pay a volume-weighted average of 4.3 basis points more than US commercial banks.

[13] That this effect shows up as a negative coefficient on foreign to domestic lending rather than as a positive coefficient on foreign to foreign lending indicates that in general, foreign lenders fare worse than their domestic counterparts on disclosure dates.

Table 6
Time series evidence on the relationship between spreads and portfolios of foreign banks in the federal funds market

	Normal days	Coefficients represent differences from normal				
		Last day of year	Last day of quarter	Last day of month	Settlement days	High payment days
Special day indicators	− 0.009 (0.025)	4.515 (1.787)[b]	− 0.080 (0.731)	− 0.503 (0.244)[a]	0.032 (0.124)	0.128 (0.092)
Special day indicators interacted with relative share	0.001 (0.040)	− 6.345 (2.487)[b]	− 0.148 (1.209)	0.714 (0.353)[a]	− 0.104 (0.182)	− 0.250 (0.156)
Observations	422	3	6	17	54	36

Standard errors calculated using method of Newey and West (1987) shown in parentheses.
[a] Significant at 5% level;
[b] Significant at 1% level.
Note: This table presents the values of α, ϕ_j, $j = 1, \ldots, 5$, β_j, $j = 0, \ldots, 5$ from the regression

$$spread_t = \alpha + \sum_{j=1}^{5} \phi_j I_{jt} + \beta_0 \ relative \ share_t + \sum_{j=1}^{5} \beta_j I_{jt} \ relative \ share_t + \ \varepsilon_t,$$

where $spread_t$ measures the difference between the volume-weighted average interest rate received for funds lent by foreign banks to US banks and the volume-weighted average interest rates received for funds lent by foreign banks to foreign banks on date t. α is a constant term. $relative\ share_t$ is defined as the total lending by foreign banks to US banks on date t divided by the total lending by foreign banks on date t. I_{jt} equals 1 when date t is a special day of type j, 0 otherwise. $j = 1, \ldots, 5$ represents year-, quarter-, and month-end, settlement days, and high payment days. ε_t is the error term, allowed to be heteroskedastic and serial correlated up to lag length of ten business days.

Contrast the finding of $\beta_0 \approx 0$ with the finding that the coefficient on the interaction between relative share and the year-end dummy is negative, highly statistically significant, and economically large ($\beta_1 = -6.345$). This suggests that at year-end, an increase in the share of foreign banks' interbank loan portfolio directed to US banks is correlated with a decline in the interest rate received by foreign bank lending to US banks relative to foreign bank lending to other foreign banks. To the extent that this relationship is causal, the estimated value of β_1 suggests that for each additional 1% portfolio shift towards lending to US banks, foreign banks sacrifice over 6 basis points in spread.[14]

Table 5 indicated that foreign banks receive lower interest rates when lending to US banks at year-end. Table 6 documents that at year-end, the decline in interest rates received by foreign banks when lending to US banks is correlated with an

[14] Table 6 also indicates a correlation between portfolio shares and spreads at month-end. However, the magnitude of the estimated correlation is much smaller and is of the opposite sign to that found at year-end. Further, Table 5 indicates that there is no pattern to spreads received by foreign banks that lend at month-end.

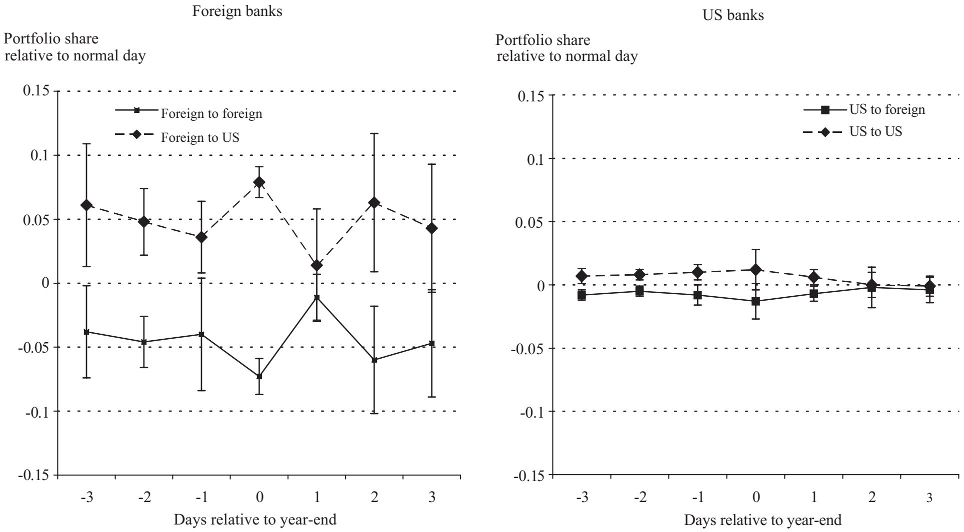

Fig. 1. Panel evidence on calendar variation in interbank loan portfolios, by type of institution. The left (right) panel plots the values and two-standard-deviation bars of $\gamma_{c,\text{yearend}+q}$, $q = -3, \ldots, 3$ from the two regressions ($c = 1, 2$) using only the sample of lending banks that are chartered outside (within) the United States

$$relative\ share_{ict} = \alpha + \sum_{q=-3}^{3} \gamma_{cq} I_{\text{yearend},t+q} + \sum_{j=2}^{5} \phi_{cj} I_{jt} + \varepsilon_{ict},$$

where *relative share*$_{ict}$ measures the difference between the share of bank i's federal funds loan portfolio that was of type c on date t and bank i's average share of lending of type c by bank i on normal days. $c = 1, 2$ represents loans to US banks and foreign banks, respectively. α is a constant term. $I_{\text{yearend},t+q}$ equals 1 when date $t+q$ is a year-end, 0 otherwise. I_{jt} equals 1 when date t is a special day of type j, 0 otherwise. $j = 2, \ldots, 5$ represents quarter-, and month-end, settlement days, and high payment days. ε_{ict} is the error term, allowed to be heteroskedastic and correlated across errors in the same cluster. A cluster is defined as all bank-date observations occurring within the same reserve maintenance period.

increase in foreign bank portfolio shares of lending to US banks. What remains to document is the magnitude of the portfolio shift by foreign banks. To do so, Fig. 1 plots the γ coefficients and two standard error bars estimated from the regression

$$relative\ share_{ict} = \alpha + \sum_{q=-3}^{3} \gamma_{cq}\ I_{\text{yearend},t+q} + \sum_{j=2}^{5} \phi_{cj} I_{jt} + \varepsilon_{ict}, \tag{5}$$

where the dependent variable *relative share* is now defined to measure the difference between the share of bank i's federal funds loan portfolio that was of type c on date t and the share of lending that bank i does of type c, on average, on normal days. The classification $c = 1, 2$ represents loans to US banks and foreign banks, respectively.

According to the previous results, we expect to find that foreign banks reallocate their federal funds loans away from foreign banks towards US banks. As the left panel of Fig. 1 documents, foreign bank portfolios at year-end hold an 8% greater share of loans to US borrowers and a similarly lower share of loans to foreign borrowers relative to normal days. The two standard error bars indicate that this year-end portfolio shift is highly statistically significant, too. The left panel also indicates similar portfolio shifts by foreign banks on nearby days, although they are always of a smaller magnitude and estimated with far less precision than the effect estimated at year-end.

6. Other explanations?

Section 5 documented that the unique disclosure requirements of foreign banks create an incentive for foreign banks to tilt their lending towards US banks around disclosure dates. Further, Tables 5 and 6 and Fig. 1 presented evidence suggesting that window dressing plays a key role in the repricing of risk at year-end. Nonetheless, one cannot be certain that these results are not being driven by seasonal patterns in the quantity of risk. More specifically, an alternative interpretation of the repricing found in Section 4 is that riskier institutions become relatively riskier at year-end. If this were true, one would expect to find that this change in the quantity of risk would reveal itself in higher credit spreads. Further, regardless of any disclosure requirements, one might believe that since foreign banks are typically riskier, this year-end increase in relative risk might lead to the repricing and portfolio rebalancing documented in Section 5.

If risk premiums rise at year-end due to a seasonal increase in the quantity of risk, one might expect to find more defaults on December 31 than on other days of the year. In Musto (1997), the author cites the evidence of Fons and Bergqwist (1994), who report that there were no domestic or foreign defaults at year-end on either rated or unrated commercial paper between 1972 and 1993. This, Musto (1997) argues, casts doubts on the hypothesis that risk rises at year-end. Perhaps more relevant to the current study, the Federal Deposit Insurance Corporation (2001) reports that none of the 337 bank failures between January 1, 1991 and May 3, 2001 occurred precisely at year-end. Although evidence of more failures at year-end would be supportive of an increase in year-end risk, the absence of year-end failures does not necessarily refute the possibility that such a calendar-related change in the quantity of risk is responsible for the repricing found. This is because the increase in default risk documented in Table 2 of 60 basis points at an annual rate translates into an increased chance of failure at year-end of approximately 1.6 in 10,000. There are simply too few observations to precisely estimate changes in outcomes that happen so rarely.

Even if it were possible to refute higher year-end default probabilities with the data, one might still believe that market participants act as if the year-end were riskier. Of particular concern with regard to the previous analysis is that one of the three year-end dates in the sample period is December 31, 1999. Because this year-end was associated with Y2K, it could have been the case that additional risk premiums were charged for the possibility of unique millennium-ending catastrophes that would affect financial institutions. To determine whether this unique event could be driving the previous results, all the regressions in the paper were repeated with observations from December 31, 1999 removed from the sample. Although the magnitude of the effects differed slightly, year-end increases in risk premiums and foreign banks' year-end willingness to accept less for lending to US banks were still both statistically and economically significant.

It is difficult to argue persuasively that a change in the quantity of risk at year-end does not play *any* role in the empirical results of this paper. Rather, the evidence suggests that window dressing does lead to significant repricing and portfolio rebalancing. If this were not the case, US banks would have the same incentive as foreign banks to shift their portfolios away from foreign institutions at year-end. However, the right panel of Fig. 1 indicates that US banks do not alter the composition of their interbank loan portfolio between foreign and domestic banks at or immediately after the year-end. During the three days prior to the year-end, US banks do tend to lend more to other US banks, but only slightly, with the portfolio share of interbank loans to US banks rising by around 1%. This result suggests that the unique nature of disclosure requirements faced by foreign banks contributes to the repricing of risk and portfolio rebalancing presented in this paper.

7. Summary and conclusion

A close examination of cross-sectional differences in pricing based upon transaction level data suggests that there is a significant increase in the price of risk in the federal funds market at year-end. This repricing is driven by market participants and, to the extent that the participants' incentives do not change, is likely to continue. The particular incentive illustrated is the desire to reveal a safer portfolio on public disclosure dates. Evidence was found suggesting that foreign banks try to disclose greater lending to (the safer) US commercial banks on disclosure dates, and are willing to sacrifice over 25 basis points to do so at year-end.

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