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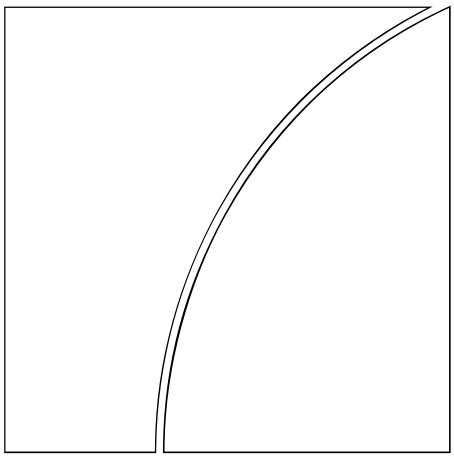

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The costs and benefits of moral suasion: Evidence from the rescue of long-term capital management

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Abstract

This study examines the level of unsecured borrowing done by the firms that would ultimately rescue Long-Term Capital Management in the days leading up to the hedge fund's rescue. Although there is some evidence that these banks borrowed less at the height of the crisis, further examination reveals that this reduction in borrowing was demand-driven and did not result from rationing on the part of the market. This suggests that the market believed that the troubles at LTCM would not have solvency-threatening repercussions for the fund's major creditors. Further, it is shown that large banks that were not involved with the LTCM rescue saw the rates they pay for unsecured funds decline following the hedge fund's resolution. This finding is consistent with an increase in the perceived strength of a too-big-to-fail policy.

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Introduction[1]

The events surrounding the trouble experienced by Long-Term Capital Management (LTCM) and its eventual rescue were portrayed, as they were happening, as a serious threat to the health of the US economy. As is well known, the Federal Reserve played a key role in organising and hosting meetings between LTCM and the institutions that would ultimately rescue the troubled hedge fund. In justifying Fed involvement in the resolution, Federal Reserve Bank of New York President William J McDonough said, "The abrupt and disorderly closeout of Long-Term Capital's positions would pose unacceptable risks to the US economy" (McDonough (1998), p 1051). This quote emphasises that much of what was driving the Fed's involvement with LTCM was the uncertainty regarding the consequences of doing the alternative, namely letting the fund collapse and having its financial contracts unwound in a forced liquidation. Because it was difficult to know what might have happened in the absence of Fed involvement, policymakers chose to facilitate a resolution that allowed the hedge fund's financial contracts to be closed out in an orderly fashion. One important consequence of the Fed's choice was that it avoided potentially excessive financial hardship or possibly the failure of major commercial and investment banks.

After the fact, it is difficult to determine whether or not the Fed's decision to intervene was a good one because one can only directly observe the benefits of the action (orderly resolution and no major bank failures) but not the costs. Nevertheless, this paper attempts to provide some evidence on the magnitude of the benefits and costs of the Fed's action. To do so, we will focus on a set of nine large commercial banks that ultimately were part of the group of 14 institutions that jointly rescued LTCM. The paper will refer to these institutions as the major bank "creditors" of LTCM, although the term creditors should be interpreted broadly. While it is presumed that these institutions would have experienced significant losses had LTCM not been resolved in an orderly manner, these potential losses need not have arisen from direct credit exposures to LTCM. Rather, it could have been the case that these institutions were holding proprietary trading positions similar to those of the hedge fund, thereby making them similarly exposed to market movements that might follow a forced liquidation of LTCM.

To shed light on the magnitude of the benefits of Fed involvement, the paper will examine whether financial markets thought that the troubled hedge fund would cause the failure of or major distress to other financial institutions. In particular, the paper will examine the level of unsecured overnight borrowing done by these nine institutions as an indication of whether the market believed that these banks had a significant risk of insolvency during September 1998. If markets believed that the solvency of these nine institutions was in doubt, then these institutions should have had trouble borrowing large quantities of unsecured funding overnight.[2]

To consider the potential costs of Fed involvement, we look for evidence that might suggest that the safety net was expanded by the Fed's involvement with LTCM. For example, if the market interpreted Fed intervention as a strengthening of an implicit too-big-to-fail (TBTF) policy, then one might expect large banks that were not creditors of LTCM to have been viewed as an implicitly safer counterparty after the resolution relative to before the crisis. The ability of such institutions to borrow at more favourable terms following the resolution of LTCM would be evidence in support of this notion. To address this question, we examine the rates paid by large banks that were not exposed to LTCM before and after the hedge fund's resolution.

Analysis of data from the unsecured, overnight federal funds market delivers the following empirical results. First, the nine large commercial bank counterparties to LTCM reduced their borrowing of overnight, unsecured funds during the last days of the crisis period. However, it is shown that this reduction was accompanied by an increase in the gross level of overnight lending done by these same institutions. These two findings jointly suggest that the nine banks were voluntarily reducing their net

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[1] The author appreciates the helpful comments received from Kristian Rydqvist, René Stulz, and Juha Tarkka, participants at the 2000 American Economics Association meeting, the 2001 CEPR Workshop on Moral Hazard Issues in Banking, and the 37th Annual Conference on Bank Structure and Competition, and colleagues at the Bank for International Settlements. The views expressed are those of the author and do not necessarily reflect the views of the Bank for International Settlements.

[2] Implicitly, the empirical tests are a joint test of the market's belief that LTCM would cause a creditor bank to fail and that policymakers would allow these creditor banks to fail. Too-big-to-fail issues are discussed more fully in later sections.

borrowing of overnight funds rather than being rationed from the market. The lack of rationing, in turn, implies that market participants were not overly worried about the solvency of these institutions. The paper then finds that large and complex US commercial banks that were not exposed to LTCM paid lower interest rates to borrow overnight unsecured money after the hedge fund's rescue than they did before the crisis began to unfold. One interpretation of this finding is that the market has viewed the Fed's action as an enhancement of TBTF.

The paper is organised as follows. Section 2 discusses the benefits and costs of the LTCM rescue. Section 3 briefly reviews what the literature has concluded about the LTCM episode. Section 4 describes the data used in the study. The empirical results regarding the market's view of the solvency of the LTCM creditor banks are given in Section 5. Section 6 provides some evidence on the potential costs of Fed intervention. Section 7 concludes.

Benefits and costs

On 23 September 1998 it was announced that a consortium of 14 large financial institutions had come to the collective rescue of the hedge fund Long-Term Capital Management. Further, this rescue was facilitated by the Federal Reserve Bank of New York through its provision of "good offices" (Greenspan (1998), p 1048). Barring such a rescue, it was feared that the forced liquidation of the heavily leveraged hedge fund would lead to large losses at many of the world's largest commercial and investment banks. Further, these losses might cause these institutions to begin unwinding financial positions and liquidating collateral that could, in turn, lead to unpredictable and possibly severe price movements and extensive financial losses at a much broader set of financial institutions. In explaining the Fed's role in testimony to Congress, Fed Chair Alan Greenspan said, "... there is no reason for central bank involvement unless there is a substantial probability that a fire sale would result in severe, widespread, and prolonged disruptions to financial market activity" (Greenspan (1998), p 1047). Federal Reserve Bank of New York President William McDonough supported Greenspan's position by arguing in similar Congressional testimony, "... there was a likelihood that a number of credit and interest rate markets would experience extreme price moves and possibly cease to function for a period of one or more days and maybe longer" (McDonough (1998), p 1052).

In addition to the views expressed by Fed policymakers, other observers have portrayed the Fed's role as the action of a risk-averse central bank hoping to avoid unpredictable and potentially solvency-threatening losses at major financial institutions. As Edwards (1999) argues,

> "Perhaps the more honest case for Fed intervention in LTCM would not pretend that the Fed was merely an interested bystander, but would simply argue that it was the best way for regulators to intervene ... had LTCM not been rescued, and had the solvency of banks and securities firms been threatened due to a fire sale liquidation of LTCM's positions, then regulators would have to decide between relaxing capital standards [or] forcing the closure or re-capitalisation of some large institutions" (Edwards (1999), p 204).

Overall, then, the possible benefits of Fed intervention have at least two dimensions. First, such policymaker action would limit the market disruption arising from a forced liquidation of LTCM. Second, Fed intervention would prevent the failure of any major commercial or investment bank, thereby avoiding the disruptions to economic activity that such a failure might cause.

With regard to the costs of the Fed's role in the LTCM resolution, some have argued that facilitating a private sector rescue of a failing hedge fund was "too-big-to-fail" in disguise. In other words, since the Fed's action prevented major commercial and investment banks from having to pay the full costs of a market-imposed failure of LTCM, the central bank may have set a damaging precedent that implicitly extends the safety net. With regard to this possibility, the Fed has consistently argued that the costs of its actions were not likely to be severe. McDonough emphasised to Congress, "… no Federal Reserve official pressured anyone, and no promises were made. Not one penny of public money was spent or committed" (McDonough (1998), p 1053). Policymakers, however, did not claim that their actions could be taken without regard for the potential impact on the safety net. As Greenspan concluded, "We do not have the choice of accepting the benefits of the current system [of a wide safety net] without its costs" (Greenspan (1998), p 1050). As Edwards (1999) explains the issue,

> "… quickly bailing out creditors and investors makes markets more fragile in the long-run, so that when a market fracture occurs, it becomes even more difficult to contain the damage … [however] … [r]egulators have an obvious bias to intervene to prevent real and imagined crises on their watch, even if the long-term consequences pile up because of greater risk-taking" (Edwards (1999), p 203).

The previous discussion documents both the benefits and costs of Fed involvement in the LTCM rescue. In what follows, the market's perception of one of the benefits, namely preventing the failure of major financial institutions, is examined. The conclusion reached, that the solvency of the major LTCM creditors was never in serious doubt, is in part already understood. In particular, months after the rescue, Fed Governor Laurence Meyer reported to Congress on the Fed's review of supervisory practices following the LTCM incident and stated, "Our reviews indicated and the financial results indicate that, while the LTCM incident and other episodes over the past two years may have significantly impacted earnings, they did not threaten the solvency of any U.S. commercial banking institution" (Meyer (1999), p 317). What is novel about this paper, however, is that one can glean from the data what the market's perception of the LTCM banks' insolvency risk was at the time that the crisis was developing. Thus, the findings could conceivably have been an input to any policymaker decision. Further, the finding that the LTCM resolution might have been interpreted as an extension of the safety net suggests that the Fed's action may not have been costless, despite not directly involving any public money.

Previous studies

With the exception of numerous press accounts and public statements by various Fed officials, there has been relatively little work related to the events surrounding the collapse of LTCM. In general, studies of this episode are hindered by the lack of publicly available information on the trading positions taken by LTCM and other institutions. Of the few academic analyses of the LTCM episode, Scholes (2000) and Jorion (2000) both discuss the lessons for modern risk management practices. Being involved with LTCM, it is not surprising that Scholes (2000) concludes that failures in the hedge fund's sophisticated value-at-risk (VaR) models were not the cause of the fund's demise. Rather, he believes the main lesson to be drawn is that policymakers and firms should rely more heavily on stress testing to ascertain vulnerabilities to potential crises. Jorion (2000), while agreeing with Scholes that VaR approaches to risk management are not inherently flawed, does take issue with how the hedge fund applied this methodology. He shows that the method by which LTCM used VaR, namely optimising portfolios subject to a VaR constraint, leads to potentially significant biases in the estimation of portfolio risk. Further, he stresses that LTCM made faulty assumptions with regard to portfolio correlations, arguing persuasively that many of LTCM's supposedly uncorrelated positions were uniformly exposed to the risk of a generalised flight to liquidity. Thus, the blame for LTCM's demise lies not in the VaR methodology, but rather in its implementation.[3]

With regard to the potential costs of Fed intervention, Edwards (1999), in a qualitative discussion of the LTCM crisis, argues that the Fed's intervention in the LTCM episode will "probably not" expand the safety net (Edwards (1999), p 204). He further provides a useful background to the LTCM episode by documenting the growing significance of hedge funds and the events that led to LTCM's demise. Edwards also notes that the Fed could have used traditional lender of last resort facilities to address the hedge fund's problems rather than provide "good offices".

Of particular relevance to this paper is a recent study by Kho, Lee, and Stulz (2000). These authors document an economically large and statistically significant decline in the equity price of the firms that would ultimately participate in the bailout of LTCM on or about 2 September, when it first became public that LTCM had suffered very large losses in the month of August. Such a decline in equity prices did not occur in large banks that did not ultimately participate in the LTCM rescue. This result leads the authors to conclude that "... the market was perfectly capable of distinguishing between

[3] In contrast to these studies on the use of risk management by LTCM, Bank for International Settlements (1999a) emphasises the lack of proper risk management on the part of the banks that had relationships with LTCM.

banks that were at risk and those that were not three weeks before the rescue" (Kho et al (2000), p 7). Thus, their evidence runs counter to the claim that it was nearly impossible to know exactly who would be most affected by a forced liquidation if one were to have occurred.

The role of the federal funds market and data construction

In this paper, we use data on the unsecured federal funds market. Before explaining how the data were constructed, it is useful to explain the general role of overnight money markets in the day-to-day management of financial institutions. Banks use overnight money markets as their marginal source and use of funds. For instance, a bank that has excess funds may find it beneficial to lend to another institution overnight. This lending can be done against collateral, in which case this transaction is deemed a reverse repurchase (repo) agreement. Alternatively, the loan can be unsecured. Depending on the method by which the money is transferred, this loan of unsecured overnight money may be a federal funds transaction. Conversely, a bank may find itself short of funds one day. Such a bank might therefore increase its overnight borrowing and, again, the most common approaches would be to enter into a repo transaction or to borrow unsecured.

Nearly all unsecured overnight borrowing between US commercial banks is settled (ie the money is delivered) using Fedwire, the large-value transfer system owned and operated by the Federal Reserve, and thus these loans have become known as federal funds transactions.[4] These unsecured loans form the basis of the analysis conducted in the following two sections. To identify individual transactions, data on every payment transferred across Fedwire during 1998 were collected.[5] Each payment identifies, among other items, the sending and the receiving bank and the amount, in dollars and cents. Only a relatively small number of the approximately 375,000 Fedwire payments each day are either the delivery or the repayment of a federal funds loan. Stigum (1990) states that federal funds transactions are typically in round lots and are at least $1 million in value. Therefore, Fedwire payments that were at least $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 satisfied this initial criterion. Then, for each of these possible deliveries, the following 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 restricted to range between 50 basis points below the minimum and 50 basis points above the maximum rates witnessed by the federal funds brokers surveyed each day by the Fed.

Pairs of payments on adjoining business days satisfying these search criteria were identified as a federal funds transaction. For example, if the Fedwire transaction data contain 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%.[6] This process identified 781,675 transactions over the 252 business days.[7] Based on the information contained in the underlying Fedwire payments, each transaction identifies the borrowing bank, the lending bank, the amount of the loan, and (implicitly) the interest rate charged.

Economic theory suggests that riskier financial institutions should pay higher interest rates when they borrow money. Furfine (2001) documents that this holds true in practice in the overnight federal funds

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[4] Respondents may also lend money unsecured and overnight to their correspondent bank, but these transactions are processed as accounting entries on the books of the banks and therefore do not involve Fedwire.

[5] The Fedwire system distinguishes between payments made on the "funds" system from those made on the "book entry" system. The funds system tracks payments that are not contingent upon any other payment. This system will include both the delivery and the repayment of federal funds transactions. The book-entry system records payments made at the same time as a security is being delivered. Thus, the book-entry system would track the funds transfer end of repurchase agreements on securities eligible for Fedwire settlement. The data in this study come from Fedwire funds payments and therefore will not include the funding leg of a repo transaction.

[6] Federal funds transactions are quoted on a discount yield basis.

[7] By design, this search approach only identifies overnight transactions. However, according to a Federal Reserve Bank of New York (1987) survey, overnight transactions account for 96% of the funds market.

market. However, if a bank is perceived to be at any significant risk of failure, it becomes more likely that it will find itself rationed from borrowing in overnight, unsecured markets rather than simply forced to pay a higher rate of interest. A simple example illustrates this point. Suppose a bank is perceived to have a 1% chance of defaulting on a one-year obligation. Assuming risk neutrality implies that the bank will pay interest at a rate 1% higher than the risk-free rate for unsecured money.[8] Suppose, by contrast, that it is perceived that a bank has a 1% chance of defaulting on a one-day obligation. The 1% overnight default risk leads to an interest rate risk premium of 3,678% when expressed at an annual rate.[9] Such huge risk premiums do not exist in overnight money markets as potential lenders choose simply to refrain from lending unsecured to institutions with any appreciable probability of default. Simply stated, markets are generally only willing to lend unsecured when the borrower has a relatively small probability of default. Thus, two federal funds borrowers with slightly different, yet small default risks will pay slightly different interest rates. A third borrower, which has a noticeably higher probability of default, will find it difficult to attract funds at any rate of interest.

To obtain an indication of how high default risk must go before quantity rationing sets in, Figure 1 graphs the distribution of interest rate premiums paid by all institutions that borrowed in the funds market at least once during the first half of 1998. A bank's premium is defined as the volume-weighted average of the difference between the interest rate paid less the daily effective funds rate.[10] As indicated by the white boxes, spreads cover a range of more than 100 basis points. However, banks that were either big or complex are captured virtually completely within 20 basis points, and banks that ultimately participated in the rescue of LTCM, on average, all paid between 0 and 10 basis points above the effective rate for funds borrowed during the first half of 1998. Thus, if one of the creditors of LTCM was willing to pay interest at a rate much higher than 10 basis points above the effective rate, this could have the effect of signalling to the market that the institution was in serious difficulty. As an illustration, suppose that an LTCM creditor might pay 25 basis points above its normal rate for overnight funds before withdrawing from the market.[11] This additional risk premium compensates lenders for an increase in overnight default risk of 1 in 144,000.[12]

The relationship between the level of default risk and whether a bank pays a higher rate of interest or is quantity-rationed has implications for the methodology employed in the following two sections. When examining the borrowing of LTCM creditor banks in the days leading up to the LTCM rescue, what is of interest is the market's perception of whether overnight default probabilities became non-trivial. Thus, it is appropriate to focus on the quantities borrowed by the LTCM creditors rather than the interest rates that these institutions were paying. By contrast, when examining the aftermath of the LTCM episode to examine whether there was an increase in the strength of a TBTF policy, one is interested to know whether the markets believed that a small decrease had occurred in certain banks' probability of default. Thus, it is appropriate to focus on the interest rates paid by institutions potentially made better off by the resolution.

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[8] Implicit in this calculation is a 100% loss given default.

[9] Calculated as $(1.01)^{365} - 1$.

[10] The daily effective funds rate is the volume-weighted average of all funds traded in this market that were brokered by the set of firms surveyed each day by the Federal Reserve.

[11] 25 basis points may be a reasonable estimate of how much a bank could reasonably be expected to pay relative to its peers before being rationed from the market. For instance, during the height of the fears regarding Continental Illinois, Ellis and Flannery (1992) note that Continental failed to report offering rates for its uninsured CDs between 16 May and 3 October 1984, signalling that no interest rate would compensate potential lenders for the non-trivial risk of default. In the two weeks immediately prior to its absence from this market, the rates offered by Continental Illinois were, on average, 25.9 basis points above the average rate offered by other large banks.

[12] Calculated as (0.0025/360).

Evidence from before the resolution

The empirical model

The hypothesis to be tested in this section is whether participants in the federal funds market rationed the major creditors to LTCM in the days leading up to the hedge fund's rescue. To examine this question empirically, one must specify who the major creditors are. Following Kho et al (2000), this paper assumes that the 14 institutions that later agreed to rescue the hedge fund were the major creditors.[13] Of the 14, however, four (Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley) are investment banks. As such, these institutions do not have accounts at a Federal Reserve Bank and therefore the overnight funding of these institutions is not included in the data constructed. Of the remaining 10 institutions, only nine participate directly in the overnight federal funds market and can be identified in the data.

To detect differences between borrowing levels immediately before the resolution and those during normal periods, it was required to limit the sample to institutions with enough presence in the funds market to construe what "normal" levels were. Defining the first six months of 1998 as the "normal" period, the sample was trimmed to comprise active market participants, chosen as those institutions that borrowed funds at least three out of every four days during the 126 business days of the first half of 1998. This selection criterion identified 164 institutions, including all nine LTCM commercial bank creditors.

It is not possible to use the level of a bank's daily borrowing as the dependent variable in a regression analysis. As Table 1 indicates, the banks in the sample have notably different typical levels of activity in the federal funds market. For instance, the largest borrowing total on a single day for a single bank was nearly $30 billion, yet the mean borrowing level for a typical active market participant is only $369 million. To control for the dramatic differences in borrowing levels across banks in the sample, a modified *z-score* measure of a bank *i*'s *borrowing* of overnight federal funds on day *t*, zb_{it}, was constructed as follows. The mean and standard deviation of a bank's borrowing during the first half of 1998 was calculated for each of the 164 institutions. Then, zb_{it} was defined as a bank's observed borrowing less the bank's mean borrowing divided by the bank's standard deviation of borrowing. Note that the mean and standard deviations were calculated using data from 1 January to 30 June 1998 only. Thus, zb_{it} measures the number of standard deviations that a given bank's borrowing is away from its normal level. This transformed variable was comparably distributed across institutions, leading to a more meaningful basis of comparison in the statistical analysis. After this calculation, zb_{it} served as the dependent variable in the regression equation given by (1).

$$(1)\quad zb_{it} = \alpha + \sum_{j=2}^{5} \delta_j period_{tj} + \sum_{n=1}^{4} \lambda_n control_{in} + \sum_{j=2}^{5} \beta_j period_{tj} LTCM_i + \sum_{n=1}^{4}\sum_{j=2}^{5} \phi_{nj} period_{tj} control_{in} + \varepsilon_{it}$$

The variable $period_{tj}$ is an indicator variable that equals 1 if date *t* is in period *j*. The sample period of 1998 was divided into six subperiods. The first period, from 1 January to 30 June, is the benchmark period, and thus the analysis assumes that observations from this part of the year accurately reflect the norm. Periods 2 to 5 are various non-overlapping subperiods of 1998 beginning on 1 July and continuing until 23 September, the day when the rescue of LTCM was announced. Because the interest in this section is studying funds market activity prior to the rescue of LTCM, the sixth and final period, from 24 September to the end of 1998, is not included in this regression.

Subperiods 2 to 5 were chosen in an attempt to control for other events occurring during the same approximate time period.[14] More precisely, the second period was chosen to run from 1 July to 16 August, and therefore covers the period just before the announcement that Russia would default on its government debt. The third period stretches from the Russian debt announcement to 1 September, the day before it became public that LTCM had suffered tremendous losses for the month of August. The fourth period extends from the public awareness of LTCM troubles until 17 September, the day

[13] Also following Kho et al (2000), the paper includes Citibank as a creditor institution since its pending merger with Travelers had been announced.

[14] Bank for International Settlements (1999b) provides an international perspective of how the LTCM episode was but one of many unsettling events that occurred in the autumn of 1998.

before it became known in the market that the Federal Reserve was directly involved with the troubles surrounding the hedge fund. The fifth period goes from 18 September, the day the Fed became involved, until 23 September, the day the rescue was announced (after the market closed). This period is considered separately to control for the possibility that knowledge of Fed involvement might have conveyed new information to the market. Finally, the sixth period, from 24 September until the end of 1998, represents the "aftermath". This period will be the focus of Section 6.

The variables of primary interest are the period dummy variables interacted with the variable *LTCM*, which is defined to equal 1 whenever the borrowing bank is one of the nine creditors of LTCM. The regressions also included four control variables in order to isolate the impact of being an LTCM creditor. The first control is the variable Big, which was defined to equal 1 when the borrowing institution, in terms of December 1998 worldwide total assets, was at least as big as the smallest of the LTCM creditor banks. This threshold identified 24 of the 164 institutions. This variable allows one to distinguish between effects common to the LTCM creditors and those common to all very large institutions. Analogous to wanting to control for bank size, one might also wish to control for bank complexity. The variable LCBO was defined to equal 1 if the borrowing bank was one of the 32 commercial banks identified in a recent Federal Reserve staff study as "large, complex banking organisations" (Federal Reserve (1999), p 28).[15,16]

Another control variable attempts to control for another major event that occurred at approximately the same time, specifically the default on Russian bonds. According to the Bank for International Settlements (1999c), the banks most heavily exposed to Russia during the latter part of 1998 were those in Germany. As bank level exposures to Russia were not available for the sample of 164 institutions, the paper attempts to control for the possible impact of the Russian default both by using various subperiods and by including a control variable Germany, which is equal to 1 if the particular institution was headquartered in Germany. Five of the 164 institutions in the sample were based in Germany.

A final variable controls for the possibility that the nine LTCM creditor banks may be more or less risky than the typical federal funds borrower. That is, banks might have refrained from lending to the LTCM creditors during the crisis period not because they were creditors to LTCM but because uncertain periods lead to a retrenchment away from riskier borrowers in general. The risk of an institution in this market can be proxied by the rates paid by a bank for overnight funds relative to what the market was paying. To be precise, interest rate spreads for each bank on each day were calculated as the difference between a bank's actual volume-weighted average rate paid for funds and that day's effective federal funds rate. The average of this daily interest rate spread for each institution during the baseline period of January-June 1998 was defined as the control variable *Risk*.

Results

The first column of Table 2 reports the results of this regression. For the first three crisis subperiods, the level of borrowing done by the nine LTCM creditors was not statistically different from normal times. Once the Fed became involved with the resolution, however, the borrowing by these nine institutions was lower by 0.42 standard deviations, a finding that is statistically significant at a 15% level of confidence. By contrast, the coefficient for large banks during this period indicates a highly significant increase in borrowing of 0.53 standard deviations. Recalling that all the LTCM banks are also defined as being Big, these two coefficients indicate that large banks that were unexposed to LTCM borrowed significantly more during this period relative to the typical bank. Those with LTCM exposures did not.

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[15] As the term suggests, these are not simply the 32 largest banks in the United States. The designation takes into account the bank's level of complexity. The smallest of the 32 LCBOs is the 46th largest bank in terms of year-end 1998 total assets.

[16] Because the designations "LTCM", "Big", and "LCBO" are correlated, it is helpful to clarify their differences. First and foremost, note that, by definition, all nine LTCM banks are also classified as Big. Conversely, of the 24 Big institutions, nine are LTCM banks and six are LCBOs. Relatively few of the Big institutions are LCBOs because most of the Big institutions are foreign and the LCBO designation is only for US banks. Of the 32 LCBOs, only four are LTCM banks. Only six of the 32 LCBOs are large enough to be considered Big.

The regression results also indicate that German banks had relatively high levels of borrowing following the Russian default and prior to Fed involvement with LTCM. Complex banks also increased their borrowing during the first three crisis subperiods. The results further indicate that riskier institutions tended to borrow less during the second half of 1998, consistent with a flight from risk in this market. The magnitude of this effect increased as the crisis continued.

The results reported in the first column of Table 2 for the nine LTCM banks document that, relative to other very large institutions, the nine creditors to LTCM had lower levels of borrowing after the Fed became involved with the resolution. One possible explanation of this finding is that participants in the overnight money market believed that the LTCM creditors had a serious chance of default. As a result, the market's willingness to supply funds to the LTCM creditors fell, causing the LTCM banks to be unable to increase their borrowing levels to the same extent as other large banks. Alternatively, the finding that the LTCM creditors did not borrow as much as other large institutions might indicate that these institutions had a relatively lower demand for funds.

Before understanding how empirical analysis can distinguish between these two alternative explanations, it is necessary to discuss an important institutional feature about the federal funds market. In particular, the largest borrowers, among them the LTCM creditors, are also the largest lenders. That is, major market participants not only use federal funds as their own marginal source and use of overnight money, they also serve as dealers in the market, both buying funds from and selling funds to smaller bank counterparties. Thus, one can conduct similar analysis regarding the level of bank selling during the time period. The intuition is that a bank that finds itself unable to borrow as much as it wishes would probably reduce the funds that it was simultaneously selling. By doing so, the bank could hope to preserve its *net* level of borrowing (eg the difference between its gross borrowing and gross lending). Presumably, banks that were finding themselves rationed would be interested in maintaining their prior levels of net borrowing, for it is net borrowing that measures a bank's true economic level of overnight unsecured borrowing that ultimately can be used to fund investment activities.

Thus, the ability to observe a bank's lending in addition to its borrowing helps one to distinguish whether the lower level of borrowing done by the LTCM banks was the result of market rationing (eg supply-induced) or intentional (eg demand-induced). The second and third columns of Table 2 report the results from analogous regressions, only replacing the dependent variable with the modified z-score of the gross level of lending and the net level of borrowing, respectively. As these results indicate, the nine LTCM banks were the only category of active market participant that increased its gross funds lent relative to the market in the days immediately before the resolution. The increase in funds lent combined with these banks' lower level of borrowing to generate a 0.61 standard deviation decline in the level of net borrowing done by the LTCM banks. Overall, these results suggest that the lower level of borrowing by LTCM banks during the days immediately before the crisis was intentional. That is, since the LTCM banks did not attempt to maintain their net borrowing levels by reducing their gross funds lent, the results are not consistent with the market rationing these institutions.

Further support for this conclusion comes from the final two columns of Table 2. These columns report the results from the same regression analysis, with the average interest rate paid for funds borrowed and the average interest rate received for funds lent used as the dependent variable, respectively. In the final days before the resolution, there was no change in the interest rate paid by the LTCM creditors for borrowed funds but a 4.56 basis point reduction in the average rate received for funds lent by these same institutions (significant at the 6% level). These findings are consistent with the notion that the LTCM creditors wanted to increase their interbank lending during this time period and were willing to sacrifice nearly 5 basis points, relative to what was being received by other large banks, to do so.

Robustness

The previous results suggest that the LTCM banks did not offset declines in gross borrowing by reducing their gross lending in order to maintain their net level of borrowing. Although suggesting that there was no rationing on the part of the market, these findings do not preclude some rationing, nor do they consider the potentially important role that a too-big-to-fail policy may have on the market's willingness to lend to banks that have a non-trivial chance of failing. In this subsection, we consider these two reasons for why the interbank market might have been willing to lend to the LTCM banks, even if their risk of failing had risen significantly.

We first consider the possibility that although the market as a whole did not ration the LTCM banks, part of the market may have done so. Suppose that only some segment of the interbank market was sufficiently knowledgeable about the troubled hedge fund and began to ration credit to the LTCM banks. The data would still show no rationing if the LTCM banks responded by shifting their borrowing to other, less sophisticated sources. To investigate this possibility, we look at the type of institution that was lending money to the LTCM creditors during the crisis period. Institutions were allocated to four categories: creditors of LTCM, "sophisticated" institutions, "unsophisticated" institutions, and all other institutions. Institutions were defined as "sophisticated" if they were not creditors of LTCM, but were either Big or were LCBOs, where these variables were defined as before.[17] "Unsophisticated" institutions comprise financial institutions that were neither large nor complex and also quasi-government organisations such as the federal home loan banks and the federal mortgage agencies. For each date, each bank's share of overnight lending coming from each of these lender categories was constructed. These four share variables served as the dependent variable in the four regression equations given by (2).

$$(2) \qquad s_{cit} = \alpha + \sum_{q=1}^{3} \delta_q cat_{iq} + \sum_{d=1}^{3} \omega_d share_{dt} + \sum_{q=1}^{3}\sum_{j=2}^{5} \phi_{qjc} period_{tj} cat_{iq} + \varepsilon_{cit} \quad , \quad c = 1,...,4$$

For example, the first regression uses the share of bank *i*'s overnight borrowing on date *t* from LTCM creditors (*c=1)* as the dependent variable. This share is regressed on a constant, dummy variables indicating whether bank *i* is either an LTCM creditor (*q=1*), a Big bank (*q=2*), or a large, complex banking organisation (*q=3*), and these indicators interacted with the four crisis subperiods used earlier. The second, third, and fourth regressions are identical, but replace the dependent variables with the share of bank *i*'s borrowing on date *t* from sophisticated (*c=2*), unsophisticated (*c=3*), and other (*c=4*) institutions, respectively. Each regression also controls for the possibility that the overall source of funds in this market may be changing by including variables measuring the share of the overall market supplied by the LTCM banks (*d=1*), Big banks that were not LTCM (*d=2*), and LCBO*s* that were not LTCM or Big (*d=3*).[18] To focus attention on the final subperiod, Table 3 reports the estimates for subperiod 5, which again represents the time after the Fed became involved but before the resolution was announced. After controlling for changes in the market's source of funds, the results indicate that LTCM creditors borrowed less from other LTCM creditors during this time.[19] There is not a statistically significant increase in the share of borrowing done by the LTCM creditors from either sophisticated or unsophisticated institutions. Thus, these results do not indicate that the LTCM banks were borrowing more from the relatively uninformed institutions immediately before the resolution.

We now consider whether the LTCM banks were not rationed because the market believed that these major institutions were too-big-to-fail. That is, lenders of overnight money may have believed that although the LTCM creditor banks had a significant probability of defaulting on their interbank borrowing in the absence of intervention, policymakers would most likely not let this happen. To investigate this possibility, Table 4 reports the increase in the interest rate premium that a risk neutral lender would require to compensate itself for an increase in overnight default risk of various magnitudes as a function of the probability that the borrower is too-big-to-fail assuming that federal funds lenders would suffer a 100% loss in the event of the failure of its counterparty. For example, Table 4 indicates that a bank whose overnight default probability has increased by 1 in 100,000 will see its risk premium rise by 36 basis points for unsecured borrowing if it has no chance of being considered TBTF. The increase in the required risk premium is also 36 basis points when the borrower's failure probability increases by 1 in 50,000 if there is a 50% chance that the borrower will be deemed TBTF. Thus, from the perspective of a lending institution, higher overnight default probabilities of a borrower are directly offset by higher probabilities of the borrower being considered TBTF. Clearly, if a borrowing institution is definitely too-big-to-fail, then there would be no need for a risk premium, much less any rationing.

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[17] Note that, unlike in the earlier analysis, the categories used here are defined to be mutually exclusive. In particular, the LTCM creditors are not part of the "sophisticated" group.

[18] The results are similar when the share variables (*d=1, …, 3*) are omitted.

[19] Because the LTCM creditors were collectively trying to reduce their net borrowing, they would not be expected to borrow from each other.

The last three columns of Table 4 indicate the required likelihood of a TBTF rescue that is implicit in a bank's continued willingness to lend money for various increases in overnight default probability. The columns differ with respect to the assumptions regarding how much risk premiums can increase before rationing sets in and the loss to the federal funds lender in the event of the failure of its counterparty. As argued earlier, it may be reasonable to assume that the LTCM banks would not pay more than an additional 25 basis points for fear of conveying to the market that something out of the ordinary was happening. With this assumption, and a 100% loss given default, a lender would have to be more than 86% sure that the borrower is too-big-to-fail before being willing to lend if the overnight probability of default increases by one chance in 20,000. The results in the final column of Table 4 indicate that even if risk premiums could rise by 50 basis points and a federal funds lender would lose only 50% of its principal in the event of counterparty failure, lenders would still need to be over 72% confident of a too-big-to-fail rescue in order to continue to lend to an institution that suffers an increase in overnight failure probability of 1 in 10,000. Thus, Table 4 indicates that even under fairly conservative assumptions, lenders would have needed to be reasonably sure that the LTCM banks were TBTF to be willing to continue to extend funds, even if these banks' overnight default probability had risen by only one chance in 10,000.

Deciding whether markets should have reasonably expected such a high probability of a TBTF rescue is difficult given that there have been no major bank failures in the United States since the passage of the FDIC Improvement Act (FDICIA) in 1991. As Wall (1993) describes, FDICIA requires policymakers to resolve a failing organisation according to the least costly method of resolution. By definition, this would preclude the complete protection of unsecured interbank creditors. Nevertheless, Wall (1993) describes FDICIA's "systemic risk exception" clause, which allows unsecured creditors of a failing institution to be protected if failure to do so would "have serious adverse effects on economic conditions or financial stability" (Wall (1993), p 1). Although this clause in FDICIA does allow some potential for TBTF to survive, it seems reasonable to suggest that markets should have been far from certain that such a policy would have been applied to the LTCM creditors. In support of this claim, Benston and Kaufman (1998) find that uninsured depositors at failing US banks have been protected noticeably less since FDICIA. Further, they note that the Bank of England did not fully protect uninsured depositors following the collapse of both BCCI and Barings even though it had pursued a TBTF policy earlier. Given this likely uncertainty surrounding a TBTF rescue, the failure of rationing to materialise suggests that the interbank market believed that the risk that the LTCM banks would default remained small.

Interpretation

The previous results indicate that the lower levels of borrowing by the LTCM creditors relative to other large banks in the days before the resolution represented a voluntary action by these institutions. Thus, the market did not perceive that the LTCM banks were in imminent danger of failing. Nevertheless, the behaviour of these nine institutions was atypical. In particular, in the days immediately preceding the resolution, these banks chose to increase the level of funds sold at a cost of nearly 5 basis points. In conjunction with their borrowing activity, this action noticeably reduced the banks' net level of overnight borrowing that would be able to fund other investment activities. One interpretation of this is that after the Fed became involved, the LTCM creditors sought to reduce their investments in risky short-term activities (eg trading positions), and instead, placed more in the relatively safe investment of lending in the funds market (to non-LTCM-exposed counterparties). An alternative and possibly complementary interpretation of the reduction in net borrowing by the LTCM banks was a desire to temporarily hold more liquid assets. Given the unrest in securities markets during this time period, a shift from holding securities in a trading book to lending more in the funds market may have been a logical way to achieve this goal.

Regardless of whether the LTCM banks' actions were an attempt to reduce risks, increase liquidity, or both, the results indicate that the change in behaviour occurred only during the period after the Fed became involved. One explanation of this timing is that Fed involvement might have conveyed new information to the nine creditors that the problems at LTCM were more serious and could cause greater losses than previously thought. A natural response to this new information might have been for the banks to reduce risk-taking and increase the liquidity of their short-term investments. The Fed's involvement also conveyed the fact that the Fed would not use public money to assist in any creditor bailout of LTCM. This, too, might have led institutions that had expected public support to act in this way.

Evidence from after the resolution

Some argue that the Fed's role in the resolution of LTCM was to solve a coordination problem among a diverse group of creditors. Interpreted in this light, the Fed's action can be viewed as an expost improvement to bankruptcy procedures. However, interpreting the Fed's action in this way suggests that not all institutions should expect to benefit from such improved bankruptcy procedures in the future. In particular, the Fed's action might be seen as increasing the protection given to major financial institutions because it is these institutions that are most likely to later benefit from similar Fed action. In this way, selective intervention might be viewed as analogous to a more traditional TBTF policy.

In this section, we examine whether the Fed's decision to facilitate an orderly resolution may have changed the market's perception of the protection against adverse events given to select institutions. Such changes in protection would alter the perceived probability of a major institution failing, and thus should be reflected in the risk premiums paid for unsecured funds. Thus, this section explores whether, after the LTCM resolution, there was any reduction in the interest rates paid to borrow unsecured, overnight funds by the set of institutions most likely to benefit from an implicit extension of a too-big-to-fail policy. Recall that since this is an implicit test of the existence of small changes to small probabilities, it is appropriate to focus on interest rates paid.

The analysis will be based on a comparison of interest rates charged during the last period of 1998 (from the 24 September to 31 December) to those charged during the baseline period (1 January to 30 June).[20] Table 5 reports the estimates from regressions analogous to those run earlier. The first column indicates that whereas the LTCM creditor institutions saw the rates that they pay on overnight funds increase by 3.82 basis points (relative to other very large institutions), the large, complex banking organisations began attracting funds at a rate 4.20 basis points lower.

These results could be driven by two possibilities. First, the LTCM banks could have increased the amount they were borrowing and therefore driven up the rate they needed to pay. Second, the interbank market could have increased the rate that they require in order to lend any given amount to the LTCM banks. That is, it is necessary to determine whether the higher interest rates paid for funds by the LTCM banks were a result of different market treatment (ie supply-induced) or a result of a change in the behaviour of the LTCM banks themselves (ie demand-induced). The results in Table 5 for borrowing and lending during this period document that the LTCM creditors did not change their level of borrowing. Combined with the fact that very large banks, in general, were reducing their borrowing, this suggests that the market was demanding a premium to lend to the LTCM banks. By contrast, the large, complex banking organisations were increasing their borrowing during this period yet paying a lower rate of interest. This, in turn, is consistent with an increase in the market's willingness to extend funds to these institutions.[21]

Overall, the empirical results for the time after the resolution suggest that the market may have perceived that LTCM creditors were riskier than before. This increase in perceived risk could reflect a reduction in perceived TBTF benefits (ie a more substantial public bailout had been expected). Alternatively, higher interest rate spreads paid by the LTCM creditors after the resolution may simply reflect the fact that the market, having witnessed an extraordinary crisis resolution, now views these banks as riskier than was earlier perceived because they became overly exposed to a single institution. The opposite conclusions apply to the large, complex banking organisations. First, the market may have perceived that these institutions are marginally safer following the LTCM resolution, perhaps because these institutions were wise enough not to become involved with whatever activities would have exposed them to the troubles at LTCM. Alternatively, the finding that these institutions began paying lower rates for unsecured borrowing could reflect the market's view that a TBTF policy has been extended. In interpreting these results, it is important to recall that a widening of the difference between the spreads paid by the LTCM creditors and complex banks of approximately 8 basis points is quite substantial, given that these institutions had previously paid similar premiums.

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[20] The results that follow are robust to beginning the "post-crisis" period after the Fed's inter-meeting cut on 15 October.

[21] Very large banks that were not LTCM creditors also witnessed a decline in their risk premiums of nearly 2 basis points (significant at the 7% level). However, as these institutions were simultaneously reducing their borrowing, the change in interest rates paid may have been demand-driven.

Conclusion

This paper has provided two key empirical results regarding the events surrounding the resolution of the hedge fund Long-Term Capital Management. First, participants in the federal funds market did not restrict their borrowing to the nine major creditors of LTCM. The observed decrease in borrowing done by these nine banks was accompanied by an increase in their interbank lending, suggesting that the resulting decline in net borrowing was by choice. Further, there was no apparent shift towards borrowing from less knowledgeable institutions. Numerical estimates suggest that a perception of too-big-to-fail also seems unlikely to be the driving force behind this result. These findings suggest that the market never believed that these major institutions had a significant probability of default.

The second major result of the paper is the finding that large, complex banking organisations began paying lower interest rates for unsecured overnight money following the resolution of the LTCM crisis. One possibility is that markets viewed these institutions as safer because they avoided the difficulties related to the troubled hedge fund. Alternatively, this result suggests that the Fed's action, even though it provided no public money, may have been perceived in the market as an implicit extension of a too-big-to-fail policy.

Ultimately, these findings cannot lead one to conclude whether the Fed should have intervened in the way in which it did because the benefits and costs of Fed action are neither measured in their entirety nor weighted by an appropriate social welfare function. Nevertheless, the results suggest that the benefits of Fed intervention may have been lower and the costs higher than perceived at the time.

Table 1

Borrowing and lending in the federal funds market

Entries in the table represent averages of daily figures using only observations from banks that borrowed on a given day. The sample period for these statistics is January-June 1998. Values are expressed in millions of dollars. Active indicates an institution that borrowed on at least three out of every four days during the first half of 1998.

	Gross borrowing			
	Category of institution			
	LTCM creditor	**Big or complex but not LTCM creditor**	**Active, but not big, not complex, and not LTCM creditor**	**All others**
Minimum	1	1	1	1
Median	3,934	703	111	10
Maximum	29,940	22,390	6,516	4,150
Mean	5,673	1,340	369	53
Standard deviation	6,010	2,220	671	176
Number of institutions	9	42	113	489
	Gross lending			
	Category of institution			
	LTCM creditor	**Big or complex but not LTCM creditor**	**Active, but not big, not complex, and not LTCM creditor**	**All others**
Minimum	1	1	1	1
Median	1,029	255	108	30
Maximum	23,550	19,370	6,056	1,045
Mean	4,701	903	321	215
Standard deviation	6,000	2,140	532	592
Number of institutions	9	41	105	427
	Net borrowing			
	Category of institution			
	LTCM creditor	**Big or complex but not LTCM creditor**	**Active, but not big, not complex, and not LTCM creditor**	**All others**
Minimum	– 18,700	– 18,970	– 4,448	– 10,450
Median	1,857	366	46	– 15
Maximum	22,000	18,690	6,512	3,460
Mean	1,239	590	170	– 159
Standard deviation	6,400	2,500	741	540
Number of institutions	9	42	113	489

Table 2

Borrowing and lending in the federal funds market prior to the resolution of LTCM

Estimated from the regression equation $$y_{it} = \alpha + \sum_{j=2}^{5} \delta_j period_{tj} + \sum_{n=1}^{4} \lambda_n control_{in} + \sum_{j=2}^{5} \beta_j period_{tj} LTCM_i + \sum_{n=1}^{4} \sum_{j=2}^{5} \phi_{nj} period_{tj} control_{in} + \varepsilon_{it}$$

	Dependent variable (y_{it})				
	Gross borrowing (zb_{it})	**Gross lending** (zs_{it})	**Net borrowing** (zn_{it})	**Interest rate paid** (r_{it}^{b})	**Interest rate received** (r_{it}^{l})
Time period dummies					
Constant term	*0.00*	*0.00*	*0.00*	*0.00*	– 4.29 (0.24)[1]
19980700<=date<=19980816	– 0.02 (0.03)	0.33 (0.05)[1]	– 0.12 (0.03)[1]	– 0.55 (0.23)[2]	– 2.77 (0.45)[1]
19980817<=date<=19980901	0.04 (0.05)	0.36 (0.10)[1]	– 0.12 (0.05)[2]	0.68 (0.27)[2]	– 2.25 (0.67)[1]
19980902<=date<=19980917	0.04 (0.05)	0.94 (0.22)[1]	– 0.21 (0.05)[1]	2.76 (0.32)[1]	– 0.61 (0.68)
19980918<=date<=19980923	0.29 (0.10)[1]	0.19 (0.09)[2]	0.15 (0.09)	2.35 (0.39)[1]	4.33 (0.88)[1]
Borrower is a creditor of LTCM					
LTCM dummy	*0.00*	*0.00*	*0.00*	*0.00*	– 0.09 (1.19)
19980700<=date<=19980816	0.05 (0.09)	– 0.16 (0.09)	0.08 (0.09)	0.90 (0.86)	0.53 (1.65)
19980817<=date<=19980901	– 0.19 (0.15)	0.03 (0.14)	– 0.21 (0.15)	0.17 (0.80)	– 2.28 (2.14)
19980902<=date<=19980917	0.08 (0.15)	– 0.15 (0.19)	0.14 (0.18)	0.87 (1.12)	– 0.52 (2.45)
19980918<=date<=19980923	– 0.42 (0.29)	0.66 (0.32)[2]	– 0.61 (0.31)[2]	– 0.97 (1.97)	– 4.56 (2.39)

Table 2 (cont)

	Dependent variable (y_{it})				
	Gross borrowing (zb_{it})	**Gross lending** (zs_{it})	**Net borrowing** (zn_{it})	**Interest rate paid** (r_{it}^{b})	**Interest rate received** (r_{it}^{l})
Borrower is as big as the smallest LTCM creditor					
Big dummy	*0.00*	*0.00*	*0.00*	*0.00*	6.03 (1.02)[1]
19980700<=date<=19980816	0.04 (0.06)	– 0.33 (0.08)[1]	0.15 (0.06)[2]	– 0.54 (0.45)	1.68 (1.32)
19980817<=date<=19980901	– 0.07 (0.11)	– 0.30 (0.12)[2]	0.08 (0.11)	– 0.92 (0.63)	0.72 (1.65)
19980902<=date<=19980917	0.09 (0.14)	– 0.48 (0.24)[2]	0.06 (0.14)	– 1.00 (0.86)	– 1.85 (1.75)
19980918<=date<=19980923	0.53 (0.24)[2]	– 0.08 (0.19)	0.39 (0.24)	1.87 (1.30)	– 1.17 (2.17)
Borrower is a large, complex banking organisation					
LCBO dummy	*0.00*	*0.00*	*0.00*	*0.00*	4.93 (0.41)[1]
19980700<=date<=19980816	0.29 (0.04)[1]	0.08 (0.06)	0.17 (0.05)[1]	– 1.03 (0.37)[1]	0.36 (0.75)
19980817<=date<=19980901	0.40 (0.08)[1]	0.13 (0.12)	0.20 (0.08)[2]	– 1.11 (0.45)[2]	1.34 (1.13)
19980902<=date<=19980917	0.28 (0.10)[1]	– 0.32 (0.20)	0.24 (0.09)[1]	– 1.13 (0.54)[2]	1.53 (1.07)
19980918<=date<=19980923	0.04 (0.17)	0.33 (0.18)	– 0.14 (0.15)	– 0.06 (0.62)	– 0.28 (1.41)

Table 2 (cont)

	Dependent variable (y_{it})				
	Gross borrowing (zb_{it})	**Gross lending** (zs_{it})	**Net borrowing** (zn_{it})	**Interest rate paid** (r_{it}^{b})	**Interest rate received** (r_{it}^{l})
Borrower is a German bank					
German dummy	*0.00*	*0.00*	*0.00*	*0.00*	– 4.51 (1.25)[1]
19980700<=date<=19980816	0.11 (0.09)	– 0.01 (0.07)	0.11 (0.09)	– 0.52 (0.73)	0.91 (1.72)
19980817<=date<=19980901	0.46 (0.22)[2]	– 0.17 (0.11)	0.41 (0.17)[2]	– 0.53 (0.99)	– 2.30 (2.55)
19980902<=date<=19980917	0.84 (0.22)[1]	– 0.71 (0.14)[1]	0.98 (0.19)[1]	3.18 (1.18)[1]	– 3.42 (3.13)
19980918<=date<=19980923	– 0.08 (0.36)	0.03 (0.23)	– 0.03 (0.29)	0.21 (1.90)	– 0.60 (2.68)
The bank's typical interest rate spread paid					
Risk	*0.00*	*0.00*	*0.00*	*1.00*	– 0.24 (0.03)[1]
19980700<=date<=19980816	– 0.01 (0.00)[1]	0.01 (0.00)[2]	0.00 (0.00)	– 0.08 (0.03)[2]	0.03 (0.05)
19980817<=date<=19980901	– 0.02 (0.00)[1]	0.02 (0.01)[1]	– 0.02 (0.00)[1]	– 0.13 (0.05)[1]	0.03 (0.07)
19980902<=date<=19980917	– 0.04 (0.01)[1]	0.02 (0.01)[2]	– 0.02 (0.00)[1]	– 0.13 (0.05)[1]	0.07 (0.07)
19980918<=date<=19980923	– 0.05 (0.01)[1]	0.01 (0.01)	– 0.03 (0.01)[1]	– 0.11 (0.12)	0.05 (0.09)
Observations	30,340	27,935	30,340	28,935	28,121

Robust standard errors in parentheses. The normal period is 19980101 to 19980630. Numbers in *italics* are equal to shown value by construction.

[1] Significant at 1% level. [2] Significant at 5% level.

Table 3

Classification of lender identity at peak of crisis

(only estimates from 19980918<=date<=19980923 reported)

Estimated from $s_{cit} = \alpha + \sum_{q=1}^{3} \delta_{qc} cat_{iq} + \sum_{q=1}^{3} \sum_{j=2}^{5} \phi_{qjc} period_{tj} cat_{iq} + \varepsilon_{cit}$, $c = 1,...,4$

	Dependent variable: share of borrowing from		
	LTCM creditor	**"Sophisticated" institution**	**"Unsophisticated" institution**
Borrower type			
Borrower is a creditor of LTCM	– 7.01 (2.43)[1]	4.15 (3.04)	3.28 (2.85)
Borrower is as big as the smallest LTCM creditor, but is not an LTCM creditor	3.01 (3.69)	0.62 (3.50)	– 3.72 (3.18)
Borrower is a large complex banking organisation, but is not an LTCM creditor	3.81 (1.89)[2]	4.12 (2.61)	– 8.01 (2.89)[1]

Robust standard errors in parentheses.

[1] Significant at 1% level. [2] Significant at 5% level.

Table 4

Implied risk premiums as a function of default probabilities and strength of too-big-to-fail

(in basis points, assuming 100% loss given default)

Change in probability of overnight failure		**Assumed probability that borrower is TBTF**						**Probability of TBTF required to continue lending when risk premiums can only rise by**		
Odds	**Basis points**	**0**	**25%**	**50%**	**75%**	**95%**	**100%**	**25 bp and loss given default is 100%**	**50 bp and loss given default is 100%**	**50 bp and loss given default is 50%**
1 in 100,000	0.10	36	27	18	9	1.8	0	0.305556	0	0
1 in 50,000	0.20	72	54	36	18	3.6	0	0.652778	0.305556	0
1 in 20,000	0.50	180	135	90	45	9	0	0.861111	0.722222	0.444444
1 in 13,333	0.75	270	202.5	135	67.5	13.5	0	0.907407	0.814815	0.62963
1 in 10,000	1.00	360	270	180	90	18	0	0.930556	0.861111	0.722222

Table 5

Borrowing and lending in the federal funds market after the resolution of LTCM

Estimated from the regression equation $y_{it} = \alpha + \delta_6 period_{t6} + \sum_{n=1}^{4} \lambda_n control_{in} + \beta_6 period_{t6} LTCM_i + \sum_{n=1}^{4} \phi_{n6} period_{t6} control_{in} + \varepsilon_{it}$

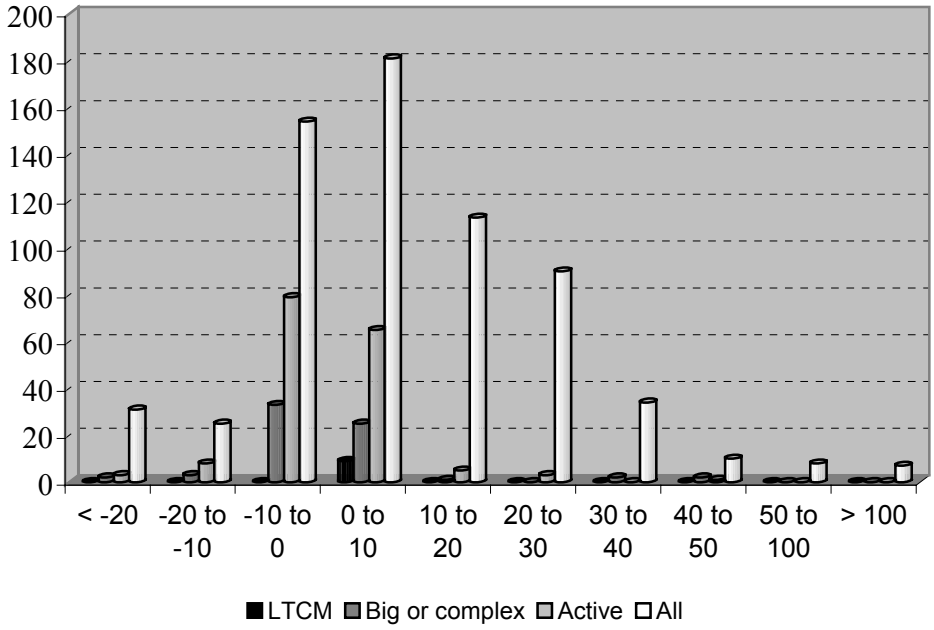
	Dependent variable (y_{it})				
	Interest rate paid (r_{it}^b)	**Interest rate received** (r_{it}^l)	**Gross borrowing** (zb_{it})	**Gross lending** (zs_{it})	**Net borrowing** (zn_{it})
Time period dummies					
19980924<=date<=19981231	7.39 (0.33)[1]	25.55 (0.57)[1]	0.24 (0.03)[1]	0.49 (0.05)[1]	– 0.05 (0.03)
Borrower is a creditor of LTCM					
19980924<=date<=19981231	3.82 (1.64)[2]	0.62 (2.10)	– 0.08 (0.10)	1.38 (0.24)[1]	– 0.40 (0.11)[1]
Borrower is as big as the smallest LTCM creditor					
19980924<=date<=19981231	– 1.88 (1.01)	– 21.44 (1.63)[1]	– 0.25 (0.08)[1]	– 0.01 (0.07)	– 0.14 (0.07)[2]
Borrower is a large, complex banking organisation					
19980924<=date<=19981231	– 4.20 (0.60)[1]	– 6.37 (0.98)[1]	0.51 (0.05)[1]	0.74 (0.09)[1]	0.13 (0.05)[2]
Borrower is a German bank					
19980924<=date<=19981231	6.87 (1.45)[1]	7.39 (2.97)[2]	3.08 (0.22)[1]	– 0.67 (0.09)[1]	2.62 (0.17)[1]
The bank's typical interest rate spread paid					
19980924<=date<=19981231	0.01 (0.05)	0.21 (0.06)[1]	– 0.03 (0.00)[1]	0.03 (0.01)[1]	– 0.01 (0.00)[1]
Observations	28,969	28,979	31,488	28,992	31,488

Robust standard errors in parentheses. The baseline period (omitted categories) is 19980101 to 19980630.

[1] Significant at 1% level. [2] Significant at 5% level.

Figure 1

Average interest rate spreads in the federal funds market



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