Federal Reserve Bank of New York

May 2006
Volume 12 Number 1

# Economic Policy Review

The *Economic Policy Review* is published by the Research and Statistics Group of the Federal Reserve Bank of New York. Articles undergo a comprehensive refereeing process prior to their acceptance in the *Review*. The views expressed in the articles are those of the individual authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

**www.newyorkfed.org/research**

Federal Reserve Bank of New York
Economic Policy Review

May 2006
Volume 12 Number 1

# Contents

## Articles:

## 15 Local or State? Evidence on Bank Market Size Using Branch Prices

Paul Edelstein and Donald P. Morgan

With the elimination of state laws against branching, banks can now compete across states. They are no longer limited to competing in local markets, defined by the Federal Reserve as metropolitan statistical areas or small groups of rural counties. Accordingly, a "local or state?" debate over market size is taking place among researchers, with some arguing that banking markets are statewide and others contending that they remain local. This article contributes to the debate with a novel, arguably better, indicator of market size: bank branch prices, as opposed to bank deposit rates. The pattern of branch price data suggests that banking markets are not necessarily local. The authors find that branch prices in ten northeastern states over the 1990s are more closely correlated with bank concentration at the state level than at the local level, consistent with the "state-market" argument. However, they caution that the relationship is not completely robust; it depends partly on how the data are parsed. Further study using a larger set of branch price data will help settle the debate more definitively.

Contracting conventions for repurchase agreements, or repos, changed significantly in the 1980s. The growth of the repo market, new uses for repos, and the emergence of new and previously unappreciated risks prompted market participants to revise their contracting conventions. This article describes the evolution of the conventions during that period, focusing on three key developments: the recognition of accrued interest on repo securities, a change in the application of federal bankruptcy law to repos, and the accelerated growth of a new form of repo—tri-party repo. The author argues that the emergence of tri-party repo owed to the efforts of individual market participants acting in their own economic self-interest. By comparison, recognition of accrued interest and the change in bankruptcy law were effected, respectively, by participants taking collective action and seeking legislative relief because uncoordinated, individual solutions would have been more costly. These developments offer important insights into how markets operate: contracting conventions that are efficient in one market environment may have to be revised when the environment changes, and institutional arrangements can change in any number of ways.

John Kambhu

# Trading Risk, Market Liquidity, and Convergence Trading in the Interest Rate Swap Spread

- Trading activity is generally considered to be a stabilizing force in markets; however, trading risk can sometimes lead to behavior that has the opposite effect.
- An analysis of the interest rate swap market finds stabilizing as well as destabilizing forces attributable to leveraged trading activity. The study considers how convergence trading risk affects market liquidity and asset price volatility by examining the interest rate swap spread and the volume of repo contracts.
- The swap spread tends to converge to its normal level more slowly when traders are weakened by losses, while higher trading risk can cause the spread to diverge from that level.
- Convergence trading typically absorbs shocks, but an unusually large shock can be amplified when traders close out positions prematurely. Destabilizing shocks in the swap spread are associated with a fall in repo volume consistent with the premature closing out of trading positions. Repo volume also falls in response to convergence trading losses.

## 1. Introduction

The notion that markets are self-stabilizing is a basic precept in economics and finance. Research and policy decisions are often guided by the view that arbitrage and speculative activity move market prices toward fundamentally rational values. For example, consider a decision on whether central banks or bank regulators should intervene before a severe market disturbance propagates widely to the rest of the financial system. Such a decision may rest on a judgment of how quickly the effects of the disturbance would be countered by equilibrating market forces exerted by investors taking the longer view.

While most economists accept the view that markets are self-stabilizing in the long run, a well-established body of research exists on the ways in which destabilizing dynamics can persist in markets. For instance, studies on the limits of arbitrage show how external as well as internal constraints on trading activity can weaken the stabilizing role of speculators. Offering an example of external constraints, Shleifer and Vishny (1997) argue that agency problems in the management of investment funds will constrain arbitrage activity by depriving arbitrageurs of capital when large shocks move asset prices away from fundamental values. In an analysis of internal constraints on trading activity, Xiong (2001) shows that convergence traders with logarithmic utility functions usually trade in ways that stabilize markets, but they may trade in a way

John Kambhu is a vice president at the Federal Reserve Bank of New York. <john.kambhu@ny.frb.org>

The author thanks Tobias Adrian and two anonymous referees for helpful comments. The views expressed are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

that amplifies market shocks if the shocks are large enough to deplete their capital. When such traders suffer severe capital losses, they hunker down and "unwind" their convergence trade positions—that is, close out the positions—driving prices further in the same direction as the initial shock. In another line of analysis, Adrian (2004) argues that in the presence of uncertainty, the difficulty of distinguishing permanent from transitory shocks in asset prices can cause arbitrageurs to trade in ways that can either reduce or raise asset price volatility. These and other studies on the limits of arbitrage suggest how trading activity stabilizes markets most of the time but, on occasion, it can amplify price volatility.

This article analyzes empirical evidence on the limits of arbitrage in the interest rate swap market as well as on how trading risk can affect market liquidity and amplify shocks in asset prices. We study these issues in terms of the behavior of the interest rate swap spread—the spread between the interest rate swap and Treasury interest rates—and the volume of repurchase, or repo, contracts. The type of trading activity we examine is convergence trading, in which speculators trade on the expectation that asset prices will converge to normal, or fundamental, levels. Convergence trades typically move prices toward fundamental levels and stabilize markets. By countering and smoothing price shocks, the trading flows of convergence traders can potentially enhance market liquidity. However, if convergence trades are unwound prematurely, asset prices would tend to diverge further from their fundamental values rather than converge to them. A premature unwinding of these trades can occur when concerns about trading risks are more pronounced, and trading counterparties refuse to roll over positions or internal risk managers instruct traders to close out their positions. In this instance, a form of positive feedback can emerge through which trading risk amplifies asset price shocks.

Our analysis finds both stabilizing and destabilizing forces in the behavior of the interest rate swap spread and the volume of repo contracts that can be attributed to leveraged trading activity. Although the swap spread does tend to converge to its fundamental level, our findings are consistent with the argument that the spread converges more slowly when traders have been weakened by trading losses, and that higher trading risk can cause the spread to diverge from its fundamental level. We also find that repo volume is affected by trading losses and reflects shocks that destabilize the swap spread. The behavior of repo volume suggests how risk in trading activity can affect market liquidity and asset price volatility.

We begin by discussing briefly the significance of the interest rate swap market and the literature on the economic and financial risk factors that determine the interest rate swap spread. In Section 3, the data used in our analysis are presented. Section 4 describes convergence trading on the swap spread. Section 5 looks at the empirical evidence on the limits of arbitrage in the swap market and considers how the convergence of the swap spread to its fundamental level is affected by the capital, or endowments, of convergence traders. In Section 6, we consider how the variability in repo contract volume might be associated with convergence trading activity and examine the empirical relationships among shocks in trading activity, repo volume, and the swap spread.

## 2. The Interest Rate Swap Market

The interest rate swap market is one of the most important fixed-income markets for the trading and hedging of interest rate risk. It is used by nonfinancial firms in the management of the interest rate risk of their corporate debt. Likewise, financial firms use the swap market intensively to hedge the difference in the interest rate exposure of their assets and liabilities. The liquidity of the swap market also underpins the residential mortgage market in the United States, providing real benefits to the household sector. If the swap market was less liquid, lenders in the mortgage market would find it more difficult and expensive to manage the interest rate risk in fixed-rate mortgages; consequently, they would demand higher mortgage interest rates as compensation. Because of the extensive use of interest rate swaps, the volatility of the swap spread can impact a wide range of market participants. The use of swaps by market participants to meet their hedging objectives depends on a stable relationship between the interest rate swap rate and other interest rates; convergence trading activity that stabilizes the swap spread therefore can have wide-ranging benefits to the economy.

In research on the determinants of the swap spread, Lang, Litzenberger, and Luchuan (1998) investigate how hedging demand for interest rate swaps influences the spread and how the spread is affected by corporate bond spreads and the business cycle. In a complementary analysis, Duffie and Singleton (1997) show that variation in the swap spread is attributable both to credit risk and liquidity risk. Following that line of study, Liu, Longstaff, and Mandell (2002) obtain a similar result and quantify the size of the two risk factors. They find that the swap spread depends both on the credit risk of banks quoting LIBOR (the London Interbank Offered Rate) in the Eurodollar loan market and on the liquidity of Treasury securities. Furthermore, the authors conclude that much of the variability of the spread is associated with changes in the liquidity premium in Treasury security prices.

All of these papers investigate the fundamental economic and financial risk factors that determine the swap spread. In contrast, this article analyzes how variables associated with trading activity might influence the spread's stability. Furthermore, we explore how quantity variables—in this case, the volume of repo contracts—are related to the variation in financial asset prices. By examining how variables associated with trading activity are linked to shocks in the swap spread, our study is potentially related to the literature on time-varying risk premia, which may provide an alternative explanation of our results. Although a complete study of the interrelationships among trading shocks, liquidity shocks, and changes in risk premia is beyond the scope of this article, our analysis of trading activity may help future research determine how time-varying risk premia might be associated with the behavior of traders and arbitrageurs.

## 3. Data

Our analysis uses a range of fixed-income yields and quantity data (Table 1). The repo volume data consist of all overnight and continuing repurchase positions at primary dealers. They cover almost the entire repo market because every repo transaction has a dealer on one side of it.[1] Ideally, we would use data on repo positions in Treasury securities only, but disaggregated data on Treasury repos do not exist for a sufficiently long sample period. We have a long time series only for aggregate repo positions. (In any event, the predominant repo contract is a repo on Treasury securities. See Adrian and Fleming [2005] for a discussion of the repo data, the role of repos in the financing of investments, and the role of repos in the Treasury securities market.)

We use gross repo volume—the sum of dealers' repo and reverse-repo positions—because a convergence trade could involve either a repo or a reverse repo in the data, depending on whether the position was taken by a dealer or a customer of the dealer. Convergence trades are conducted by customers such as hedge funds, which transact with dealers, and by the dealers' own proprietary trading desks. A short Treasury position could appear either as a repo or a reverse repo in the data depending on whether the short position was established by a customer or a dealer. This fact prevents us from associating disaggregated repo and reverse-repo positions with the direction of an arbitrage trade. Thus, we must use gross repo positions, and can only ask whether the spread converges without regard to whether it is falling or rising to its fundamental level.

Our measure of repo volume is the deviation from its one-year moving average. This measure is used to filter out the normal growth of the market and isolate shocks in repo volume that might be associated with shocks in trading activity. By this definition, a fall in repo volume signifies a decrease relative to its moving average.

For the swap spread, we use the average of the five- and ten-year swaps to capture more trading activity in the swap market. Because we use aggregate repo data, a broad measure of swap rates would align better with the repo data.

The analysis is performed using monthly (month-average) data because trading positions in interest rate swaps are generally intended to be held for relatively long periods due to their transaction costs.[2] Such costs would cause frequent adjustments of swap positions to reduce trading profits significantly, and we would not expect to find any results in daily data. While signs of convergence trading in weekly data

Table 1
Data and Variable Definitions

| | |
|---|---|
| $s$ | Average of the five- and ten-year swap spreads. |
| $S^F$ | Fundamental swap spread. |
| $s^f$ | Observable component of the fundamental swap spread. |
| $w$ | Direction of the deviation of the swap spread from its observable fundamental level, $w_t = \lvert s_t^f - s_t \rvert / (s_t^f - s_t)$. |
| $\pi_t$ | Trading income in period $t$ as a function of the position established in period $t-1$, $\pi_t = \Delta s_t w_{t-1}$. |
| $y$ | Index of monthly returns of fixed-income arbitrage hedge funds (the Credit Suisse First Boston/Tremont Fixed-Income Arbitrage Index). |
| $RP$ | Overnight and continuing gross repo positions at primary dealers: the sum of the dealers' repo and reverse-repo positions. The variable is measured as the deviation of repo volume from its one-year moving average (in units of one trillion). |
| $r$ | Repo interest rate. |
| $A$ | Spread of the A-rated corporate bond rate over the ten-year Treasury interest rate. |
| $Tr$ | Average of five- and ten-year Treasury interest rates. |
| $Tr^{10}$ | Ten-year Treasury interest rate. |
| *UnEmp* | Unemployment rate. |
| *Data frequency* | Monthly (month average) through year-end 2004. The repo volume data are available only at a weekly frequency of Wednesday observations. For consistency with the repo data, we derive the monthly averages of all other variables from weekly Wednesday observations. The sample period is 1996-2004, as the repo interest rate data are available only from 1996. |

[1] While in principle the data would capture the entire market, in practice they do not because a few market makers are not participants in the reporting system.

might be expected, the estimates at that frequency yielded ambiguous results.[3]

## 4. Convergence Trades on the Interest Rate Swap Spread

Our analysis rests on a supposition that the swap spread is determined by fundamental economic and financial variables and by the "arbitrage" activity of convergence traders. The convergence traders form an expectation of the fundamental level of the spread and trade in an attempt to profit from that expectation. If the spread is above its expected fundamental level, a trader anticipating that the spread will fall toward that level will put in place a position that will gain if the expectation materializes.

In terms of the instruments used in a convergence trade, if the swap spread is above its fundamental level, a trader who expects the spread to fall would take a long position in an interest rate swap and a short position in a Treasury security. Such a combination of long and short positions is insulated from parallel changes in the level of swap and Treasury interest rates, but it would gain if the rates moved relative to each other as expected. If the spread between the rates fell, with the swap rate falling relative to the Treasury rate, the long swap position would gain value relative to the short Treasury position and the trader would earn the difference by closing out the position.[4]

The transactions in a convergence trade, if they are in large enough volume, would normally cause the swap spread to converge to its fundamental level by exerting a counter force to shocks that causes the spread to diverge from its fundamental level. In the case of an initial shock that drives the spread above its normal level, establishing the long position in the swap would put downward pressure on the swap rate, while selling Treasuries to establish the short Treasury position would tend to cause Treasury yields to rise. Both transactions would exert downward pressure on the spread, countering the effect of the initial shock. These relationships are explained further in Box 1.

When a convergence trade is unwound, the spread tends to move in the direction opposite the move that resulted from putting the position in place. In the previous example, the transactions to unwind the trade would cause the swap rate to rise and the Treasury yield to fall, and the spread would widen in the absence of other shocks (Box 1). In order to unwind the

Box 1

### Convergence Trades and the Change in the Swap Spread

Tables 1 and 2 below show the market impact of a convergence trade undertaken by a sufficiently large number of traders to affect market prices. The scenario depicted is that of a swap spread above its fundamental level, in which a trader expects the spread to fall back to that level. In this case, the convergence trade is a long swap position and a short Treasury position.

When the trader establishes the position (Table 1), the swap spread converges to its fundamental level; when the trader unwinds the position (Table 2), the swap spread diverges from its fundamental level—rising further above it.

Conversely, when the swap spread is below its fundamental level, the convergence trade position is the reverse of what we just described, and it has an opposite market impact on prices and rates.

Table 1

**Establishing a Convergence Trade Position When the Swap Spread Is above Its Fundamental Level**

| | Position | Adding to Position | Market Price Impact | Interest Rate Change | Spread Change |
|---|---|---|---|---|---|
| Swap | Long | Buy[a] | Rise | Fall | Fall |
| Treasury | Short | Sell | Fall | Rise | |

Table 2

**Closing Out a Convergence Trade Position When the Swap Spread Is above Its Fundamental Level**

| | Position | Closing Out of Position | Market Price Impact | Interest Rate Change | Spread Change |
|---|---|---|---|---|---|
| Swap | Long | Sell[a] | Fall | Rise | Rise |
| Treasury | Short | Buy | Rise | Fall | |

[a]To buy a swap, as represented in Table 1, means to contract to receive the fixed rate in a new swap. In this instance, when more market participants than usual are seeking to receive the swap rate, the market impact is a downward pressure on the swap rate and a rise in the mark-to-market value of outstanding swaps. The sale of a swap, as represented in Table 2, has the opposite effects of a buy.

[2]The bid-ask spread of interest rate swaps is significantly larger than that of Treasury securities. Furthermore, unwinding a swap before its maturity date may entail transaction costs in settling on a close-out value with the counterparty. Other transaction costs arise from the expense of managing collateral flows to cover margin requirements. Further transaction costs arise from the nature of transaction processing and settlement in over-the-counter (OTC) derivatives. (See the discussion of transaction processing and settlement in Bank for International Settlements [1998]. While automation and electronic trading systems have changed some of the details presented in that study, the general features of OTC derivatives trading remain the same.)

[3]The data frequency in our analysis is limited to at most weekly observations because the repo volume data are available only weekly. Using weekly data, in some cases we obtained similar results, as in the weekly analogue of the results in Table 4. However, in other cases our results were not statistically significant.

[4]A fall in the swap rate would cause the present value of the swap to increase, while a rise in the Treasury rate would cause the price of the Treasury security to fall. Thus, the asset (the long position in a swap) gains value while the value of the liability (the short position in a Treasury security) falls.

position at a profit, a convergence trader typically would wait until shocks in the direction opposite the initial upward shock bring the spread down to a level that allows the trade to be closed out profitably. In this case, convergence trading would stabilize the spread by exerting a countervailing force to shocks in the spread. However, if the convergence trade position is unwound prematurely—before the spread falls toward its fundamental level—the spread would tend to widen further as a result of the unwound trade (Box 1).

A premature unwinding of the position causes volatility in the spread in the sense that the spread diverges from its fundamental level instead of converging to it. Furthermore, a lower than usual level of convergence trading could also lead to volatility, as the market would be more vulnerable to shocks if traders who would otherwise stabilize the spread stay on the sidelines. Before examining the empirical relationship between shocks in the swap spread and a contraction of trading activity, we look at how the endowments of traders affect the spread's convergence to its fundamental level.

## 5. Limits of Arbitrage and the Swap Spread

How do trading profits affect the strength of arbitrage activity? In the model used in our analysis, we test the hypotheses that less convergence trading occurs when traders' endowments have been impaired. For instance, losses will deplete capital used to fund the margin and collateral required to establish trading positions; when such collateral constraints are binding, we would expect to find less trading activity. Alternatively, large losses may make traders more risk averse, as in Xiong (2001). Thus, significant losses would suggest a lower level of convergence trading, and consequently a slower convergence of the swap spread to its fundamental level. Here, we study the empirical evidence on such swap spread behavior.

To examine the limits of arbitrage in the swap market, we use an equation that reflects the determinants of the swap spread as described above. The swap spread tends to converge to a value that we call its "fundamental" level, and the rate of convergence depends in part on the amount of convergence trading.

$$(1) \qquad s_t = \lambda S_t^F + (1-\lambda)s_{t-1} + \mu_t ,$$

where $s$ is the observed spread, $S^F$ is the fundamental spread, $\mu$ is a random residual, and the size of the convergence coefficient ($\lambda$) depends on the amount of convergence trading, with $0 \le \lambda \le 1$. With perfect and unlimited arbitrage, we have $\lambda = 1$; with limits to arbitrage, we have $\lambda < 1$. Furthermore, as we discussed, we would expect $\lambda$ to be smaller when convergence traders are less active. Rearranging terms in equation 1, we have

$$(2) \qquad \Delta s_t = \lambda(S_t^F - s_{t-1}) + \mu_t .$$

If the fundamental spread ($S^F$) is determined by observable and unobservable variables, we can rewrite equation 2 in terms of observable variables. To this end, let $S_t^F = ax_t + \varepsilon_t$, where $x$ is the set of observable variables and $\varepsilon$ is unobservable. Equation 2 can then be rewritten as

$$(3) \qquad \Delta s_t = \lambda(ax_t - s_{t-1}) + \nu_t ,$$

where $\nu_t = \lambda\varepsilon_t + \mu_t$. For this discussion, it would be convenient to denote the observable component of the fundamental swap spread concisely—say, by $s_t^f$, where $s_t^f = ax_t$.

In estimating equation 3, we treat the coefficient $\lambda$ as state dependent. Specifically, it depends on the amount of trading activity.

### 5.1 The Level of Trading Activity

The level of trading activity is assumed to be lower when traders have been weakened by trading losses. In particular, losses will deplete capital used to fund the margin and collateral required to establish trading positions. In addition, depleted capital levels may tighten risk management constraints on trading positions, as will occur when value-at-risk limits on trading positions are defined relative to capital. In our estimation of equation 3, we infer trading income and the level of trading activity using three different approaches.

*1. Trading income and the change in the spread.* In this approach, trading gains and losses are derived from the change in the swap spread and an inferred trading position. In particular, if the spread is below its expected fundamental level, a trader anticipating that the spread will rise will put in place a position that will gain if the expectation materializes. If the spread subsequently rises, profits are earned, but the position loses if the spread falls. Thus, traders earn profits when the spread converges to its expected fundamental level and suffer losses when the spread diverges.

More precisely, in establishing a trading position at period $t-1$, traders observe the observable component of the fundamental spread and its deviation from the actual spread ($s_{t-1}^f - s_{t-1}$) in period $t-1$. After the position has been established, the subsequent change in the spread in period $t$

then determines trading income in period *t*. We write this relationship as

$$\pi_t = \Delta s_t \cdot w_{t-1},$$

where $\pi$ is trading income and $w_{t-1} = \left| s^f_{t-1} - s_{t-1} \right| / (s^f_{t-1} - s_{t-1})$ is the sign of $(s^f_{t-1} - s_{t-1})$ and indicates the direction of the trading position. Together, the change in the spread and the trading position determine the position's gain or loss.

In the conjecture on the limits of arbitrage, the convergence coefficient ($\lambda$) is expected to be smaller when traders have been weakened by losses in the previous period. In particular,

$$\lambda_t(\pi^H_{t-1}) > \lambda_t(\pi^L_{t-1}) \text{ when } \pi^H_{t-1} > 0 \text{ and } \pi^L_{t-1} < 0.$$

*2. The earnings of hedge funds and trading activity.* The endowments of convergence traders could also be inferred from the returns of fixed-income arbitrage hedge funds. Here, we assume that after hedge funds suffer losses, less arbitrage trading occurs in the next period.

Let $y_{t-1}$ denote the earnings of fixed-income arbitrage hedge funds in the previous period; the convergence coefficient ($\lambda$) is conjectured to depend on $y_{t-1}$ as

$$\lambda_t(y^H_{t-1}) > \lambda_t(y^L_{t-1}) \text{ when } y^H_{t-1} > 0 \text{ and } y^L_{t-1} < 0.$$

*3. Repo volume and trading activity.* In this approach, the level of trading activity is inferred from the change in repo volume. Because repo contracts are used in convergence trading, we might expect a fall in repo volume to signal trading losses. In particular, significant trading losses might force a close-out of trading positions that would be reflected in falling repo volume. Accordingly, if a decline in repo volume occurred when traders have been weakened by losses, we would expect less convergence trading and a smaller convergence coefficient ($\lambda$) when repo volume falls.

If $\Delta RP$ denotes the change in the volume of repos outstanding, we would expect

$$\lambda(\Delta RP^H) > \lambda(\Delta RP^L) \text{ when } \Delta RP^H > 0 \text{ and } \Delta RP^L < 0.$$

## 5.2 The Fundamental Swap Spread

We now specify the relationship between the fundamental swap spread and its observable determinants. The model of the fundamental spread is adapted from Lang, Litzenberger, and Luchuan (1998), who examine the fundamental economic and financial variables that determine the swap spread. Following their lead, we define the equation

$$(4) \quad S^F_t = \alpha_1 + \alpha_2 A_t + \alpha_3 Tr_t + \alpha_4 UnEmp_t + \alpha_5 \Delta r_t + \varepsilon_t,$$

where *A* is the A-rated corporate bond spread over the ten-year Treasury rate, *Tr* is the average of the five- and ten-year Treasury interest rates, *UnEmp* is the unemployment rate, *r* is the repo interest rate, and $\varepsilon$ is an unobservable random shock.[5] In this model of the fundamental swap spread, we assume that the corporate bond spread is an exogenous variable, as it is an index of economywide bond prices and may be influenced by a broader set of forces than those that affect the swap market. While we make this assumption here, the nature of the interrelationship between the swap spread and the bond spread remains an open question and is a topic for future research.[6]

## 5.3 Estimation Results for the Limits of Arbitrage

In estimating our model, we substitute the fundamental swap spread (equation 4) into the observed swap spread (equation 2) and estimate all the coefficients jointly (equation 3). We estimate three versions of equation 3 using different indicators of the level of trading activity as described above. The regression results are presented in Table 2. In Models 1 and 2, trading activity is inferred from trading income, which in Model 1 is derived from the change in the spread and the inferred trading position, while in Model 2 it is inferred from the earnings of fixed-income arbitrage hedge funds. In Model 3, trading activity is inferred from the volume of repo contracts.

All three regressions in Table 2 yield similar results, with similar coefficients in each row and similar differences

[5] In addition to using the spread of the A-rated corporate bond over the Treasury rate, we also used the spread of the BBB-rated corporate bond over the AAA-rated bond yield. We obtained similar results employing this specification, but we found lower levels of statistical significance. For the long-term Treasury rate, we used the ten-year rate and the average of the five- and ten-year rates, arriving at similar results both times. In addition to the variables described in Lang, Litzenberger, and Luchuan (1998), we found that the repo rate also influences the swap spread. An alternative specification of the shock in the repo rate ($\Delta r$) can be defined as the difference between the levels of the repo rate and the three-month Treasury rate. We obtained similar results using both specifications of the repo rate shock. In an alternative specification of the fundamental swap spread, we represented the fundamental spread by the twelve-month moving average of the swap spread plus the shock in the repo rate. We obtained the same results here as we did using the macro variables model of the fundamental spread, but we found lower levels of statistical significance.

[6] In a preliminary analysis of an extended model that included the corporate bond spread as an endogenous variable, we obtained the same results as we did using the model in this article. This issue deserves further study, however, before one draws conclusions about the nature of the interrelationship between the corporate bond and swap spreads. In a related topic, research by Collin-Dufresne and Solnik (2001) provides insight on the spread between LIBOR bond yields and swap rates.

TABLE 2

## Regression Results for Convergence of the Swap Spread Conditional on the Level of Trading Activity

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| | Trading Income Inferred from Lagged Change in Spread | Trading Income Inferred from Hedge Fund Earnings | Trading Income Inferred from Repo Volume |
| $z_t(\alpha x_t - s_{t-1})$ | 0.322 (se=0.080, $p$=0.000) | 0.253 (se=0.060, $p$=0.000) | 0.339 (se=0.082, $p$=0.000) |
| $(1-z_t)(\alpha x_t - s_{t-1})$ | 0.092 (se=0.074, $p$=0.217) | 0.152 (se=0.132, $p$=0.252) | 0.055 (se=0.061, $p$=0.371) |
| *const.* ($\alpha_1$) | 1.147 ($p$=0.000) | 1.089 ($p$=0.018) | 0.295 ($p$=0.514) |
| *A* | 0.289 ($p$=0.000) | 0.290 ($p$=0.000) | 0.365 ($p$=0.000) |
| *Tr* | 0.054 ($p$=0.000) | 0.055 ($p$=0.134) | 0.126 ($p$=0.006) |
| *UnEmp* | -0.279 ($p$=0.000) | -0.269 ($p$=0.000) | -0.212 ($p$=0.000) |
| $\Delta r$ | 0.370 ($p$=0.000) | 0.372 ($p$=0.003) | 0.487 ($p$=0.002) |
| Adjusted $R^2$ | 0.155 | 0.119 | 0.176 |

Source: Author's calculations.

Notes: Regression results for the equation

$$\Delta s_t = \lambda^p z_t(\alpha x_t - s_{t-1}) + \lambda^n (1-z_t)(\alpha x_t - s_{t-1}) + \upsilon_t ,$$

with

$$\alpha x_t = \alpha_1 + \alpha_2 A_t + \alpha_3 Tr_t + \alpha_4 UnEmp_t + \alpha_5 \Delta r_t ,$$

$$z_t = 1 \text{ if } q_t > 0 \text{ and 0 otherwise,}$$

where

in Model 1: $q_t = \pi_{t-1} = \Delta s_{t-1} w_{t-2}$ (derived trading income, where $w_{t-2}$ indicates the direction of the trading position),

in Model 2: $q_t = y_{t-1}$ (earnings of fixed-income arbitrage hedge funds),

in Model 3: $q_t = \Delta RP_{t-1}$ (change in repo volume),[a]

and $w_t = \left| s_t^f - s_t \right| / (s_t^f - s_t), s_t^f = \alpha x_t .$

In the regression, all coefficients are estimated jointly. Standard errors (se) and $p$-values are in parentheses, with Newey-West standard errors and covariance. The sample period is 1996-2004.

[a]In this case, we assume that when traders suffer losses, trading positions are closed out and repo volume falls. We obtain similar results for both current and lagged changes in repo volume. The results reported in the table are for a lagged change in repo volume.

between rows. The estimated convergence coefficient ($\lambda$) is indeed less than 1, a result consistent with less than perfect arbitrage in the market. Furthermore, the coefficient is smaller when the inferred level of trading activity is lower, as can be seen from a comparison of the table's top two rows, where the second row represents the case of less active traders. In an F-test of whether the difference between the convergence coefficients in the two cases is statistically significant, we find that it is in the first and third models but not in the second. Nevertheless, even in the second model, we find that the convergence coefficient is statistically significant for a higher level of trading activity, but not for less active traders. Thus, we have strong results in the first and third models but a weaker result in the second.

In terms of the limits to arbitrage, the similar results across the three measures of trading activity and trading income support the argument that the amount of convergence trading depends on traders' endowments. If trading losses lead to a retreat of convergence traders, the swap spread would converge more slowly to its fundamental level. We indeed find such a relationship between inferred trading losses and the speed of convergence of the swap spread.

## 6. Shocks in Trading Activity, Repo Volume, and the Swap Spread

Here, we examine how trading shocks can affect the swap spread in ways beyond the effects of limits to arbitrage that slow the convergence of the spread to its fundamental level. In particular, we look at how shocks in trading activity can heighten volatility in the swap spread.

### 6.1 Convergence Trading and the Volume of Repurchase Contracts

The analysis requires a signal of shocks in trading activity. For this indicator, we use the volume of repo contracts because one leg of a convergence trade on the swap spread is a position in Treasury securities that would normally involve a transaction in the repo market. Thus, even though data on convergence trading positions do not exist, large changes in these positions may be reflected in changes in repo market variables. While the behavior of aggregate repo volume is driven by multiple trading and financing motivations, we might still expect some of the variation in repo volume to be associated with convergence trading on the swap spread given the large size of the swap market.[7] Accordingly, we seek an empirical relationship between the behavior of the swap spread and repo volume that would be consistent with the effects of shocks in convergence trading.

### 6.2 Trading Shocks and the Swap Spread

To analyze how trading shocks might affect the volatility of the swap spread, we add to the equation for the change in the swap spread the proxy variable for trading activity: the volume of repo contracts. In our view, a contraction of trading positions will be reflected in a fall in repo volume, while a premature unwinding of convergence trading positions will disturb the swap spread. Thus, we would expect to find a relationship between a fall in repo volume and disturbances in the spread.

We expect a fall in repo volume to be associated with a swap spread diverging from its fundamental level. For instance, when the spread is above its fundamental level, convergence traders will establish a position that would gain from a falling spread. Unwinding the position prematurely, however, will cause the spread to rise further above its fundamental level rather than converge to it (Box 1, Table 2). Such a trading shock will destabilize the swap spread in the sense that the spread will diverge from its fundamental level instead of converge to it.

To identify the direction of the impact on the swap spread of a trading position contraction, we weight repo volume by the sign of the deviation of the swap spread from its fundamental level. This conditioning adjustment is necessary because the unwinding of a position could cause either a rising or falling swap spread, depending on the direction of the position. The sign of the deviation of the spread from its fundamental level allows the identification of the price impact because that deviation determines the direction of the trading position.

In formal terms, to infer the direction of convergence trades put in place in period $t$, we use the indicator variable $w_t = \left|s_t^f - s_t\right| / (s_t^f - s_t)$, the sign of the deviation of the swap spread from its observable fundamental level. As an indicator of the direction of the convergence trade position put in place in period $t$, the variable $w_t$ informs us of the market impact of an unwinding of the position in the next period.

If the position established in period $t-1$ is closed out in period $t$, the resulting fall in repo volume in period $t$ conditioned by $w_{t-1}$ captures the impact on the spread in period $t$. This specification leads to a modification of equation 3 through the addition of the volume of repo contracts,

$$(5)\quad \Delta s_t = \beta^0 \Delta RP_t + \beta^1\big|_{\Delta RP<0} \Delta RP_t w_{t-1} + \lambda(ax_t - s_{t-1}) + \nu_t .$$

In this equation, $\beta^0$ is a coefficient for a baseline effect of repo volume, and the trading shock effect is captured by $\beta^1$. To isolate the effect of the premature closing out of positions, we restrict the trading shock coefficient ($\beta^1$) to the conditional case of falling repo volume.[8] As mentioned above, in the trading shock term, $w_{t-1}$ converts a fall in repo volume into the appropriate impact on the spread: either an upward or downward shock depending on the position being unwound. With the conditioning variable $w$ on repo volume, we expect the trading shock coefficient ($\beta^1$) to be positive (see Box 2 for more details). As before, we expect the convergence coefficient ($\lambda$) to be less than 1 as well as to be smaller when traders have suffered losses.

Before proceeding with the estimation of equation 5, we consider the possibility of a simultaneous relationship between

[7] In April 2004, the U.S. dollar interest rate swap market had average daily trading volume of $195 billion of notional amount (Bank for International Settlements 2005). By comparison, over the same period, the average daily trading volume in Treasury coupon securities (notes and bonds) by primary dealers was $449 billion, according to the Federal Reserve Bank of New York (http://www.newyorkfed.org/markets/statrel.html).

[8] We also estimated a variation of the restriction on the trading shock coefficient using separate coefficients for rising and falling repo volume; we obtained the same results as we did using the specification in equation 5. The estimated coefficient for falling repo volume was the same as the result using equation 5, while the estimated coefficient restricted to rising repo volume was not statistically different from zero.

Box 2

## Derivation of the Sign of $\beta^1$

The fall in repo volume that occurs when a trading position is closed out signifies that the change in repo volume is negative, while the change in the spread depends on the direction of the position (in particular, if speculators took positions on whether the spread would fall or rise, which in turn depends on whether the spread was above or below its fundamental level).

If the swap spread is above its fundamental level, the weight $w$ is negative; the results in Box 1, Table 2, show that the change in the spread is positive. Therefore, the change in the spread is positive, as is the weighted change in $RP$ (see table below).

If the swap spread is below its fundamental level, the weight $w$ is positive; the converse case in Box 1 indicates that the change in the spread is negative. Therefore, the change in the spread is negative, as is the weighted change in $RP$ (see table below).

In all cases, a positive relationship therefore exists between the change in the swap spread and the weighted change in repos outstanding.

### Relationship between a Change in the Swap Spread and the Weighted Change in Repo Volume

| Swap Spread | $w$ | $\Delta RP$ | $\Delta S$ | $\beta^1 = \Delta s / \Delta RP \cdot w$ |
|---|---|---|---|---|
| Above fundamental level | (-) | (-) | (+) | (+) |
| Below fundamental level | (+) | (-) | (-) | (+) |

Notes: (+) denotes a positive value; (-) denotes a negative value.

$w = |s^f - s| / (s^f - s)$.

repo volume and the swap spread. In addition to the effect of repo volume on the swap spread in equation 5, the swap spread in turn could influence repo volume through its effect on trading gains and losses.

## 6.3 Trading Losses and Repo Volume

We now consider the possibility that repo volume is affected by trading losses if such losses lead to a contraction of trading positions and thus a fall in repo volume. In leveraged trading activity such as repo or derivatives transactions, a trading loss would create a credit exposure with the trader's counterparty. When the exposure reaches some threshold level, the counterparty may demand to close out the position or call for collateral to cover its exposure. If the additional collateral is not provided, the position would be closed out. In this scenario, we would expect repo volume to fall when traders suffer significant losses.

Alternatively, a trading firm's internal risk management discipline could also lead to the same relationship between losses and repo volume. A trading loss that exceeds a loss limit would trigger a risk management instruction to close out the losing position, with the same observed relationship occurring between trading losses and repo volume as in the counterparty credit risk scenario.

In an initial test of the relationship between repo volume and trading income, we express the relationship as

$$(6) \qquad \Delta RP_t = \psi + \gamma^0 \pi_t + \gamma^1 \pi_{t-1} + \kappa \Delta Tr_t^{10} + \varphi_t,$$

where $\pi$ is trading income, $Tr^{10}$ is the ten-year Treasury interest rate, and $\varphi_t$ is an unobserved random residual. The ten-year Treasury rate is included to account for the effect of the interest rate environment on the repo market.[9] In addition, we include both current and lagged trading income. If traders unwind their positions when they experience losses, both $\Delta RP$ and $\pi$ would be negative and the coefficient on trading income ($\gamma$) would be positive.

In the exploratory estimate of the relationship between repo volume and trading income (equation 6), we use the earnings of fixed-income arbitrage hedge funds as a proxy for trading income. The estimation results confirm the presence of such a relationship (Table 3). In column 1, the regression seeks a relationship between repo volume and trading income, and we find a statistically significant positive coefficient on trading income for both current and lagged hedge fund earnings. In column 2, to test whether trading losses lead to a contraction of repo volume, we condition the coefficient on trading income upon gains versus losses. Trading losses are indeed found to have the conjectured effect on repo volume, with statistically significant positive coefficients on trading income under the restriction of trading losses.

## 6.4 Trading Losses, Repo Volume, and the Swap Spread

Our model using repo volume considers the possibility of a simultaneous relationship between repo volume and the swap spread. In addition to the effect of repo volume on the swap spread (equation 5), the swap spread could in turn influence repo volume through its effect on trading gains and losses (equation 6). We now account for such a relationship between the two variables.[10]

[9] The ten-year to three-month term spread could also be used in this equation; it would yield similar results.

Table 3

## Regression Results for Repo Volume and Trading Losses

| | Unconditional Coefficient | Conditional Coefficient |
|---|---|---|
| *const.* ($\psi$) | -0.011 ($p$=0.000) | -0.018 (0.020) |
| $y_t$ | 0.006 ($p$=0.026) | |
| $y_{t-1}$ | 0.014 ($p$=0.000) | |
| $y_t\|_{y_t>0}$ | | 0.008 ($p$=0.337) |
| $y_t\|_{y_t<0}$ | | 0.005 ($p$=0.060) |
| $y_{t-1}\|_{y_{t-1}>0}$ | | 0.019 ($p$=0.007) |
| $y_{t-1}\|_{y_{t-1}<0}$ | | 0.012 ($p$=0.000) |
| $\Delta Tr_t^{10}$ | -0.059 ($p$=0.000) | -0.059 ($p$=0.000) |
| Adjusted $R^2$ | 0.329 | 0.322 |

Source: Author's calculations.

Notes: Regression results for the equations

$$\Delta RP_t = \psi + \gamma^0 y_t + \gamma^1 y_{t-1} + \kappa \Delta Tr^{10}{}_t + \varphi_t$$

and

$$\Delta RP_t = \psi + \gamma^{01}|_{y_t>0} y_t + \gamma^{02}|_{y_t<0} y_t + \gamma^{11}|_{y_{t-1}>0} y_{t-1} + \gamma^{12}|_{y_{t-1}<0} y_{t-1} + \kappa \Delta Tr_t^{10} + \varphi_t,$$

where

$y$ = earnings of fixed-income arbitrage hedge funds.

$p$-values are in parentheses, with Newey-West standard errors and covariance. The sample period is 1996-2004.

If we define trading income endogenously, as we do in the expression $\pi_t = \Delta s_t w_{t-1}$, substituting for trading income in equation 6 leads to

$$(7)\ \Delta RP_t = \psi + \tau \Delta s_t + \gamma^0 \Delta s_t w_{t-1} + \gamma^1 \Delta s_{t-1} w_{t-2} + \kappa \Delta Tr_t^{10} + \varphi_t,$$

where, in addition to substituting for trading income, we include the swap spread by itself to capture a baseline relationship between repo volume and the swap spread. In this equation, trading gains and losses depend on whether the swap spread is moving toward or away from its fundamental level. A converging spread leads to gains while a diverging spread results in losses.

This equation, combined with the swap spread equation (equation 5), gives us a simultaneous-equations model in which trading shocks, as reflected in repo volume, affect the swap spread, while shocks in the swap spread cause trading losses and the closing out of trading positions that in turn lead to a fall in repo volume.

Bringing together equations 5 and 7 gives us the following model of the swap spread and repo volume

$$(8)\ \Delta s_t = \beta^0 \Delta RP_t + \beta^1|_{\Delta RP<0} \Delta RP_t w_{t-1} + \lambda(ax_t - s_{t-1}) + \nu_t$$

$$(9)\ \Delta RP_t = \psi + \tau \Delta s_t + \gamma^0 \Delta s_t w_{t-1} + \gamma^1 \Delta s_{t-1} w_{t-2} + \kappa \Delta Tr_t^{10} + \varphi_t,$$

with $ax_t = \alpha_1 + \alpha_2 A_t + \alpha_3 Tr_t + \alpha_4 UnEmp_t + \alpha_5 \Delta r_t$, where equations 8 and 9, respectively, are equations 5 and 7 relabeled.

## 6.5 Estimation Results of the Simultaneous-Equations Model

We estimate equations 8 and 9 using two-stage least squares; we estimate the coefficients of the fundamental swap spread jointly with the other coefficients. The results are presented in Table 4.

We find using the equation for the change in the swap spread (Table 4, column 1), as we did using the single-equation model, that the convergence coefficient is smaller when the inferred level of trading activity is lower. This relationship occurs when trading has been unprofitable (compare rows 3 and 4). In row 2, we find a statistically significant positive coefficient for falling repo volume, indicating that the swap spread diverges from its fundamental level when repo volume falls.[11] This result is consistent with the argument about the effect on the swap spread of unwinding trading positions. Furthermore, for the repo volume equation (column 2), we find that repo volume varies directly with trading income (note the statistically significant positive coefficient in row 6), which would occur if traders unwound their positions when they suffered losses.

These results are consistent with the argument that shocks in the swap spread are associated with trading risk. The swap spread tends to diverge from its fundamental value when repo volume falls, and repo volume tends to fall when convergence traders experience losses.

[10] A simultaneous relationship between repo volume and the repo interest rate might also be possible. In tests of simultaneity, however, we found no sign of such a relationship among the repo market variables. A more general model with repo volume would also include other trading activity that involves the repo market—for instance, carry trades, trading on corporate bond spreads, and mortgage-backed securities trades. Such a large-scale model of trading activity, however, is beyond the scope of this article.

[11] As discussed in footnote 8, we also estimated a variation of the model with separate coefficients for rising and falling repo volume; we obtained the same results as we did using the specification in Table 4.

Table 4

## Regression Results for the Swap Spread, Repo Volume, and Trading Losses

| | $\Delta s$ | $\Delta RP$ |
|---|---|---|
| $\Delta RP_t$ | 0.108 ($p$=0.472) | |
| $\Delta RP_t\, w_{t-1}\big\vert_{\Delta RP<0}$ | 0.949 ($p$=0.000) | |
| $(\alpha x_t - s_{t-1})\big\vert_{\pi_{t-1}>0}$ | 0.411 (se=0.087, $p$=0.000) | |
| $(\alpha x_t - s_{t-1})\big\vert_{\pi_{t-1}<0}$ | 0.198 (se=0.064, $p$=0.003) | |
| $\Delta s_t$ | | 0.009 ($p$=0.902) |
| $\Delta s_t w_{t-1}$ | | 0.242 ($p$=0.001) |
| $\Delta s_{t-1} w_{t-2}$ | | 0.020 ($p$=0.805) |
| $\Delta Tr_t^{10}$ | | -0.047 ($p$=0.009) |
| *const.* $(\alpha_1, \psi)$ | 1.226 ($p$=0.000) | -0.001 (0.862) |
| $A$ | 0.287 ($p$=0.000) | |
| $Tr$ | 0.046 ($p$=0.063) | |
| $UnEmp$ | -0.290 ($p$=0.000) | |
| $\Delta r$ | 0.310 ($p$=0.002) | |
| Adjusted $R^2$ | 0.206 | 0.110 |

Source: Author's calculations.

Notes: We use two-stage least squares regression results for the equations

$$\Delta S_t = \beta_0 \Delta RP_t + \beta^1\big\vert_{\Delta RP<0} \Delta RP_t\, w_{t-1} + \lambda^P\big\vert_{\pi_{t-1}>0}(\alpha x_t - s_{t-1}) + \lambda^n\big\vert_{\pi_{t-1}<0}(\alpha x_t - s_{t-1}) + \upsilon_t,$$

$$\Delta RP_t = \psi + \tau \Delta s_t + \gamma^0 \Delta s_t w_{t-1} + \gamma^1 \Delta s_{t-1} w_{t-2} + \kappa \Delta Tr_t^{10} + \varphi_t,$$

with

$$\alpha x_t = \alpha_1 + \alpha_2 A_t + \alpha_3 Tr_t + \alpha_4 UnEmp_t + \alpha_5 \Delta r_t,$$

$$w_t = \left|s_t^f - s_t\right| / (s_t^f - s_t),$$

$$s_t^f = \alpha x_t,$$

$$\pi_{t-1} = \Delta s_{t-1} w_{t-2}.$$

Standard errors (se) and $p$-values are in parentheses, with Newey-West standard errors and covariance. The sample period is 1996-2004.

Convergence trading usually stabilizes the swap spread because traders take positions that counter shocks to the spread in a buy-low/sell-high speculation that maintains market liquidity. The results in this section, however, suggest that large shocks can be amplified by the premature unwinding of convergence trades. Generally, traders unwind their inventory when shocks in a direction opposite the initial shock enable them to close out their positions profitably in a controlled fashion, smoothing out liquidity shocks as they do so. If convergence trades are unwound prematurely, though, they impact market liquidity and can cause the spread to diverge from its fundamental level rather than converge to it. When traders take positions that counter shocks in the spread, the inventory built up in those positions overhangs the market and becomes a potentially destabilizing force, even though the change in that inventory usually stabilizes the spread. Although speculative trading normally absorbs shocks as traders execute their buy-low/sell-high strategies, the untimely liquidation of the accumulated trading positions can release back into the market the shocks that had been absorbed by that inventory.

## 7. Conclusion

This study offers evidence of stabilizing as well as destabilizing forces in the behavior of the interest rate swap spread that might be attributable to speculative trading activity. Our results are consistent with the argument that the swap spread converges more slowly to its fundamental level when the capital, or endowments, of traders has been impaired by trading losses. Furthermore, while convergence traders tend to stabilize the swap spread, we also find evidence of how trading risk can sometimes cause the spread to diverge from its fundamental level.

Our results suggest that convergence trading typically absorbs shocks, but an unusually large shock can be amplified by the premature unwinding of traders' positions. Destabilizing shocks in the swap spread are found to be associated with a fall in the volume of repo contracts in a way

that is consistent with an unwinding of trading positions. We also find that repo volume drops in response to losses in convergence trading. Together, these results are consistent with the argument that trading risk, as reflected in fluctuations of repo volume, on occasion can destabilize the swap spread.

Although other explanations of the relationship between shocks in repo volume and the swap spread might ultimately be put forth, our results suggest that it would be worthwhile to pursue further research on how shocks in trading activity affect spreads in fixed-income markets.

# References


*Adrian, T*. 2004. "Inference, Arbitrage, and Asset Price Volatility." Federal Reserve Bank of New York Staff Report no. 187, May.

*Adrian, T., and M. J. Fleming*. 2005. "What Financing Data Reveal about Dealer Leverage." Federal Reserve Bank of New York Current Issues in Economics and Finance 11, no. 3 (March).

*Bank for International Settlements*. 1998. "Report on OTC Derivatives: Settlement Procedures and Counterparty Risk Management." Committee on Payment and Settlement Systems and Euro-currency Standing Committee. Report no. 27, September. Basel, Switzerland.

———. 2005. "Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in 2004." March. Basel, Switzerland.

*Collin-Dufresne, P., and B. Solnik*. 2001. "On the Term Structure of Default Premia in the Swap and LIBOR Markets." Journal of Finance 56, no. 3 (June): 1095-1115.

*Duffie, D., and K. J. Singleton*. 1997. "An Econometric Model of the Term Structure of Interest Rate Swap Yields." Journal of Finance 52, no. 4 (September): 1287-1321.

*Lang, L. H. P., R. H. Litzenberger, and A. Luchuan*. 1998. "Determinants of Interest Rate Swap Spreads." Journal of Banking and Finance 22, no. 12 (December): 1507-32.

*Liu, J., F. A. Longstaff, and R. E. Mandell*. 2002. "The Market Price of Credit Risk: An Empirical Analysis of Interest Rate Swap Spreads." NBER Working Paper no. 8990, June.

*Shleifer, A., and R. W. Vishny*. 1997. "The Limits of Arbitrage." Journal of Finance 52, no. 1 (March): 35-55.

*Xiong, W*. 2001. "Convergence Trading with Wealth Effects: An Amplification Mechanism in Financial Markets." Journal of Financial Economics 62, no. 2 (November): 247-92.

Paul Edelstein and Donald P. Morgan

# Local or State? Evidence on Bank Market Size Using Branch Prices

- Each Federal Reserve Bank defines the banking markets in its District at the local rather than the state level. The effect of bank mergers on market competition depends crucially on this definition of size, as competition could be stifled if the combined deposit share of two merging banks in one market is too large.
- The elimination of state laws against branching now enables banks to compete across states—implying that banking markets are getting bigger and spurring a "local or state?" debate over market size.
- An analysis of bank market size suggests that branch prices—the amount a bank pays to buy another bank's branches—may be a better indicator of size than the current measure, bank deposit rates.
- The results indicate that banking markets are not necessarily local. Prices for bank branch sales in ten northeastern states over the 1990s are more closely correlated with bank concentration at the larger, state level than at the local level.

## 1. Introduction

Geographic markets are currently defined by market analysts at each of the twelve Federal Reserve Banks, with oversight by the Federal Reserve Board and even the U.S. Supreme Court. In 1963, in *U.S. v. Bank of Philadelphia*, the Court ruled that the market for bank deposits is local. That 1963 ruling still unifies market analysis at each of the twelve Reserve Banks. The flavor of analysis differs somewhat across Banks, but the stock is the same. Analysts stake off their District into *local* markets: either metropolitan statistical areas (MSAs) or small groups of rural counties. Once they have designated the markets, analysts keep tabs on the distribution of deposits at banks operating in the markets.[1]

Designating the market correctly matters a lot when it comes to bank mergers. Suppose one bank wants to buy another bank that operates in the same designated market. If the banks' combined share of deposits in that market is too large, regulators may frown upon the merger because it might stifle competition. Some bankers push back by challenging the Fed's designated markets; "we are not too large," bankers sometimes contend, "your designated market is too small."

To be fair, a lot has changed since the Supreme Court decreed that bank deposit markets are local. Competition across markets was limited then by state laws against branching. With those laws gone, banks can now just build

Paul Edelstein, formerly a research associate at the Federal Reserve Bank of New York, is a graduate student in economics at the University of Michigan; Donald P. Morgan is a research officer at the Federal Reserve Bank of New York.
<don.morgan@ny.frb.org>

The authors thank Ryan Morgan, Kristin Wilson, and two anonymous referees for assistance. The views expressed are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

or buy a branch in another city if doing so seems profitable.[2] Technology has also improved. Circa 1963, savers deposited and withdrew funds in person, so local nearby banks had a distinct advantage over more remote competitors. Now savers can bank at far-flung ATMs or via phone or Internet, so location matters less. In a study of European banking markets, Corvoisier and Gropp (2001) find that market *contestability*—the threat of competition from potential entrants—increases with the number of Internet hosts per capita. Better information technology has also lowered the costs of managing widespread branch networks (Berger and DeYoung 2002).

In view of these changes, Radecki (1998) challenges the local-market paradigm. He observes that banks with branches in multiple markets tend to pay the same deposit rates all over the state. Moreover, deposit rates depend more on bank concentration (a proxy for competition[3]) at the state level than at the local level. Hannan and Prager (2001) challenge some of Radecki's results—they find more differences in deposit rates across markets—but even they still concede that the growing role of multimarket banks tends to blur market boundaries.

Part of the disagreement over market size stems from data limitations. As Biehl (2002) points out, comparisons of deposit rates across banks in different locations can be misleading; if deposits differ across two cities, does it mean that the cities represent different markets, or that banks in those cities offer different levels of service? Comparing profits would be preferable (because profits capture differences in prices *and* services), but profits at the branch level are not available to researchers.

The branch prices we study are less limited. Increasingly, banks are entering new markets by buying one or more branches from other banks (Benz 1998). The price of a given branch should depend on the branch's expected profits, and expected profits, in turn, depend on competition. All else equal, branches in less competitive (that is, more concentrated) markets will fetch higher prices because the absence of competition enables branch owners to lower deposit rates or service levels (or both).

Using prices on 110 branch deals over 1992-99 in ten northeastern states, we run a type of "horse race" to determine whether branch prices depend more on concentration at the local level (as the local-market paradigm implies) or at the larger, state level. Our branch price data seem to work well in the sense that branch prices are always correlated with concentration at one level or another. Some of the specific findings are consistent with the state-market hypothesis; across all years in our sample, branch prices are more closely correlated with bank concentration at the state level than at the designated market level. State-level concentration also tends to matter more for branch prices in dollars and cents, not just in statistical terms. However, the correlation between branch prices and state concentration depends partly on how we cut the data, so we cannot conclude entirely in favor of the state-market hypothesis. Branch price data certainly advance the local-versus-state debate, and with enough such data, that question might be settled once and for all.

The next section discusses conceptual definitions of markets and summarizes actual Federal Reserve practices in designating markets. Section 3 reviews some of the evidence on market size, most of which, it should be admitted, favors the local-market hypothesis. In Section 4, we present our findings, showing that branch prices also depend on concentration at the state level, not just at the local level. Section 5 discusses robustness and caveats.

## 2. Banking Market Definitions: Concepts and Practices

By "market," we mean the market for bank deposits in particular. Banks sell loans and many other services, of course, but in its 1963 ruling, the U.S. Supreme Court accepted the argument that antitrust analysts can use deposits as a proxy for the full "cluster" of banking services. Without that assumption, market analysis would forever beg "market for *what?*" questions.

So how big is the deposit market? The U.S. Department of Justice, the main antitrust agency, suggests that the market for deposits (or *any* product for that matter) can be viewed as:

> a region such that a hypothetical monopolist . . . would profitably impose at least a "small but significant and nontransitory" increase in price.[4]

The key word in that definition is *profitably*. The monopolist just represents a hypothetical case where the conjectured market is so small—a city block, for example, or a village—that a single provider could serve it. Suppose the hypothetical monopolist tried to raise prices (or lower deposit rates) in the conjectured market. If savers flock to another nearby bank or branch, or if another bank steps in and offers higher deposit rates, the monopoly bank's attempt to raise prices will be *un*profitable, and hence, transitory. Thus, the conjectured market is too small.

[1]The District flavor enters in how analysts decide to group or divide rural counties into a designated market (DiSalvo 1999).

[2]Branching is less expensive than chartering a whole new bank with its own capital, board, and management (as was required before).

[3]We discuss the use of bank concentration as a proxy for competition later.

[4]See <http://www.usdoj.gov/atr/public/guidelines/horiz_book/12.html>.

The Justice Department guidelines above are more of a thought experiment, or a conceptual view. In practice, analysts at the twelve Federal Reserve Banks designate markets using simpler analysis. Following the Supreme Court's decree, most analysts define markets as MSAs or groups of rural counties, then fine-tune the definitions using commutation patterns between locales reported in the U.S. census (DiSalvo 1999). Sufficiently high commuting between two rural counties, for example, might justify treating the counties as part of the same market.

The local-market paradigm implies about 2,000 banking markets in the United States (Table 1). The number and size of markets vary considerably across Federal Reserve Districts, ranging from about 3,500 square miles in the densely populated New York District to just 1,400 square miles in the sparsely populated Kansas City District. A sparsely populated region does not necessarily imply small markets, however. For example, analysts in Minneapolis judge that markets in their District are larger than those in the New York District, even though their population is sparser than the population in the Kansas City District. Note the vast range of deposits per market, too: $31.2 billion per market in New York, versus just $379 million per market in Kansas City.

Table 1
Summary of Banking Market Definitions by Federal Reserve Bank

| Bank | Number of Markets | Population Density of District | Population per Market | Square Miles per Market | Deposits per Market (Millions of Dollars) |
|---|---|---|---|---|---|
| Boston | 86 | 193.2 | 145,488 | 753.2 | 2,217.6 |
| New York | 15 | 464.2 | 1,638,095 | 3,529.0 | 31,265.5 |
| Philadelphia | 33 | 327.9 | 359,018 | 1,095.0 | 4,611.5 |
| Cleveland | 120 | 224.2 | 137,029 | 611.3 | 2,072.8 |
| Richmond | 194 | 162.8 | 129,458 | 795.3 | 1,719.9 |
| Atlanta | 288 | 131.1 | 124,629 | 950.6 | 967.7 |
| Chicago | 256 | 164.4 | 123,928 | 753.7 | 1,423.6 |
| St. Louis | 266 | 74.5 | 45,575 | 611.4 | 544.7 |
| Minneapolis | 102 | 18.6 | 76,365 | 4,108.9 | 1,002.1 |
| Kansas City | 359 | 28.9 | 40,549 | 1,404.7 | 379.9 |
| Dallas | 267 | 57.6 | 77,051 | 1,336.6 | 667.0 |
| San Francisco | 132 | 39.9 | NA | NA | NA |

Source: DiSalvo (1999).

## 3. Evidence on Bank Market Size

Researchers have considered a variety of evidence on bank market size, ranging from "how far is your bank?" types of survey questions to more technical studies of how bank deposit and loan rates relate to market concentration.

### 3.1 Survey Findings

According to the Survey of Consumer Finance, a periodic survey conducted by the Federal Reserve, the median distance between households and their primary depository institution in 1999 was just three miles, the same as it was in 1989 (Amel and Starr-McCluer 2001). Savers also stay with the same nearby bank for a long time; Kiser (2002) finds that the median tenure of a household's main bank is ten years. When savers do switch banks, the most common reason cited is relocation, suggesting the importance of having a local provider.

Small business borrowers like their banks nearby as well (and vice versa, presumably), but the distance between them has grown. According to the Federal Reserve's National Survey of Small Business Finance, the distance between the typical small firm and its bank lender in 1970 was just sixteen miles, compared with sixty-eight miles in the 1990s (Petersen and Rajan 2000). The four-fold increase suggests some expansion of banking markets, but at sixty-eight miles, the latest figure implies that markets remain relatively local.

This survey evidence shows convincingly that savers and borrowers like to be close to their banks, but it does not tell us how far banks will travel when they see profit opportunities in another market. Back when states limited branching, a bank could not simply branch into another city if savers there seemed underserved. Now banks can branch freely, so the relevant market, from the suppliers' (banks') perspective, could be growing even if demanders (savers) remain close to their banks.

### 3.2 Uniform Pricing

Stigler (1966, p. 86) defines a market as "the area within which the price of a commodity tends toward uniformity." If prices differ across two regions, those regions must represent different markets.

Radecki (1998) observes that large multimarket banks operating in the six most populous states (New York, Michigan, Texas, California, Pennsylvania, and Florida) tend to pay similar deposit rates all over the state, and that deposit

rates are increasingly correlated with *state*-level concentration. Banks see the market as the whole state, he concludes. Hannan and Prager (2001) reaffirm the correlation between deposit rates and *local* concentration using more recent data, but they confirm that the concentration-price relationship weakens as the share of multimarket banks grows. Heitfield and Prager (2002) revisit the uniform-pricing finding using a larger data set. Rates on checking still differ significantly across markets (MSAs) within a state, they find, suggesting that the market for checking accounts remains local.[5] NOW account and money market deposit account rates are correlated with both local- and state-level banking concentration, but state-level concentration matters more in more recent years.

As Biehl (2002) observes, differences in deposit rates might reflect different products, rather than different markets. Perhaps deposit rates in *A* are lower, but services (such as minimums) are higher. Profits are preferable to deposit rates, as profits capture any additional revenues earned by banks in less competitive markets as well as any additional savings to banks achieved by cutting back on deposit services. The branch prices we study later are closer to profits, so they may be more informative.

### 3.3 The Price-Concentration Relationship

For a given market definition, analysts measure deposit market concentration using the Herfindahl-Hirschman Index (HHI). If deposits at bank $i = S_i$ percent of market deposits, *market HHI* $= \Sigma_i S_i^2$. The HHI ranges from 0 (infinitely many banks with an infinitesimal deposit share) to 10,000 (one bank with 100 percent of deposits). According to Department of Justice guidelines, a market with an HHI below 1,000 is unconcentrated, a market with an HHI between 1,000 and 1,800 is moderately concentrated, and one with an HHI above 1,800 is highly concentrated.[6]

The Justice Department guidelines presume that higher concentration indicates less competition. Researchers call this the structure-conduct paradigm: if market structure is highly concentrated, firm conduct will be uncompetitive. Some economists argue that the structure-conduct paradigm is exactly backward—conduct dictates structure, not vice versa. Better performing banks (those that offer less expensive or better services) will wind up with a larger market share. Thus, concentration may reflect greater efficiency, rather than lack of competition.

These differing views predict nearly opposite relationships between bank prices and profits, on the one hand, and bank concentration, on the other. The structure-conduct view equates concentration with lack of competition, so all else equal, concentration should be associated with lower deposit rates, less efficiency, and higher profits. The conduct-structure view equates concentration with greater efficiency, so concentration should be associated with higher deposit rates and greater efficiency in more concentrated markets.

Studies of the banking industry largely support the structure-conduct view. In fact, banks in more concentrated markets pay lower deposit rates (Berger 1995; Berger and Hannan 1989), charge higher loan rates (Hannan 1991), and are less efficient (Berger and Hannan 1998).[7] In view of this evidence, and following most of the related literature, this article uses higher concentration as a proxy for lower competition, rather than greater efficiency.

## 4. Branch Price Data and Their Relation to State and Local Concentration

Our sample comprises 110 branch sales between 1992 and 1999 in ten northeastern states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, and Vermont. The branch sale data were obtained from SNL Financial. The SNL Financial deal data were matched with branch-level Summary of Deposits data collected by the Federal Deposit Insurance Corporation. We found complete matches for 111 of the initial 220 deals obtained from the SNL Financial data. Our small data set makes some results sensitive to how we treat the data, as we discuss below.

The distribution of deals across years and states is reported in Table 2. Sixty-nine deals occurred in New York, New Jersey, and Pennsylvania. The number of deals picked up substantially after 1993—the year before passage of the Riegle-Neal

[5]Differences in deposit rates across two cities certainly imply different markets, but uniform rates *do not* necessarily imply a single market (Heitfield and Prager 2002).

[6]See <http://www.usdoj.gov/atr/public/guidelines/horiz_book/15.html>. According to Department of Justice bank merger guidelines, bank mergers in predefined markets will not raise competitive concerns as long as 1) the post-merger HHI does not exceed 1,800 and 2) the merger increases the HHI by more than 200. If the 1,800/200 screen is violated, applicants may be required to provide additional information to assure that competition will not suffer.

[7]Significantly, Berger and Hannan (1998) allow for the possibility that efficiency differences could cause differences in concentration by using two-state least squares (using population as an instrument for concentration). Their finding that concentration reduces efficiency helps explain why banks in more concentrated markets do not earn substantially higher profits, even though they charge higher loan rates and pay lower deposit rates; bank managers may sacrifice higher profits in exchange for a "quiet life."

Table 2

## Distribution of Bank Branch Sales in Northeastern States, 1992-99

| Year | Number of Deals | Mean Branches | Standard Deviation | Minimum Branches | Maximum Branches |
|---|---|---|---|---|---|
| 1992 | 4 | 1.00 | 0.00 | 1 | 1 |
| 1993 | 1 | 1.00 | — | 1 | 1 |
| 1994 | 15 | 1.93 | 1.75 | 1 | 7 |
| 1995 | 38 | 3.61 | 4.10 | 1 | 20 |
| 1996 | 13 | 3.54 | 5.17 | 1 | 20 |
| 1997 | 11 | 4.36 | 4.88 | 1 | 16 |
| 1998 | 15 | 2.67 | 2.77 | 1 | 10 |
| 1999 | 14 | 4.43 | 7.02 | 1 | 28 |
| **State** | **Number of Deals** | **Mean Branches** | **Standard Deviation** | **Minimum Branches** | **Maximum Branches** |
| Connecticut | 8 | 5.25 | 6.32 | 1 | 20 |
| Delaware | 2 | 4.50 | 4.95 | 1 | 8 |
| Maine | 5 | 2.20 | 1.64 | 1 | 4 |
| Maryland | 10 | 2.40 | 2.27 | 1 | 7 |
| Massachusetts | 12 | 4.92 | 6.23 | 1 | 20 |
| New Hampshire | 1 | 3.00 | 0.00 | 3 | 3 |
| New Jersey | 14 | 3.00 | 2.54 | 1 | 11 |
| New York | 24 | 3.92 | 5.90 | 1 | 28 |
| Pennsylvania | 31 | 2.13 | 2.74 | 1 | 16 |
| Vermont | 4 | 4.25 | 3.30 | 1 | 8 |
| Total | 111 | 3.31 | 4.34 | 1 | 28 |

Source: Authors' calculations.

Interstate Banking and Branching Efficiency Act. The average branch sale involved 3.3 branches, with a range of 1 to 28. About half (55) the deals involved just a single branch. Average deposits across deals were $122.5 million.

Table 3 reports summary statistics on branch prices. The pricing of a branch deal requires some explanation. In most deals, the buyer acquires the physical assets, such as premises, and assumes the deposit liabilities (Berkovec, Mingo, and Zhang 1997).[8] Deposit liabilities usually exceed assets, so the difference represents the "price" paid by the buyer, even if no money changes hands. The price is usually expressed as a premium per deposit. For example, if a bank buys a branch with assets worth $75 and deposits of $100, the premium per deposit is 4 (25/100). The average premium per deposit in this sample ranged from 0 to 21.9, with an average of 6.56.

The reasons for selling a branch are varied. Some sellers may need to raise capital or be rid of far-off, hard-to-manage branches. Other sellers may unload branches to reduce their market share

[8]The branch seller may include loans in the deal if there are no nearby loan-servicing facilities, but buyers often choose not to purchase loans because of uncertainty about their quality (Benz 1998, p. 33).

Table 3

## Summary Statistics on Branch Sales and Bank Concentration

| Variable | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Premium-deposit ratio | 6.52 | 3.91 | 0 | 21.88 |
| Deposits (thousands of dollars) | 122.54 | 2,589.86 | 2.2 | 1,600 |
| Log (deposits) | 3.59 | 1.47 | .79 | 7.38 |
| Branches | 3.31 | 4.34 | 1 | 28 |
| Log (branches) | 0.73 | 0.87 | 0 | 3.33 |
| Dow Jones Bank Index (percentage change) | 0.00 | 0.60 | -5.76 | -0.44 |
| Bank concentration | | | | |
| Market HHI[a] | 355 | 598 | 18 | 5,137 |
| State HHI | 667 | 221 | 382 | 1,790 |

Source: Authors' calculations.

Notes: HHI, the Herfindahl-Hirschman Index, measures deposit market concentration. $HHI = \Sigma_i (S_i)^2$, where $S_i$ = share of market (or state) bank deposits at bank $i$.

[a]Market is defined by each Federal Reserve Bank.

before merging with another bank in that market; by selling branches before applying to merge, banks can avoid a forced divestiture of branches as a condition of merger approval.

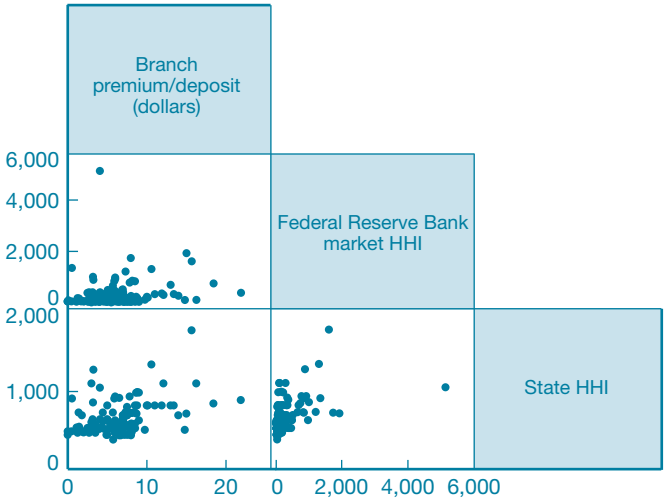
Table 3 also reports statistics on bank concentration (HHI) at both the state and market levels at the date of the deal. The state HHI is measured precisely for all deals. The market HHI is measured precisely for single branch deals and for multiple branch deals when all branches are located in the same market, but for multimarket deals, "the market HHI" is actually the weighted average of the HHI across the markets where the branches in the deal are located. The HHI in each market is weighted by the share of total deal deposits located at branches in each market.[9] Averaging causes some error in the market HHI measurement, but probably not much; there were only twenty-three multimarket deals, and sixteen of them involved just two markets (six deals involved three markets and one deal involved four markets).

Chart 1 presents a scatterplot of the prices for each branch deal against the corresponding state HHI and market HHI. Note the outlier in the branch premium–market HHI plot; as we will see, the relationship between branch prices and market HHI depends on whether we include that observation.

[9]For example, if 25 percent of the deposits in a deal were at branches in a market with an HHI of 1,000 and 75 percent were at branches in a market with an HHI of 2,000, the weighted HHI for the deal would be 1,750.

Chart 1

## Branch Price versus Federal Reserve Bank Market HHI and State HHI




Sources: SNL Financial (branch premia); authors' calculations (HHI).

Notes: HHI, the Herfindahl-Hirschman Index, measures deposit market concentration. The lower-right panel shows the relationship between state HHI and market HHI.

Chart 2 plots average branch prices and HHI—market and state—for deals occurring each year. All three trends are upward. The upward trend in concentration reflects the merger wave over the 1990s.

According to Benz (1998, p.33), the deposit premium depends on "the relative attractiveness of the *market area* and earnings potential" (emphasis added). Market attractiveness, in turn, should depend on concentration: all else equal, a branch in more concentrated markets should have higher earnings and thus a higher premium.

To test which measure of concentration matters most in explaining branch price, we regress branch prices on market HHI, state HHI, and a short set of control variables

$$price/deposit = \alpha + \gamma\, market\ HHI + \beta\, state\ HHI + \chi\, controls + \varepsilon.$$

The local-market hypothesis implies a positive coefficient on market HHI and a zero coefficient on state HHI: $\gamma > 0$, $\beta = 0$. The state-market hypothesis implies the opposite: $\gamma = 0$, $\beta > 0$.

Our control set is limited by our small sample. Branch prices should depend on overall banking profitability, so we include the average monthly return on the Dow Jones Bank Stock Index ($DJBANK_i$). Larger branches may fetch higher prices because of economies of scale, so we include the deal deposits, measured in log units (*log deposits*).

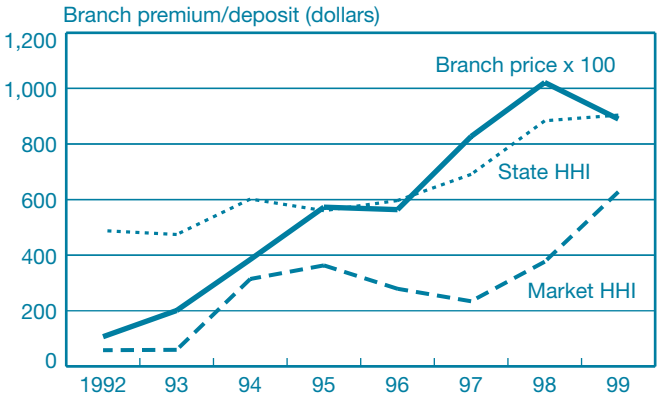
In some regressions, we control for the state where the branches were located and/or the year the branches were sold. The state indicators account for fixed differences between states in the average branch premium. Controlling for the state amounts to subtracting the mean of each variable (over time) from every observation on that variable. Controlling for the year amounts to subtracting the mean of each variable (over states) from each observation of that variable. With the "demeaned" variables, the regressions estimate how deviations from average in the branch premium within a given state or year (or both) are related to deviations from average in each HHI within the same state or year (or both).

Table 4 reports the regression results. Both HHIs were divided by 100 to avoid reporting many zeros. Regressions 1-4 include market HHI, but not state HHI. The coefficient on market HHI is significant at the 1 percent to 5 percent level for every regression (1-4). Regressions 5-8 include state HHI, but not market HHI. In the regressions without year controls (5-6), the coefficient on market HHI is significant at the 1 percent level. The $R^2$ for those regressions is 23 percent to 29 percent higher than it is for the corresponding regressions with just market HHI (1-2). Looking across all years, in other words, one sees that branch prices depend more on the state HHI than on the market HHI.

In the regressions *with* year controls (7-8), state HHI is insignificant. The $R^2$ for those regressions is lower than it is for the corresponding regressions with just market HHI (1-2), but

Chart 2

## Average Branch Prices and HHI Each Year




Sources: SNL Financial (branch premia); authors' calculations (HHI).

Note: HHI, the Herfindahl-Hirschman Index, measures deposit market concentration.

Table 4

## Do Branch Prices Depend on Concentration (HHI) at the Local Market Level or at the State Level?

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Constant | -8.43*** | -13.15*** | -11.21*** | -13.48*** | -10.91*** | -17.57*** | -11.63*** | -5.87** | -2.20* | -8.84*** | -1.99 | -16.38*** |
| | (2.81) | (3.32) | (2.38) | (2.73) | (2.52) | (2.93) | (2.42) | (2.88) | (1.16) | (2.09) | (1.25) | (25.63) |
| Market HHI/100 | 0.25*** | 0.33*** | 0.16* | 0.26** | | | | | 0.06 | 0.20 | 0.17 | 0.28** |
| | (0.09) | (0.12) | (0.09) | (0.11) | | | | | (0.13) | (0.13) | (0.11) | (0.12) |
| State HHI/100 | | | | | 0.67*** | 1.23*** | 0.17 | 0.65 | 0.62*** | 1.14*** | -0.01 | 0.62 |
| | | | | | (0.13) | (0.24) | (0.14) | (0.42) | (0.17) | (0.24) | (0.19) | (0.39) |
| Log deposits | 1.35*** | 1.61*** | 1.33*** | 1.44*** | 1.23*** | 1.31*** | 1.29*** | 1.38*** | 1.24*** | 1.32*** | 1.33*** | 1.39*** |
| | (0.27) | (0.27) | (0.23) | (0.23) | (0.24) | (0.22) | (0.24) | (0.24) | (0.24) | (0.21) | (0.24) | (0.23) |
| Bank stock index | 69.90*** | 37.97* | 30.81 | 27.64 | 71.53*** | 39.47 | 32.3 | 32.3 | 70.46*** | 38.87 | 30.73 | 29.69 |
| Percentage change | 23.75 | 21.88 | 26.71 | 25.05 | 22.37 | 24.75 | 27.81 | 27.91 | 22.69 | 24.06 | 26.69 | 3.52 |
| State controls? | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |
| Year controls? | No | No | Yes | Yes | No | No | Yes | Yes | No | No | Yes | Yes |
| Number of observations | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| $R^2$ | 0.35 | 0.45 | 0.60 | 0.65 | 0.43 | 0.58 | 0.58 | 0.63 | 0.43 | 0.60 | 0.60 | 0.66 |

Source: Authors' calculations.

Note: HHI, the Herfindahl-Hirschman Index, measures deposit market concentration.

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.

the difference in $R^2$ is very small. Within a given year, in other words, it does not matter much whether one looks at market HHI or state HHI.

The final regressions, 9-12, include both market HHI and state HHI. Without year controls (9-10), the state HHI coefficient is significant at the 1 percent level, but the market HHI coefficient is insignificant. The (adjusted) $R^2$ for regressions 9 and 10 is barely different from that for the corresponding regressions (5-6) with state HHI by itself. Given state HHI, in other words, market HHI has very little marginal explanatory value for branch prices.

In the regressions *with* year controls (11-12), state HHI is insignificant. Market HHI is also insignificant in the regression without state controls (12), but is significant in the regression with year *and* state controls (11). State HHI is insignificant within a given year partly because our sample comprises only eight years; limited variation in state HHI across states makes the relationship between state HHI and branch prices hard to estimate precisely (hence the higher standard errors of the within-year estimates). Controlling for the year does not handicap market HHI so much because we have sixty-six markets in our sample. We suspect that the dominance of market HHI over state HHI in explaining variation in branch prices within a year mostly reflects the fact that our small sample is spread more widely across markets than across states. It will take more data to verify that conjecture, however. With a bigger data set, we would control for year, state, *and* market.

More data would also help with the outlier observation on market HHI (Chart 1) that we exclude from the regressions. With that outlier included, market HHI is never significant (in any regression), but state HHI remains significant.

Which HHI—state or market—matters most in dollar terms? The market HHI coefficient (when significant) ranges from 0.16 to 0.33, with a midpoint of 0.25. The state HHI coefficient (when significant) ranges from 0.62 to 1.14, with a midpoint of 0.88. The state HHI coefficient estimate

is 3.5 times larger than the market HHI coefficient, but then again, market HHI varies more than state HHI (Table 1). The standard deviation in market HHI is only about 2.7 times larger than the standard deviation in state HHI, however, so in the end, state HHI matters more for branch prices: the branch premium per deposit increases by 1.95 per one-standard-deviation increase in state HHI (222 x 0.0088). The average premium per deposit is 6.5, so an increase of 1.95 is large. By contrast, the premium per deposit increases by just 1.5 per one-standard-deviation increase in market HHI.

## 5. Robustness and Caveats

### 5.1 Divestiture?

Our source for branch price data, SNL Financial, does not identify which deals, if any, were divestitures pursuant to a merger.[10] The forced nature of divestitures is potentially problematic: divestitures occur in more concentrated markets, so *if* divested branches sell for less, our estimate of the price-market concentration relationship might be biased downward. Prices on divested branches are determined through competitive bidding, however, so sellers should not necessarily have to sell at a discount. We also analyzed whether the particular markets covered in our sample were more concentrated than the average market in northeastern states (implying that divestitures might be more likely in our sample), but found that they were not.

### 5.2 Similar Results for Single-Branch Deals

Recall that for multibranch deals, market HHI is the weighted average of the HHI across the markets involved. By contrast, none of the deals in our sample covers multiple states, so state HHI is not an average.

Does averaging the HHI across markets cause errors in market HHI that make state HHI look more important by comparison? No. Regressions with just the set of fifty-four single-branch deals are very similar to regressions using multibranch deals as well. The relative size and significance on market HHI and state HHI are about the same as they are in regressions 9-12 in Table 4; only state HHI is significant in the models without year effects (analogous to 9 and 10), but only market HHI is significant with year effects.

[10]Regulators may require the merging banks to reduce their market share by selling off branches.

### 5.3 No Controls for Branch Efficiency

A potential problem arises from the fact that our regressions do not control for differences in branch efficiency. More efficient branches will certainly sell for higher prices, and branch efficiency might be correlated with market (or state) concentration as the better branches wind up dominating the market. Thus, the positive correlation between branch prices and concentration (market or state) *might* really reflect an omitted third variable—efficiency—that is positively correlated with both branch prices and concentration.[11]

Controlling directly for branch efficiency would be the natural way to rule out this alternative interpretation of our findings, but compiling branch-level efficiency measures would be prohibitive. As a shortcut, we did control for the number of years since a state relaxed branch restrictions as a (statewide) proxy for branch efficiency.[12] Including years since deregulation as an additional control variable did not alter the relative importance of market HHI and state HHI in explaining branch prices.

## 6. Conclusion

Are banking markets local or statewide? We do not settle the question here, but we advance it with a new, arguably better, indicator of market size: bank branch prices. Some of our regression results are consistent with the hypothesis of statewide banking markets. Across all years in our sample—1992-99—branch prices are more closely correlated with bank concentration at the state level than at the designated market level. State-level concentration also tends to matter more for branch prices in dollars and cents, not just in statistical terms.

Some caveats are in order, however. First, our data cover only branch sales in northeastern states. Whether our results apply to the rest of the country is another question. Second, the relationship between branch prices and state concentration for northeastern states is significant across years but not within years. The insignificant relationship within years may stem from our small data set of just ten states, but it might also mean that the relationship between branch prices and state

[11]It is not obvious, however, that omitting branch efficiency leads to bias that favors state HHI over market HHI. Also, observe that this alternative interpretation is more in line with the performance-structure view discussed earlier, wherein differences in firm performance lead to differences in market structure. Our analysis is more in line with the structure-performance paradigm, wherein differences in market structure dictate firm performance. Recall also that the balance of evidence supports the structure-performance paradigm, wherein differences in concentration across markets reflect differences in competition (not efficiency).

[12]See Strahan (forthcoming) for a review of his findings on the efficiency gains associated with branching deregulations.

concentration across years is spurious. We cannot say for sure without more data.

Going forward, other researchers might wish to consider studying branch prices over all states. With branch price data covering the entire country, we might settle the "local or state?" debate once and for all. Of course, it may not be just one or the other; markets in the northeast may be larger than those in other parts of the country. Either way, it is important to banking consumers to get the markets right.

# References


*Amel, D. F., and D. G. Kean*. 1985. "State Laws Affecting Commercial Bank Branching, Multibank Holding Company Expansion, and Interstate Banking." Unpublished paper, Board of Governors of the Federal Reserve System, August.

*Amel, D. F., and M. Starr-McCluer*. 2001. "Market Definition in Banking: Recent Evidence." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series no. 2001-16, February.

*Benz, H. M*. 1998. "Making a Branch Sale or Acquisition Work." America's Community Banker 7, no. 1 (January): 30-5.

*Berger, A. N*. 1995. "The Profit-Structure Relationship in Banking—Tests of Market-Power and Efficient-Structure Hypotheses." Journal of Money, Credit, and Banking 27, no. 2 (May): 404-31.

*Berger, A. N., and R. DeYoung*. 2002. "Technological Progress and the Geographic Expansion of the Banking Industry." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series no. 2002-31, June.

*Berger, A. N., and T. H. Hannan*. 1989. "The Price-Concentration Relationship in Banking." Review of Economics and Statistics 71, no. 2 (May): 291-9.

———. 1998. "The Efficiency Cost of Market Power in the Banking Industry: A Test of the 'Quiet Life' and Related Hypotheses." Review of Economics and Statistics 80, no. 3 (August): 454-65.

*Berkovec, J. A., J. J. Mingo, and X. Zhang*. 1997. "Premiums in Private versus Public Bank Branch Sales." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series no. 1997-33, June.

*Biehl, A. R*. 2002. "The Extent of the Market for Retail Banking Deposits." Antitrust Bulletin 47, no. 1 (spring): 91-106.

*Corvoisier, S., and R. Gropp*. 2001. "Contestability, Technology, and Banking." Unpublished paper, European Central Bank, October.

*DiSalvo, J. V*. 1999. "Federal Reserve Geographic Banking Market Definitions." Unpublished paper, Federal Reserve Bank of Philadelphia, September.

*Gelder, R. H., and G. Budzeika*. 1970. "Banking Market Determination—The Case of Central Nassau County." Federal Reserve Bank of New York Monthly Review, November: 258-66.

*Hannan, T. H*. 1991. "Bank Commercial Loan Markets and the Role of Market Structure: Evidence from Surveys of Commercial Lending." Journal of Banking and Finance 15, no. 1 (February): 133-49.

*Hannan, T. H., and R. A. Prager*. 2001. "The Competitive Implications of Multimarket Bank Branching." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series no. 2001-43, October.

*Heitfield, E., and R. A. Prager*. 2002. "The Geographic Scope of Retail Deposit Markets." Board of Governors of the Federal Reserve System Finance and Economics Discussion Series no. 2002-49, August.

*Jayaratne, J., and P. E. Strahan*. 1997. "The Benefits of Branching Deregulation." Federal Reserve Bank of New York Economic Policy Review 3, no. 4 (December): 13-29.

*Kiser, E*. 2002. "Household Switching Behavior at Depository Institutions: Evidence from Survey Data." Antitrust Bulletin 47, no. 4 (winter): 619-40.

*McLaughlin, S*. 1995. "The Impact of Interstate Banking and Branching Reform: Evidence from the States." Federal Reserve Bank of New York Current Issues in Economics and Finance 1, no. 2 (May).

*Petersen, A. M., and R. G. Rajan*. 2000. "Does Distance Still Matter? The Information Revolution in Small Business Lending." NBER Working Paper no. 7685, May.

*Radecki, L. J*. 1998. "The Expanding Geographic Reach of Retail Banking Markets." Federal Reserve Bank of New York Economic Policy Review 4, no. 2 (June): 15-34.

*Rhoades, S. A*. 1992. "Evidence of the Size of Banking Markets from Mortgage Loan Rates in Twenty Cities." Board of Governors of the Federal Reserve System Staff Study no. 162, February.

## References (Continued)

*Savage, D. T*. 1993. "Interstate Banking: A Status Report." Federal Reserve Bulletin, December: 1075-89.

*Stigler, G. J*. 1966. The Theory of Price. 3rd ed. New York: MacMillan.

*Strahan, P. E*. Forthcoming. "The Real Effects of U.S. Banking Deregulation." Federal Reserve Bank of St. Louis Review.

*United States General Accounting Office*. 1993. "Interstate Banking: Benefits and Risks of Removing Regulatory Restrictions." Report to the Chairman, Committee on Banking, Housing, and Urban Affairs, U.S. Senate. GAO/GGD-94-26, November.

*Whalen, G*. 2000. "Interstate Banking, Branching, Organization Size, and Market Rivalry." Office of the Comptroller of the Currency Economic Working Paper no. WP2000-7, July.

Kenneth D. Garbade

# The Evolution of Repo Contracting Conventions in the 1980s

- The growth of the repo market, new uses for repos, and the appearance of previously unappreciated risks led to dramatic changes in repo contracting conventions in the 1980s.
- The changes included recognition of accrued interest on repo securities, a revision to how federal bankruptcy law applied to repos, and the faster growth of tri-party repo—a new form of repurchase agreement.
- Individual market participants, motivated largely by profit, hastened the growth of tri-party repo.
- Because uncoordinated, individual solutions would have been too costly, market participants took collective action to bring about the recognition of accrued interest on repo securities and petition Congress to amend federal bankruptcy law.

## 1. Introduction

Repurchase agreements, or repos, play an important role in U.S. securities markets. Securities dealers use repos to finance market-making and risk management activities, and the agreements provide a safe and low-cost way for mutual funds, corporations, and others to lend both money and securities. At the end of 2004, primary dealers with a trading relationship with the Federal Reserve Bank of New York were borrowing a total of $3.2 trillion on repos and lending a total of $2.4 trillion. Repurchase agreements also play an important role in the implementation of monetary policy—the Federal Reserve uses them to dampen transient fluctuations in the supply of reserves available to the banking system. In 2004, the New York Fed's Trading Desk arranged 192 overnight repos, with an average size of $5.9 billion.

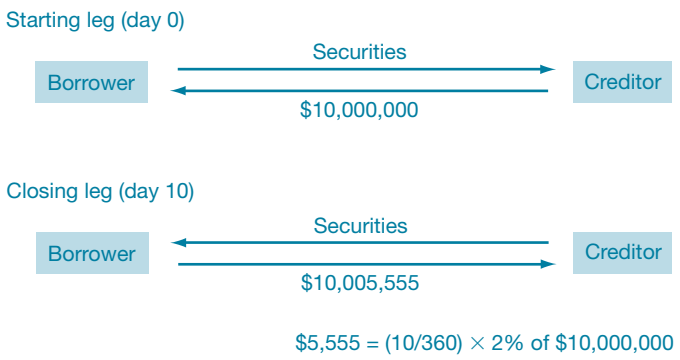
A repo is a sale of securities coupled with an agreement to repurchase the securities at a specified price on a later date. It is analogous to a loan, in which the proceeds of the initial sale correspond to the principal amount of the loan and the excess of the repurchase price over the sale price corresponds to the interest paid on the loan. A market participant might, for example, sell securities for $10 million and simultaneously agree to repurchase them ten days later for $10,005,555. As Exhibit 1 shows, this is comparable to borrowing $10 million for ten days at an interest rate of 2 percent per annum. If the borrower fails to repurchase the

Kenneth D. Garbade is a vice president at the Federal Reserve Bank of New York.
<kenneth.garbade@ny.frb.org>

The author thanks Al Clark, Craig Coats, Megan Cohen, Jeffrey Ingber, Arlen Klinger, Sandy Krieger, Rosalie Kurtz, Martin Leibowitz, Joan Lovett, John Macfarlane, Kara Masciangelo, Michael Nelson, Gregory Rappa, Marcy Recktenwald, Allan Rogers, William Silber, and Joseph Sommer, as well as two anonymous referees, for help researching this article and for comments on earlier drafts. The views expressed are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

Exhibit 1

## Borrowing $10 Million at a 2 Percent Interest Rate on a Ten-Day Repo




securities, the creditor can sell them to a third party and use the proceeds to satisfy its claim for repayment. Conversely, if the creditor does not return the securities to the borrower, the borrower can use the funds that it otherwise would have repaid to the creditor to replace the securities.[1]

Repos have a long history. Federal Reserve Banks used them to extend credit to member banks as early as 1917, when a wartime tax reduced the attractiveness of rediscounting commercial paper.[2] During the 1920s, the New York Fed used repurchase agreements to extend credit to nonbank dealers in bankers' acceptances to encourage the development of a liquid secondary market for acceptances.[3] Repos fell into disuse during the Great Depression and World War II, but reappeared following the restoration of Federal Reserve control of monetary policy in 1951.[4]

Contracting conventions for repurchase agreements hardly changed between the revival of repos in the early 1950s and 1981. However, they began to change dramatically in 1982. The collapse of Drysdale Government Securities, a midsized dealer, in May of that year led to an important change in the treatment of accrued interest on repo securities. The collapse of a second dealer, Lombard-Wall, three months later prompted an equally important change in the application of federal bankruptcy law to repos. Additional dealer failures in 1984 and 1985 accelerated the growth of a new form of repo, tri-party repo.

This paper examines how repo contracting conventions evolved in the 1980s. In the next section, we consider the revival of repo financing in the 1950s and the contracting conventions associated with that revival. Section 3 describes how the rising level and volatility of interest rates and growing Treasury debt fueled a significant expansion in the size of the repo market in the 1970s and early 1980s, as well as an important change in how market participants used repos. Existing contracting conventions proved inadequate for the expanding and changing market. Sections 4, 5, and 6 describe how new and previously unappreciated risks led participants to modify those conventions.

Understanding how repo contracting conventions evolved in the 1980s is important for two reasons. First, the evolution illustrates how contracting conventions that are efficient in one market environment may need to be revised when the environment changes. The experience with repurchase agreements suggests that revisions may sometimes come slowly and only in the wake of "precipitative events" that focus attention on inefficient practices.[5] Second, the evolution demonstrates that institutional arrangements can change in a variety of ways. The growth of tri-party repo followed from the autonomous adoption of a more efficient contract form by individual market participants acting in their own economic self-interest. In contrast, the change in the treatment of accrued interest was the result of collective action by the major government securities dealers and the change in bankruptcy law was brought about by market participants seeking relief in the form of Congressional legislation, because in both cases uncoordinated, individual action would have been more costly.

[1] See, generally, the Bond Market Association's 1996 Master Repurchase Agreement (<http://www.bondmarkets.com/agrees/master_repo_agreement.pdf>).

[2] Beckhart, Smith, and Brown (1932, p. 310), Harris (1933, p. 289), and Simmons (1954, p. 25). See also the wartime extension of credit to nonmember banks by the Federal Reserve Bank of New York using repurchase agreements on Treasury certificates of indebtedness (Federal Reserve Bank of New York 1919, pp. 24-5; Beckhart, Smith, and Brown 1932, pp. 310-1).

[3] Committee on Banking and Currency (1927a, pp. 431-6, testimony of Benjamin Strong, Governor, Federal Reserve Bank of New York), Committee on Banking and Currency (1927b, pp. 930-5 and 981-91, testimony of W. R. Burgess, Assistant Federal Reserve Agent, Federal Reserve Bank of New York), Committee on Banking and Currency (1931, pp. 818-24), Beckhart, Smith, and Brown (1932, pp. 363-4), Hardy (1932, pp. 249-53), Harris (1933, pp. 289-90), and Roosa (1956, p. 25). Additionally, in 1920 the Federal Reserve Bank of New York used repurchase agreements to encourage the development of a liquid secondary market in certificates of indebtedness (Federal Reserve Bank of New York 1921, p. 17; Beckhart, Smith, and Brown 1932, pp. 334-5).

[4] Simmons (1954, p. 26). Between mid-1942 and mid-1947, the Federal Reserve used repurchase agreements to encourage investors to hold Treasury bills at the wartime "posted" rate of 3/8 percent. See Federal Reserve Bank of New York Circular no. 2476 (August 8, 1942), Circular no. 3230 (July 3, 1947), and Simmons (1947, p. 337; 1952, p. 26; and 1954, pp. 27-8). The Federal Reserve reintroduced the use of repurchase agreements for monetary policy purposes in June 1949, but used them only intermittently before 1951 (Simmons 1954, pp. 23-5 and 32-4).

[5] The importance of precipitative events in fostering change was also noted in a recent study of the origins of the Federal Reserve book-entry system (Garbade 2004).

## 2. Repurchase Agreements after the Treasury-Federal Reserve Accord

Monetary policy after the Treasury-Federal Reserve Accord of March 1951 placed renewed emphasis on controlling inflation and reduced emphasis on keeping interest rates low. Nonbank dealers in Treasury securities, almost all of whom were located in New York, began to search for cheaper financing than what was available from the large New York banks that had historically funded most dealer loans. Rising interest rates also gave large state and local governments and nonfinancial corporations an incentive to substitute short-term loans for interest-free bank demand deposits. Minimal risk, operational simplicity, negotiable maturities, and a unique set of contracting conventions made repos ideally suited for both dealer financing desks and institutional cash managers.[6] Two particularly important contracting conventions involved margin and the allocation of property rights to repo securities.

### 2.1 Credit Risk and Margin

Credit risk on a repurchase agreement arises when the market value of the underlying securities differs from the principal amount of the repo. (The borrower is also liable for interest but, as suggested by Exhibit 1, this is usually small compared with the principal amount of a repo.)

The creditor bears risk when the value of the repo securities declines below the repo principal, because the proceeds derived from liquidating the securities will not satisfy the creditor's claim if the borrower defaults on its repurchase commitment. To protect against the adverse consequences of a decline in the market value of repo securities, a creditor might request "margin" by, for example, expressing a willingness to lend $10 million only against securities worth at least $10.2 million.

Conversely, the borrower bears risk when the value of the repo securities rises above the repo principal, because the principal will not cover the cost to the borrower of replacing the securities if the creditor fails to return them. To protect against the consequences of a rise in the market value of repo securities, a borrower might request margin by expressing a willingness to borrow $10 million only against securities worth no more than $9.8 million.

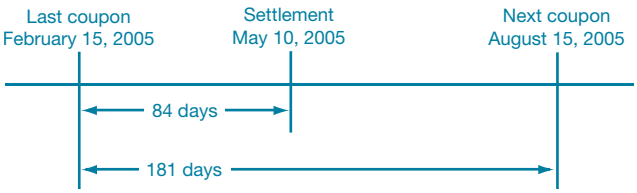
Margin can protect a creditor (that lends $10 million against securities worth at least $10.2 million), or it can protect a borrower (that borrows $10 million against securities worth no more than $9.8 million), but it cannot protect both parties simultaneously. During the 1950s and 1960s, it was customary for repo borrowers—primarily nonbank Treasury dealers—to give margin to creditors, because the creditors were typically more creditworthy than the dealers. In addition, creditors did not lend on accrued interest on notes and bonds. (Box 1 explains accrued interest.) Creditors lending on notes and bonds demanded, and received, securities with a *quoted* value that exceeded the principal amount of a loan by the agreed-upon margin.[7]

[6] Meltzer (2003, pp. 629-716) discusses the shift of control of monetary policy from the Treasury to the Federal Reserve after the end of World War II. Writing shortly before the Accord, Simmons (1951, p. 413) states that probably no more than ten large New York banks accounted for most lending to government securities dealers. The revival and growth of the repo market in the 1950s is noted in Simmons (1954), Roosa (1956, pp. 22 and 47-8), U.S. Treasury and Federal Reserve System (1959, pp. 30 and 32-5), Board of Governors of the Federal Reserve System (1959, pp. 17, 32, 47, and 49), Meltzer and von der Linde (1960, pp. 76-8), U.S. Treasury and Federal Reserve System (1960, pp. 53 and 67-91), Gaines (1962, pp. 213 and 225-6), Willis (1970, pp. 21-7), Lucas, Jones, and Thurston (1977, p. 43), and Smith (1978, p. 355).

Box 1
### Accrued Interest

When a dealer is asked to bid on Treasury notes that a customer wants to sell, the dealer quotes a bid price denominated in percent of the principal amount of the notes, with fractions of a percent in 32nds. For example, the dealer might bid $99^{15}$, or 99.468750 percent of principal (99.468750 = 99 + 15/32), for $10 million principal amount of the 4 ¼ percent notes maturing on August 15, 2014.

The *invoice price* of the notes, that is, the amount paid to the customer upon delivery of the notes, is the quoted price *plus* accrued interest to the settlement date of the transaction. Suppose, for example, that the dealer is bidding on Monday, May 9, 2005, for settlement on May 10. The 4 ¼ percent note last paid a coupon on February 15 and will pay its next semiannual coupon (equal to 2.125 percent of principal) on August 15. There are, therefore, 181 days in the current coupon period, with 84 days having elapsed since the last coupon payment:




The accrued interest on the August 15 coupon payment, as of the May 10 settlement date, is 0.986188 percent of principal (0.986188 = (84/181) × 2.125). The invoice price on the customer's sale is 100.454938 percent of the principal amount of the notes (100.454938 = 99.468750 quoted price, plus 0.986188 accrued interest), or $10,045,494.

## 2.2 Property Rights to Repo Securities

The most complicated feature of a repo was the allocation of property rights to the underlying securities. Describing a repo as "a sale of securities coupled with an agreement to repurchase the securities at a later date" suggests that it was a pair of conventional transactions, one for current settlement and the other for deferred settlement. This was not the case. Consistent with the convention noted above, that creditors did not lend on accrued interest, a borrower was entitled to any coupons paid on repo securities during the term of a repo. In addition, the parties to multiday repos commonly agreed that a borrower could substitute securities from time to time during the term of a repo. This "right of substitution" allowed a dealer to retrieve a security if it identified an opportunity to sell the security at an attractive price in an outright transaction.

The right to coupon payments and the right of substitution were rights typically enjoyed by dealers when they borrowed money on conventional loans secured with pledges of securities. The two rights made repos look very much like secured loans. However, repo *creditors* had an important right that was *not* enjoyed by conventional creditors: a repo creditor could sell repo securities, or deliver repo securities in settlement of a prior sale, during the term of the repo.[8] This reduced the cost of lending on a repurchase agreement, because a creditor did not have to treat repo securities as the property of the borrower and did not have to segregate repo securities from its own securities.

## 3. The Repo Market in the 1970s and Early 1980s

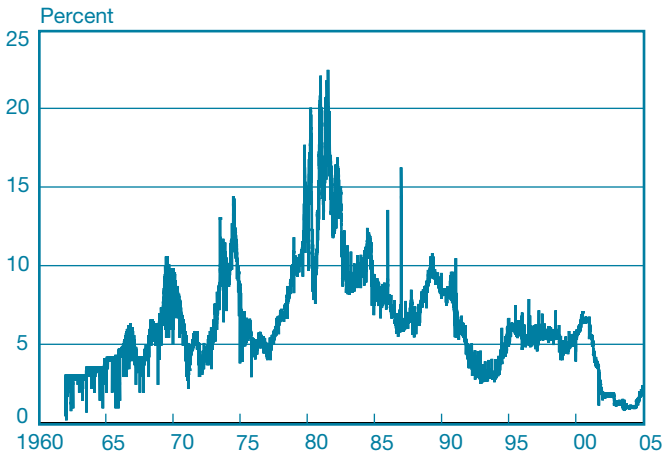
The repo market expanded and changed in the 1970s and early 1980s for three reasons:

- short-term interest rates reached successive new heights in 1969, in 1973-74, and again after October 1979 (Chart 1),
- marketable Treasury debt began to grow at a significantly faster pace after 1974 (Chart 2), and
- intermediate- and long-term interest rates became materially more volatile after October 1979 (Chart 3).

The rising level of short-term interest rates made repurchase agreements increasingly attractive to creditors. An executive at one industrial corporation stated in early 1979 that "At these interest rates, I'd be crazy to leave my money in a . . . checking account [that did not earn any interest]."[9] As time went on and interest rates rose, an increasing number of corporations and state and local governments initiated repo lending relationships. They were aided in their efforts by brokers that arranged for school districts and other small creditors to lend to dealers in regional and national repo markets. Some dealers also began to intermediate repo credit by running "matched books"—borrowing and then relending on repurchase agreements.[10]

The rapid growth in the volume of marketable Treasury debt after 1974 led to a parallel growth in dealer positions and dealer financing. The table shows that repo financing

Chart 1
Overnight Federal Funds Rate




Source: Federal Reserve Statistical Release H.15.

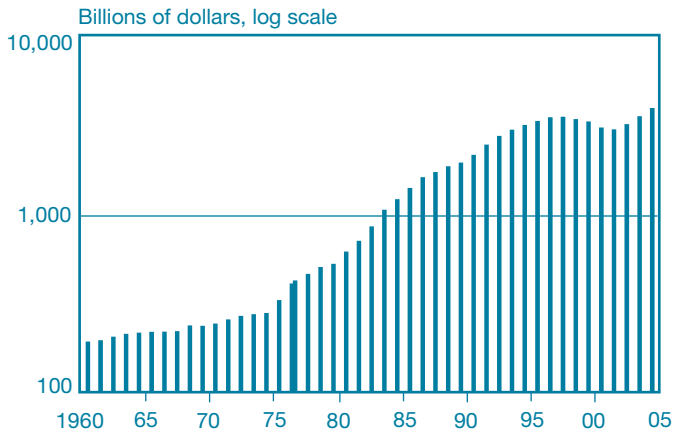
[7]Joint Economic Committee (1959, p. 1558, testimony of Girard Spencer, Partner, Salomon Brothers & Hutzler), Meltzer and von der Linde (1960, p. 92), U.S. Treasury and Federal Reserve System (1960, pp. 68, 76, and 91), Willis (1970, p. 22, fn. 2), Lucas, Jones, and Thurston (1977, p. 35), Smith (1978, p. 354), Stigum (1978, pp. 312 and 315), Committee on Banking, Housing, and Urban Affairs (1982, p. 35, testimony of Irwin Sandberg, Vice President, Federal Reserve Bank of New York), and Lumpkin (1993, p. 63).

[8]However, the creditor remained obligated to resell comparable securities to the borrower at the maturity of the repo, to remit to the borrower any coupon payments on the repo securities during the term of the repo, and to return the repo securities before the expiration of the repurchase agreement if the borrower had, and chose to exercise, a right of substitution.

[9]"More Firms Use Repurchase Agreements As a Way to Earn Interest on Idle Funds," *Wall Street Journal*, April 16, 1979, p. 15. The expansion in the repo market during the 1970s is described in Lucas, Jones, and Thurston (1977), Smith (1978), and Bowsher (1979, 1981). Those authors also cite the importance of advances in computer technology for stimulating the growth of repos, including increasingly sophisticated corporate cash management systems and the Federal Reserve's book-entry and wire transfer systems. Garbade (2004) discusses the latter factors.

[10]Matched-book credit intermediation is noted in Lucas, Jones, and Thurston (1977, p. 44), McCurdy (1977-78, p. 46), Smith (1978, p. 357), Stigum (1978, pp. 326-32), and Bowsher (1979, pp. 18-9).

Chart 2
Marketable Treasury Debt




Source: *Treasury Bulletin* (various issues).

Note: The chart depicts marketable debt on June 30 until and including June 30, 1976, and on September 30 thereafter.

Chart 3
Yields on Ten-Year Treasury Securities


Source: Federal Reserve Statistical Release H.15.

by nonbank primary dealers began to expand at the same time that marketable Treasury debt began to grow more rapidly. (A primary dealer is a dealer with a trading relationship with the Federal Reserve Bank of New York.) By the end of 1980, bank and nonbank primary dealers were borrowing a total of $55 billion on repurchase agreements. A year later, they were borrowing $94 billion.[11]

The rising volatility of interest rates affected the repo market indirectly by elevating the importance of risk management. Short sales of Treasury securities, undertaken to hedge long positions, became increasingly important. (As explained in Box 2, a short sale is a sale of a security that the seller has to borrow to make delivery.) Prior to the late 1970s, short sellers typically borrowed Treasury securities by pledging securities with a lender and paying the lender a fee of about 50 basis points per annum.[12] By the late 1970s, a significant number of market participants had adopted a simpler way to borrow securities: by lending money and "reversing in" securities on *special* (or *specific*) *collateral reverse* repurchase agreements.[13] (Box 2 explains this method of borrowing.) The use of repurchase agreements to borrow securities for delivery against short sales relied on the established convention that a creditor was free to use repo securities to settle an outright sale to a third party.

[11] *Federal Reserve Bulletin*, April 1981, p. A32, and April 1982, p. A34.

[12] Meltzer and von der Linde (1960, p. 73), Gaines (1962, p. 210), and Lucas, Jones, and Thurston (1977, p. 44).

[13] Lucas, Jones, and Thurston (1977, p. 44), Smith (1978, p. 357), and Bowsher (1981, p. 55). Some market participants borrowed securities on reverse repurchase agreements as early as the late 1950s (U.S. Treasury and Federal Reserve System 1959, p. 38).

Repo Financing by Nonbank Primary Dealers

| | Repos (Billions of Dollars, Daily Average) |
|---|---|
| 1973 | 1.4 |
| 1974 | 1.6 |
| 1975 | 3.9 |
| 1976 | 5.1 |
| 1977 | 7.9 |

Source: McCurdy (1977-78, Table 5).

Repurchase agreements evolved in the 1980s because existing contracting conventions proved inadequate for the market expansion fueled by rising interest rates and growing Treasury indebtedness, and because they proved inadequate for the growing use of repos to borrow securities. The next three sections describe how problems with the existing conventions emerged and how those problems were resolved.

## 4. Evolution of the Treatment of Accrued Interest

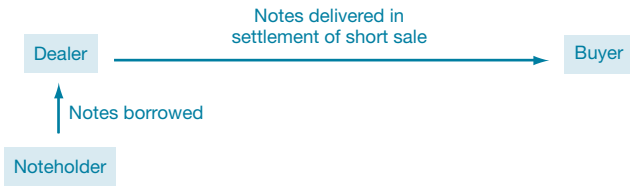
The basis for the convention by which repo borrowers gave margin to creditors—because creditors were generally more creditworthy than borrowers—began to erode when dealers started lending money to regional banks and institutional investors on special collateral reverse repurchase agreements

Box 2

## Short Sales and Special Collateral Reverse Repos

Suppose that a dealer has a long position in investment-grade corporate bonds and expects interest rates to rise. To hedge against a decline in the value of the bonds, the dealer may choose to sell Treasury notes short. If interest rates go up, the dealer will be able to close out its short position at a price below where it sold the notes. The premise of the hedge is that gains on the short notes will offset losses on the bonds.

On the settlement date of the short sale, when the dealer has to deliver the notes that it sold short, the dealer borrows the notes and delivers the borrowed notes:




The dealer can borrow the notes by entering into a special collateral reverse repurchase agreement. A *reverse* repurchase agreement is a repo seen from the perspective of the money lender. A repurchase agreement is a *special collateral* repo if the borrower and lender have agreed that only a single designated security is acceptable on the repo and that the borrower has no right to provide substitute securities. A special collateral repurchase agreement differs from a conventional, or "general collateral," repo because in the latter the borrower of funds has an option to choose—possibly subject to some limitations—the securities that the creditor is to receive and may also have the right to substitute securities during the term of the repo.

Suppose that the dealer decides to sell short a ten-year Treasury note. Suppose also that the one-week general collateral repo rate is 6 percent. The dealer might propose to a holder of the ten-year note that the holder sell the note to the dealer pursuant to a repurchase agreement at an interest rate of 5 percent per annum for one week. The holder can then earn 100 basis points for the week by relending at 6 percent the dealer's money on a general collateral repo.

When the dealer decides to close out its short position, it reacquires the notes in an outright purchase and terminates its reverse repurchase agreement by returning the notes.

in order to borrow securities needed to deliver against short sales. However, despite the changing balance of credit risks, market participants continued to ignore accrued interest on repo securities.[14]

Continued neglect of accrued interest exposed lenders of securities on special collateral repos to growing risk as interest rates rose. To understand why, consider a bond with a 12 percent coupon quoted at 98 percent of principal value. Suppose a dealer could "reverse in" $100 million principal amount of the bond from a regional bank against lending the full quoted value of $98 million. If the bond had just paid a coupon, the bond's accrued interest would be small and the bank would be reasonably well protected (lending bonds worth a bit more than $98 million against borrowing $98 million in cash). However, if the bond was about to pay a semiannual coupon, the accrued interest on the bond would be nearly 6 percent of principal. In that case, the bank would be lending bonds with a total market value of nearly $104 million. The exposure of securities lenders to credit risk on loans of notes and bonds close to their coupon payment dates became increasingly significant as coupon rates on new issues rose in parallel with the level of interest rates (see Chart 3). One market participant acknowledged that the continued neglect of accrued interest made "no sense at all."[15]

## 4.1 The Drysdale Failure

On Monday, May 17, 1982, a midsized government securities dealer, Drysdale Government Securities, failed. At the time of its collapse, Drysdale had a $4 billion short position and a $2.5 billion long position in Treasury securities. Although details on how Drysdale had depleted its equity capital were initially unclear,[16] it was quickly evident that firms that had lent securities to Drysdale were inadequately margined and were going to be left with far less cash than the replacement cost of their securities. Drysdale's failure ultimately led to counterparty losses of about $300 million.

Most of the securities borrowed by Drysdale came from other dealers through a securities lending desk at Chase Manhattan Bank. Initially, on May 17 and 18, Chase officials maintained that the bank had been acting as Drysdale's agent and that the losses would have to be borne by the dealers. The dealers, however, contended that they had lent securities to Chase and that what Chase did with the securities was a matter for Chase's account. The losses were

[14]Committee on Banking, Housing, and Urban Affairs (1982, p. 35, testimony of Irwin Sandberg, Vice President, Federal Reserve Bank of New York).

[15]Quoted in Stigum (1978, p. 315).

[16]Welles (1982) provides an extensive post-mortem. See also Stigum (1983, pp. 323-7) and Committee on Banking, Finance, and Urban Affairs (1983, p. 19, testimony of Anthony Solomon, President, Federal Reserve Bank of New York).

large enough that some dealers were liable to be "impaired" if they, rather than Chase, had to bear the losses. A senior official at one firm conjectured that "This thing is going to blow a hole in somebody."[17]

The Drysdale failure was immediately recognized as a potentially catastrophic event. Market participants remarked that "We're all in uncharted waters on this one," and that "No one really knows what's going to happen."[18] The prospect of a chain of failures was particularly worrisome: "There are hundreds of [repo] transactions out there that look safe until one participant goes under."[19]

As news of Drysdale's failure filtered through the market, uncertainty about whose capital might be impaired led some participants to begin to think about pulling back from further trading.[20] Faced with an impending crisis, the Federal Reserve Bank of New York reminded market participants that it stood ready to act as a "lender of last resort" to assist the commercial banks in meeting "unusual credit demands related to market problems."[21] The New York Fed also announced that it was temporarily suspending limits on loans of Treasury securities to primary dealers to facilitate settlements and that, contrary to previous policy, it would lend securities to finance dealer short positions.[22] This led to a ten-fold increase in securities lending by the New York Fed. Equally important, on Wednesday, May 19, Chase reversed its previous position and announced that, pending the outcome of prospective litigation, it would assume responsibility for all of the securities loans that its collateral desk had arranged.

[17]"Chase, Dealers Dispute Debts of $160 Million," *Wall Street Journal*, May 19, 1982, p. 2. A Chase official commented that "If the problem remained unresolved, it could have led very quickly to the 'impairment' of several Wall Street firms . . . ." "Chase Bank Will Pay Off Interest Owed by Defaulting Bond Dealer," *Wall Street Journal*, May 20, 1982, p. A1.

[18]"Bond Prices Seesaw, End Slightly Lower Amid Tensions Over the Drysdale Affair," *Wall Street Journal*, May 19, 1982, p. 44.

[19]"Drysdale's Default Shows Dangers of Intricate Financing Agreements," *Wall Street Journal*, May 20, 1982, p. 29.

[20]Committee on Banking, Housing, and Urban Affairs (1982, p. 26, testimony of Anthony Solomon, President, Federal Reserve Bank of New York, that "Uncertainty about clearing and financing arrangements seemed to be building. There was concern that investors and traders would pull away from the markets because of uncertainty about the magnitude of the problem, and that major securities firms would be threatened with losses that could jeopardize their ability to function."). See also Committee on Banking, Finance, and Urban Affairs (1983, p. 20, testimony of Anthony Solomon that "our primary concern at the Federal Reserve was to preserve the orderly functioning of the market until the situation could be resolved. We recognized some risk that failure to make [coupon payments due on May 15] could cause a widespread 'seizing up' of the market in which normally major participants would be reluctant to undertake new commitments or perhaps even perform on their existing commitments.").

[21]"A Dealer in Bonds Defaults on Debt," *New York Times*, May 19, 1982, p. A1.

## 4.2 Aftermath

The immediate crisis passed without any additional failures, but market participants realized that they had been to the edge of a precipice. They further understood that the cause of the problem was their neglect of accrued interest on repo securities. Allan Rogers, president of the Association of Primary Dealers in U.S. Government Securities, noted that the neglect was "not rational."[23]

A week after Drysdale's failure, the executive committee of the dealer association met to discuss contracting conventions for repos and recommended that the full membership adopt a resolution calling for recognition of accrued interest. Shortly thereafter, the Federal Reserve Bank of New York announced that it would begin recognizing accrued interest in its own repurchase agreements as soon as it could adapt its computer programs. Prompted by the Fed's new policy as well as by its executive committee, the dealer association adopted the recommended resolution at a meeting on June 14.[24]

The Federal Reserve also encouraged other market participants to recognize accrued interest on repo securities. In late July, the president of the New York Fed announced that he had charged Bank officials with working "with the dealer community in encouraging [all market participants] to recognize the value of accrued coupon interest . . . ."[25] When progress appeared to slow in late August, the Fed reiterated its view of the importance of changing the contracting convention.[26] The Fed understood that change would not be costless and that change might require "extra efforts . . . perhaps involving temporary substitution of manual for automated processing." (Box 3 explains an important operational problem created by the recognition of accrued interest.) Nevertheless, the Fed stated that it expected the change would be implemented by every primary dealer by early October—a deadline that was met "with few problems."[27]

[22]"Short-term Interest Rates Plunge as Fed Injects Reserves Due to Drysdale Problems," *Wall Street Journal*, May 21, 1982, p. 45, "How Agencies Helped Avert Drysdale Panic," *Wall Street Journal*, June 1, 1982, p. 29, and Committee on Banking, Housing, and Urban Affairs (1982, pp. 28 and 40-1, testimony of Anthony Solomon, President, Federal Reserve Bank of New York). This was the first time the Fed relaxed the terms of the securities lending program that it had put in place in 1969 to help alleviate a growing problem of settlement fails (Federal Open Market Committee 1970).

[23]"Financing Quirk at Drysdale Studied," *Wall Street Journal*, May 25, 1982, p. D5.

[24]"Repurchase Agreements Financing Change Voted," *Journal of Commerce*, June 16, 1982, p. 6A. The author is grateful to Allan Rogers for his assistance in clarifying the chronology of events following Drysdale's collapse.

[25]Letter dated July 29, 1982, from Anthony Solomon, President, Federal Reserve Bank of New York, to all primary dealers.

[26]Letter dated August 27, 1982, from Peter Sternlight, Executive Vice President, Federal Reserve Bank of New York, to all primary dealers.

Box 3

### An Operational Problem Created by the Recognition of Accrued Interest on Repo Securities

Recognition of accrued interest complicated the operational aspects of a repurchase agreement on a security that pays a coupon during the term of the repo.[a] To understand why, consider a dealer with a long position in $100 million principal amount of Treasury notes with a 12 percent coupon.

Suppose that the notes are quoted at 98 percent of principal and that just before a semiannual coupon is due the dealer finances the notes on a $103 million repo. The repo creditor has a margin of about $1 million ($1 million = $98 million quoted market value of the notes, plus a bit less than $6 million accrued interest, less $103 million repo principal). When the coupon is paid, the accrued interest vanishes and the total market value of the notes drops to $98 million. After the creditor remits the $6 million coupon payment to the borrower, the creditor has an exposure, or negative margin, of about $5 million. To cure this deficiency and restore a $1 million margin, the borrower either has to deliver additional securities to the creditor or repay $6 million. Neither action would have been required under the contracting conventions that prevailed prior to 1982 because, pursuant to those conventions, creditors did not lend on accrued interest, so passing a coupon payment back to a borrower did not expose a creditor to credit risk.

[a]The problems associated with coupon payments on repo securities were studied during the summer of 1982 by a special committee of the Association of Primary Dealers in U.S. Government Securities, headed by Miles Slater of Salomon Brothers. They are discussed in "Repo Dealers' Choice?" *Barron's*, October 18, 1982, p. 11, and Stigum (1983, pp. 402-4).

## 4.3 Assessment

When, in the late 1970s, securities dealers began lending money to regional banks and institutional investors on special collateral reverse repurchase agreements, the economic basis for the custom of repo borrowers giving margin to lenders began to erode. However, even though nonrecognition of accrued interest was an important component of lender margins, market participants continued to ignore accrued interest. This illustrates the proposition that a contracting convention that was efficient for one market environment may need to be revised when the environment changes.

[27]Committee on Banking, Finance, and Urban Affairs (1983, p. 24, testimony of Anthony Solomon, President, Federal Reserve Bank of New York).

Some market participants had concluded, well before 1982, that continued neglect of accrued interest made "no sense at all." However, it took the collapse of Drysdale to galvanize participants into action. This supports the proposition that change in an inefficient contracting provision may sometimes come slowly and only in the wake of a precipitative event that provides a compelling reason for change.

The decision of the major government securities dealers to act collectively through the Association of Primary Dealers, rather than individually, is significant. Liquidity in the repo market would have suffered if some firms and some creditors had decided to recognize accrued interest while others continued to ignore it, because a dealer could not fully fund a loan to a counterparty that recognized accrued interest with a borrowing from another counterparty that ignored accrued interest. Absence of a common contracting convention also would have led to higher operating costs, because dealers would have had to distinguish between creditors that lent only on quoted value and those that lent on accrued interest as well as quoted value. Consensus preserved the homogeneity of repos with different counterparties, thereby preserving liquidity and limiting operating costs.

## 5. Evolution of the Right to Sell a Defaulter's Securities Promptly

Prior to 1982, most repo market participants believed that a creditor could sell the securities underlying a repurchase agreement promptly in the event of the borrower's default. In the words of one participant, "If I have your bonds and you do not pay me back, it is my prerogative to sell those bonds . . . ."[28] However, the issue was not nearly so clear. If a repurchase agreement was construed as a loan secured by a pledge of the borrower's securities, the creditor's right to liquidate the securities might be subject to the "automatic stay" of bankruptcy law. (The automatic stay requires suspension of all efforts at collecting pre-petition claims immediately upon the filing of a bankruptcy petition.[29]) The creditor would then be subject to the risk of fluctuations in the market value of the securities and—if it planned on making a payment with the proceeds of the maturing repo—could be subject to a cash flow squeeze while it waited for a bankruptcy court to grant it access to the securities.

[28]Quoted in Stigum (1978, p. 332). See also Committee on the Judiciary (1983, p. 308, testimony of Thomas Strauss, Chairman, Government and Federal Agency Securities Division, Public Securities Association, that "Investors believed that they could liquidate their repo transactions in the market and cut the risk of loss as soon as they received word of a dealer's insolvency.").

[29]See Epstein, Nickles, and White (1993, ch. 3).

Although the prospect of significant delay in liquidating repo securities was unattractive to creditors, market participants had limited incentive to specify clearly that a repo was not a loan. Some participants could borrow and lend money but were constrained in their ability to purchase and sell securities, especially more volatile, longer term securities. Leaving open the question of whether a repo might be a secured loan allowed them to participate in the repo market. One dealer recalled that "We left [the characterization of a repo] purposely vague because doing so fit our needs. If a customer said, 'I can't do repo,' we said, 'OK, we will sell you securities and buy them back.' If another customer said he could not buy securities, we said, 'Fine, we will borrow money from you and give you collateral.' It was all very convenient . . . ."[30]

Prior to 1982, no court had directly addressed the question of whether repo securities were subject to the automatic stay.[31] In July of that year, Thomas Russo, a prominent attorney in private practice in New York, observed that "The most important legal uncertainty concerning repos . . . is whether they will ultimately be characterized for purposes of [bankruptcy law] . . . as secured loans or as independent contracts for the sale and repurchase of securities." He noted that "In light of Drysdale . . . and of rumors of difficulties at . . . other firms, market participants . . . are devoting substantial attention to devising strategies . . . to reduce or avoid the effects of the automatic stay and the uncertainties and delays of possibly protracted proceedings."[32]

[30]Quoted in Stigum (1983, p. 398).

[31]However, following the July 1975 collapse of a small securities firm, Financial Corp., several courts had considered the broader question of whether repos were loans or transactions. See *In re Financial Corp.*, 1 B.R. 522, 526, fn. 7 (W.D. Mo. 1979) (although a repo "had many of the attributes of a secured loan, there was nothing in the record to indicate that [it was] intended to effectuate a security interest"); *Gilmore v. State Board of Administration*, 382 So. 2d 861, 863 (Fla. App. 1980) (a repo was intended to be "two transactions, an actual purchase and sale of securities with minor characteristics of a secured loan, and a simultaneous but separate agreement to repurchase and resell similar securities on specific terms"); and *Securities and Exchange Commission v. Miller*, 495 F. Supp. 465, 467 (S.D.N.Y. 1980) (a repo "may be viewed as comprising two distinguishable transactions, which, although agreed upon simultaneously, are performed at different times"). Financial Corp.'s collapse is described in "Firm Involved in Government Securities is Placed in Receivership After SEC Suit," *Wall Street Journal*, July 11, 1975, p. 19, "How an Investment Firm's Meteoric Rise Was Reversed by an Interest-Rate Boost," *Wall Street Journal*, July 14, 1975, p. 26, and "Rate Indicators Signal Advance," *New York Times*, July 21, 1975, p. 42. See also Stigum (1978, pp. 331-2). Recent discussions of whether repos are loans or transactions appear in Schroeder (1996, 2002). See also *In re Bevill, Bresler & Schulman Asset Management Corporation*, 67 B.R. 557 (N.J. 1986) and *Granite Partners, L.P. v. Bear, Stearns & Co.*, 17 F. Supp. 2nd 275 (S.D.N.Y. 1998).

[32]*American Banker*, August 13, 1982, p. 4.

## 5.1 The Collapse of Lombard-Wall

On August 12, 1982, Lombard-Wall, a small government securities dealer with about $2 billion in assets and a similar amount of liabilities, filed for bankruptcy. Unlike Drysdale's failure three months earlier, the collapse of Lombard-Wall had little direct effect on the Treasury market. Rumors about the firm's financial condition had been circulating for weeks and many market participants had already reduced their exposure to the failing enterprise.

The most significant consequence of Lombard-Wall's insolvency came from a court decision. On August 17, the bankruptcy court overseeing the insolvency announced that the firm's repos would be treated as secured loans, rather than outright transactions, and issued a temporary restraining order prohibiting sale of the repo securities.[33] Despite submissions by the Federal Reserve Bank of New York; Goldman, Sachs; Salomon Bothers; and the Investment Company Institute (a trade association of more than 650 mutual funds) arguing that the decision would undermine the liquidity of the repo market, the bankruptcy court reiterated its position a month later.[34] The restraining order crystallized the fears of many repo creditors that they might not be able to liquidate promptly the securities of a defaulting borrower.

## 5.2 Aftermath

Following the Lombard-Wall ruling, two strategies were available to those market participants that favored placing repo securities outside the boundaries of the automatic stay: they could write contracts that made it clear that a repo was a pair of outright transactions, or they could seek an amendment to federal bankruptcy law exempting repos from application of the stay.

Dealers and institutional investors tried to write contracts that clarified the nature of a repo, but the effort got bogged down.[35] In part, this reflected a reluctance to suppress contract

[33]"Lombard Securities With Buy-Back Plan Are Frozen by Court," *Wall Street Journal*, August 18, 1982, p. 7.

[34]"Securities in Lombard-Wall Case Termed Loan Collateral by a Bankruptcy Judge," *Wall Street Journal*, September 20, 1982, p. 10. See also Committee on the Judiciary (1983, pp. 333 and 337), Hagerty (1984, pp. 409-10 and 426), Walters (1984, p. 830, fn. 9), and Osenton (1987, pp. 680-1).

[35]In September 1982, the president of one investment management company remarked that "Our legal department has been working on [the issue] for more than a year." "Repo Backing is Under Cloud," *New York Times*, September 29, 1982, p. D1. In early 1984, an observer characterized the situation as "legal gridlock." "Repo Market Remains Weak as Legal Issues Trouble Many Dealers," *Wall Street Journal*, January 30, 1984, p. 43.

provisions that made a repo look like a secured loan, including the borrower's right to coupon payments and to substitute securities, while retaining the aspect of a repo that was present in outright transactions: the creditor's right to sell repo securities to a third party.[36]

In lieu of altering their contracting conventions, private market participants and the Federal Reserve petitioned Congress for relief. Fed Chairman Paul Volcker urged adoption of an amendment exempting repos on Treasury and other specified securities from application of the automatic stay.[37] Volcker noted that "repos are a very important tool used in Federal Reserve open market operations" and argued that "it is important that the repo market be protected from unnecessary disruption." He suggested that if repos were subject to the automatic stay, "the rippling effect of the potential loss of liquidity or capital on market participants could generally disrupt the repo market and cause an otherwise manageable and isolated problem to become generalized." In an effort to hasten passage of the proposed amendment, Volcker suggested that "it would be preferable to draw the legislation in a relatively narrow manner and to confine its operation to the key repo markets in U.S. government and agency securities, bankers' acceptances and certificates of deposit."[38] The chairman of the Public Securities Association suggested similarly that statutory relief was needed to avoid "severe adverse consequences."[39]

Efforts to exempt repos from application of the automatic stay were unopposed but became entangled with other, unrelated issues in bankruptcy law.[40] A bill that included a repo amendment cleared the Senate in April 1983 but remained stalled in the House of Representatives in early 1984. Finally, in mid-1984, after a bankruptcy court froze the repo securities of yet another failed dealer,[41] Congress enacted the Bankruptcy Amendments and Federal Judgeship Act of 1984,[42] exempting from application of the automatic stay repos on Treasury and federal agency securities, bank certificates of deposit, and bankers' acceptances.

There is reason to believe that the efforts of the Federal Reserve and government securities dealers to secure an exemption for repos from application of the automatic stay were not misplaced. Chart 4 graphs overnight repo financing by primary dealers as a function of marketable Treasury debt on a monthly basis from October 1980 (when the Federal Reserve began publishing data on primary dealer repos) to September 1990. Marketable Treasury debt rose at a fairly constant rate over the interval (although the growth rate declined a bit after 1986) and it follows from Chart 4 that repo financing expanded more or less in line with the growth in Treasury debt. However, when we compare actual financing with financing predicted from a straight line fitted to the data, we see that repo financing stagnated between mid-1982 and mid-1983. (Financing volumes in the twelve months between June 1982 and May 1983, inclusive, are represented by the white circles in the chart.) Financing growth resumed in mid-1983 (depicted by the squares), but the shortfall from 1982-83 was not made up until the end of 1985. These results are consistent with the proposition that the relative size of the repo market shrunk after Drysdale and Lombard-Wall, that it stabilized (at a lower level) when it became evident that repos would ultimately be exempted from application of the automatic stay, but that it did not recover fully until eighteen months after passage of the Bankruptcy Amendments and Federal Judgeship Act of 1984.

[36]See, for example, Dunning (1982). In addition, as one commentator later observed, "Mere contractual language or testimony declaring that a transaction is not a security interest is not sufficient, standing alone, conclusively to establish that a transaction is not a security interest. The standard rule of commercial law that substance should control over form is particularly important in the bankruptcy context because parties generally wish to avoid treatment of their transactions as security interests and, therefore, would always be expected to include boiler plate language in their contract reciting their intention." Schroeder (2002, p. 594).

[37]Letter dated September 29, 1982, from Paul Volcker, Chairman, Board of Governors of the Federal Reserve System, to Robert Dole, Chairman, Subcommittee on Courts of the United States Senate Committee on the Judiciary, reprinted in Dunning and Lowy (1982, pp. 397-8). Volcker reiterated his views in follow-up letters on December 13, 1982, and January 30, 1983 (Committee on the Judiciary 1983, pp. 305 and 346-8).

[38]In a follow-up letter on December 13, 1982, Volcker stated that he had "stressed the desirability of drawing the legislation in a narrow manner to avoid major exceptions to existing bankruptcy law. Thus the Board [of Governors] continues to believe that the protection provided by the proposed legislation should be limited to those markets which are so large as to raise potential systemic problems in situations in which a bankruptcy could affect the liquidity and solvency of a large number of other entities . . . ." Committee on the Judiciary (1983, p. 347).

[39]"U.S. Government Securities Dealers Need Self-Review but No New Rules, Fed Says," *Wall Street Journal*, October 13, 1982, p. 6. The Treasury Department did not support amending federal bankruptcy law. See letter dated March 16, 1983, from Roger Mehle, Assistant Secretary of the Treasury (Domestic Finance), to Robert Dole, Chairman, Subcommittee on Courts of the United States Senate Committee on the Judiciary (concluding that "On balance . . . parties holding Treasury or other securities in connection with [a repurchase agreement] do not merit better treatment under the Bankruptcy Code than any other party making a secured loan" and stating that there was "absolutely no likelihood of a government securities market breakdown from [retaining application of the automatic stay] . . . .").

[40]Committee on the Judiciary (1983, p. 304, remark of Senator Robert Dole that proposed amendments were "uncontroversial").

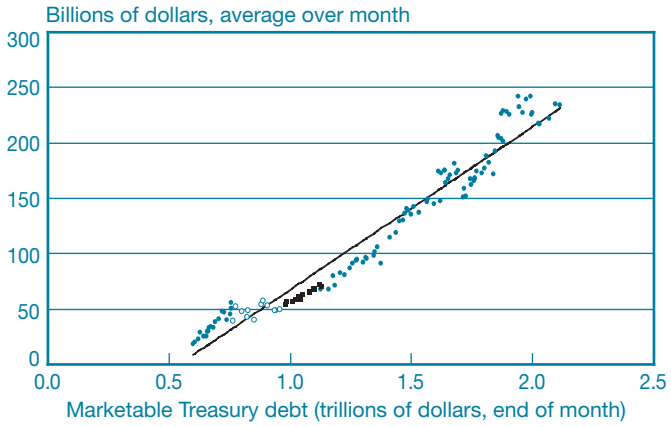
[41]"Lion Capital's Collapse Raises Issue of Unresolved Legal Status of 'Repos,'" *Wall Street Journal*, May 8, 1984, p. 2.

[42]Pub. L. 98-353, 98 Stat. 333 (1984). The provisions that deal with repurchase agreements are discussed in Levin and Donovan (1984, pp. 176-83), Schroeder (1996, pp. 1028-31), and *In re Bevill, Bresler & Schulman Asset Management Corporation*, 67 B.R. 557, 596 (N.J., 1986).

Chart 4

Primary Dealer Financing on Overnight Repos as a Function of Marketable Treasury Debt

Monthly, October 1980 to September 1990




Sources: *Treasury Bulletin* (various issues); *Federal Reserve Bulletin* (various issues).

Note: The white circles represent June 1982-May 1983 financing volumes; the squares represent June 1983-May 1984 financing volumes; the line depicts the least-squares fitted relationship between overnight repo financing and marketable Treasury debt.

## 5.3 Assessment

Removing repurchase agreements from application of the automatic stay required coordinated action because liquidity might have suffered, and operating costs might have increased, if some repos remained subject to the stay while other repos on the same underlying securities were not. Homogeneous treatment could have been obtained with industrywide repo contracts that suppressed contract terms that made repos look like secured loans. However, because market participants were unwilling to sacrifice efficiencies associated with the existing allocation of property rights, removing repos from application of the automatic stay required Congressional action. The legislative channel was more time-consuming but it preserved the allocation of property rights that participants found most useful.

Efforts to secure a statutory exemption for repos were not initiated until a precipitative event—the freezing of the Lombard-Wall collateral—provided a compelling incentive for change. This illustrates again the proposition that coordinated action may be delayed in the absence of a precipitative event.

# 6. Evolution of Creditor Possession of Repo Securities

Virtually all discussions of repurchase agreements begin by describing a repo as a sale of securities coupled with an agreement to repurchase the securities at a specified price on a later date. Left unstated, but clearly implied, is the presumption that the creditor actually takes possession of the securities during the term of the repo. However, taking possession of repo securities before the mid-1980s was not an inexpensive undertaking. A creditor had to arrange for a bank to hold the securities in a custodial account, it had to give the bank payment and delivery instructions for each transaction, and it had to pay a fee for each transaction. The director of finance for one municipality characterized bank custodial services as "an administrative nightmare."[43]

Some small and midsized creditors sought to avoid the administrative burdens of conventional repos by accepting a representation from a repo borrower that the bank that cleared securities for the borrower would hold the creditor's repo securities in a segregated account.[44] Repos based on such representations were called "letter" repos.

## 6.1 Creditor Losses on Letter Repos

In early 1984, Lion Capital Group was a small New York broker-dealer firm engaged primarily in the business of running a matched-repo book, borrowing money from local governments and school districts and relending the money to others. Lion borrowed on both conventional repos, where it delivered out securities to creditors, and letter repos, where it represented to creditors that their securities were held in safekeeping at its clearing bank. However, Lion's clearing bank was not a party to any safekeeping arrangements for the benefit of Lion's creditors and never confirmed to those creditors that it held securities for their benefit. This gave Lion an opportunity to misrepresent the status of its letter repo securities.

[43]"Growing Caution: Big Treasurys Investors Become More Careful After Two Firms Fail," *Wall Street Journal*, April 12, 1985, p. 1.

[44]A clearing bank is a bank that acts as the agent of its customer in receiving and delivering money and securities pursuant to the customer's instructions, and safeguarding securities and funds belonging to the customer. A clearing bank also provides financing for securities that the customer is unable to finance elsewhere. See Committee on Government Operations (1985, pp. 607-18, testimony of Charles Viviano, Managing Director, Security Pacific Clearing & Services Corp.) and *In re Bevill, Bresler & Schulman Asset Management Corporation*, 67 B.R. 557, 570-571 (N.J., 1986).

On May 2, 1984, Lion filed for bankruptcy. At the time of the filing, Lion had $46.5 million of securities at its clearing bank and $85 million in liabilities other than conventional, possessory, repos. $33.5 million of securities were held in a clearing account and were pledged to secure a $45 million loan from the bank. The other $13 million of Lion's securities were held in two "segregated" accounts and were not similarly pledged to the bank. Lion owed its letter repo creditors $40 million—$27 million more than what was in the segregated accounts. The repo creditors ended up recovering only 73 percent of their claims.

A year later, two more broker-dealer firms failed and imposed another $300 million of losses on letter repo creditors. On March 4, 1985, E.S.M. Government Securities collapsed with a negative net worth of about $300 million. Letter repo creditors accounted for a third of the losses. Five weeks later, Bevill, Bresler & Schulman collapsed with a negative net worth of about $225 million. Letter repo creditors incurred the bulk of the losses. The E.S.M. losses led the president of one large dealer firm to comment that "It seems inconceivable to me that you get in a position where you don't have either the money or the [securities]. That's just crazy."[45]

## 6.2 Tri-Party Repo

Creditor losses on letter repos in 1984 and 1985 demonstrated the need for a repo mechanism that was both safe and operationally inexpensive. Fortuitously, several large clearing banks had been working with their dealer customers and repo creditors to develop a new form of repo, tri-party repo, to reduce dealer financing costs and the costs of delivering repo securities. The collapse of Lion; E.S.M.; and Bevill, Bresler sharply accelerated interest in the new arrangement.[46]

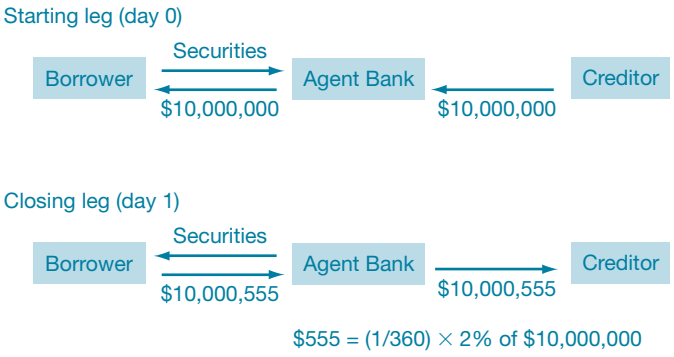
In a tri-party repurchase agreement, an "agent bank" stands between the dealer and the creditor. A previously negotiated contract among the bank, the dealer, and the creditor describes the acceptable securities and the margins required on the securities. As illustrated in Exhibit 2, at the start of a repo, the dealer delivers securities, and the creditor delivers funds, to the bank. After verifying that the securities are acceptable and have a market value that exceeds the principal amount of the repo by more than the required margin, the bank releases the funds to the dealer but continues to hold the securities as the creditor's custodial agent. At the end of the repo, the dealer returns the

[45]"Thrift Crisis: Closing of Ohio S&Ls After Run on Deposits is One for the Books," *Wall Street Journal*, March 18, 1985, p. 1.

[46]Sollinger (1994). See also Committee on Government Operations (1985, p. 616, testimony of Charles Viviano, Managing Director, Security Pacific Clearing & Services Corp.).

Exhibit 2

Borrowing $10 Million at a 2 Percent Interest Rate on a One-Day Tri-Party Repo




principal—plus interest at the negotiated rate—to the bank, the bank releases the securities back to the dealer, and the bank remits the principal and interest to the creditor.

Tri-party repo has two important credit risk characteristics. First, it protects the creditor by taking margin from a borrower and lodging repo securities with a bank that has explicitly agreed to hold the securities for the benefit of the creditor. If the borrower fails to honor its repurchase commitment, the creditor can instruct the bank to sell the securities and apply the proceeds to satisfy its claim for repayment. Second, tri-party repo protects the borrower because the bank retains possession of the repo securities during the term of the repo, so the borrower can recover the securities promptly upon tender of the repurchase price. Thus, tri-party repo resolves the conflict inherent in conventional repos that borrowers and creditors cannot both be insulated from credit risk simultaneously.

In theory, any bank can serve as an agent bank for a tri-party repo. However, there is an important operational advantage to tri-party repo when the agent bank is the dealer's clearing bank. In that case, the dealer and the creditor can negotiate the principal amount, maturity, and interest rate of a borrowing, but need not identify the specific securities that will be held by the agent bank for the benefit of the creditor. At the end of the business day, the bank runs a computer program that allocates the securities in the dealer's clearing account to the custodial accounts of individual tri-party creditors. The program identifies the allocation that minimizes the quantity of unallocated securities, subject to the constraint that no creditor receives an allocation that would violate the terms of its tri-party contract. (The objective of minimizing the quantity of unallocated securities is important because the clearing bank typically finances any unallocated securities that remain in the clearing account at a dealer loan rate in excess of the

contemporaneous repo rate.) This process eliminates the need to transfer securities between banks—as would be necessary if the dealer's clearing bank and the tri-party agent bank were different banks—and facilitates least-cost financing of the dealer's securities.[47]

Tri-party repo was pioneered by Salomon Brothers in the late 1970s, primarily as a device to reduce the cost of financing its positions in Treasury securities.[48] Traders on the firm's funding desk observed that they sometimes received deliveries of Treasury securities (from sellers and from creditors on the closing legs of maturing repurchase agreements) late in the day, when there was not enough time to redeliver the securities (to buyers or to creditors on the opening legs of new repurchase agreements). The securities were consequently left stranded in the firm's clearing account and financed at a dealer loan rate in excess of the contemporaneous repo rate. The traders realized that they could finance late-arriving securities at lower cost if they could arrange custodial accounts at the firm's clearing bank for their repo creditors, so that delivery of securities to those creditors could be done internally on the books of the bank. Thus, tri-party repo originated as a buffer financing device, standing between conventional repo financing and the residual, end-of-day financing provided by a clearing bank.

By the mid-1980s, other dealers and other clearing banks had replicated the tri-party structure. In the wake of Lion; E.S.M.; and Bevill, Bresler, it was not too difficult to appreciate that tri-party solved the problem of effecting low-cost possession of repo securities: the dealer's clearing bank functioned in a dual capacity, as a clearing bank for the dealer *and* as a custodian for creditors. One observer estimated that, by the early 1990s, large government securities dealers financed somewhat more than three-quarters of their Treasury positions with tri-party repo.[49]

### 6.3 Assessment

Tri-party repo was driven, in the first instance, by the motive that drives most private sector innovations: profit. Compared with conventional repurchase agreements, tri-party repo provided an operationally cheaper, more flexible way for a dealer to borrow money and for a creditor to lend money. Unlike the recognition of accrued interest and the exemption of repos from application of the automatic stay, the adoption of tri-party repo did not require any collective or legislative action; it depended only on the *individual* assessments of dealers and creditors of its net benefits. The losses experienced by letter repo creditors in the mid-1980s highlighted the risks inherent in letter repos and the importance of obtaining unambiguous control of a borrower's securities, and thereby hastened the adoption of tri-party repo.

[47]Committee on Government Operations (1985, p. 257, testimony of E. Gerald Corrigan, President, Federal Reserve Bank of New York) and Board of Governors of the Federal Reserve System and Securities and Exchange Commission (2002, Appendix 2).

[48]This synopsis is based on the personal recollections of John Macfarlane, who joined Salomon's funding desk in 1979.

[49]Sollinger (1994).

## 7. Conclusion

In the first two decades after the Treasury-Federal Reserve Accord of March 1951, repurchase agreements were used primarily by nonbank government securities dealers to finance their securities positions with large nonfinancial corporations and state and local governments. The repo market expanded in the 1970s, when rising interest rates and growing Treasury indebtedness attracted many new, smaller, and less sophisticated creditors. The market also changed as rising interest rate volatility led dealers to expand their hedging activities and use special collateral reverse repurchase agreements to borrow securities needed to deliver against short sales. Contracting conventions that were not inefficient in the context of the repo markets of the 1950s and 1960s—including neglect of accrued interest, ambiguity about whether repos were loans or transactions, and relatively costly mechanisms for removing repo securities from the control of borrowers—proved inadequate by the early 1980s.

Changing circumstances, and the appearance of new and previously unappreciated risks, produced change in repo contracting conventions in the 1980s. Change occurred in a variety of ways. The autonomous adoption by individual agents of a more efficient contract form—tri-party repo—was the result of the agents acting in their own economic self-interest. In contrast, recognition of accrued interest and the exemption of repos (on Treasury and certain other securities) from application of the "automatic stay" of bankruptcy law were effected, respectively, by collective action and Congressional legislation, because uncoordinated, individual solutions by market participants would have been more costly.

# References


*Beckhart, B., J. Smith, and W. Brown*. 1932. The New York Money Market, Vol. IV, External and Internal Relations. New York: Columbia University Press.

*Board of Governors of the Federal Reserve System*. 1959. The Federal Funds Market. Washington, D.C.

*Board of Governors of the Federal Reserve System and Securities and Exchange Commission*. 2002. "Interagency White Paper on Structural Change in the Settlement of Government Securities: Issues and Options." Federal Reserve System Docket no. R-1122 and Securities and Exchange Commission Release no. 34-45879.

*Bowsher, N*. 1979. "Repurchase Agreements." Federal Reserve Bank of St. Louis Review 61, no. 9 (September): 17-22.

———. 1981. "Repurchase Agreements." In T. Cook and B. Summers, eds., Instruments of the Money Market. 5th ed. Richmond: Federal Reserve Bank of Richmond.

*Committee on Banking and Currency*. 1927a. "Stabilization." Hearings before the Committee on Banking and Currency on H.R. 7895, Part 1. U.S. House of Representatives, 69th Cong., 1st Sess., March 24-25, 30-31, April 1, 6, 8-9, 12-14, 1926.

———. 1927b. "Stabilization." Hearings before the Committee on Banking and Currency on H.R. 7895, Part 2. U.S. House of Representatives, 69th Cong., 1st Sess., April 20-22, 27, 30, May 3-6, June 10, 1926, and February 4, 1927.

———. 1931. "Operation of the National and Federal Reserve Banking Systems." Hearings before a Subcommittee of the Committee on Banking and Currency Pursuant to S. Res. 71, Appendix, Part 6, Federal Reserve Questionnaires. U.S. Senate, 71st Cong., 3rd Sess.

*Committee on Banking, Finance, and Urban Affairs*. 1983. "Impact on Money and Credit Policy of Federal Debt Management." Hearing before the Subcommittee on Domestic Monetary Policy of the Committee on Banking, Finance, and Urban Affairs. U.S. House of Representatives, 98th Cong., 1st Sess., April 25.

*Committee on Banking, Housing, and Urban Affairs*. 1982. "Disturbances in the U.S. Securities Market." Hearing before the Subcommittee on Securities of the Committee on Banking, Housing, and Urban Affairs. U.S. Senate, 97th Cong., 2nd Sess., May 25.

*Committee on Government Operations*. 1985. "Failure of Bevill, Bresler & Schulman, A New Jersey Government Securities Dealer." Hearing before a Subcommittee of the Committee on Government Operations. U.S. House of Representatives, 99th Cong., 1st Sess., May 15.

*Committee on the Judiciary*. 1983. "Bankruptcy Reform." Hearing before the Subcommittee on Courts of the Committee on the Judiciary. U.S. Senate, 98th Cong., 1st Sess., January 24.

*Dunning, A*. 1982. "Drafting Repurchase and Reverse Repurchase Agreements." In A. Dunning and M. Lowy, cochairmen, Repurchase Agreements and Reverse Repurchase Agreements. Commercial Law and Practice Course Handbook Series no. 290, November 15-16. New York: Practising Law Institute.

*Dunning, A., and M. Lowy*. 1982. Repurchase Agreements and Reverse Repurchase Agreements. Commercial Law and Practice Course Handbook Series no. 290, November 15-16. New York: Practising Law Institute.

*Epstein, D., S. Nickles, and J. White*. 1993. Bankruptcy. St. Paul, Minn.: West Publishing Co.

*Federal Open Market Committee*. 1970. "Record of Policy Actions." Federal Reserve Bulletin 56, no. 1 (January): 31-3.

*Federal Reserve Bank of New York*. 1919. Fourth Annual Report for the Year Ended December 31, 1918. Washington, D.C.: U.S. Government Printing Office.

———. 1921. Sixth Annual Report for the Year Ended December 31, 1920. New York.

*Gaines, T*. 1962. Techniques of Treasury Debt Management. New York: Columbia University Graduate School of Business and Free Press of Glencoe.

*Garbade, K. D*. 2004. "Origins of the Federal Reserve Book-Entry System." Federal Reserve Bank of New York Economic Policy Review 10, no. 3 (December): 33-50.

*Hagerty, W*. 1984. "Lifting the Cloud of Uncertainty over the Repo Market: Characterization of Repos as Separate Purchases and Sales of Securities." Vanderbilt Law Review 37, March: 401-31.

## References (Continued)


*Hardy, C.* 1932. Credit Policies of the Federal Reserve System. Washington, D.C.: Brookings Institution.

*Harris, S.* 1933. Twenty Years of Federal Reserve Policy. Cambridge, Mass.: Harvard University Press.

*Joint Economic Committee.* 1959. "Employment, Growth, and Price Levels, Part 6B—The Government's Management of Its Monetary, Fiscal, and Debt Operations." Hearings before the Joint Economic Committee. U.S. Congress, 86th Cong., 1st Sess., August 5-7.

*Levin, A., and J. Donovan.* 1984. "Repurchase Agreements Under the 1984 Amendments to the Bankruptcy Code." In A. Dunning, chairman, Repurchase Agreements and Reverse Repurchase Agreements Revisited 1984. Commercial Law and Practice Course Handbook Series no. 341, November 29-30. New York: Practising Law Institute.

*Lucas, C. M., M. T. Jones, and T. B. Thurston.* 1977. "Federal Funds and Repurchase Agreements." Federal Reserve Bank of New York Quarterly Review 2, no. 2 (summer): 33-48.

*Lumpkin, S.* 1993. "Repurchase Agreements and Reverse Repurchase Agreements." In T. Cook and R. LaRoche, eds., Instruments of the Money Market. 7th ed. Richmond: Federal Reserve Bank of Richmond.

*McCurdy, C. J.* 1977-78. "The Dealer Market for United States Government Securities." Federal Reserve Bank of New York Quarterly Review 2, no. 4 (winter): 35-47.

*Meltzer, A.* 2003. A History of the Federal Reserve, Volume I: 1913-1951. Chicago: University of Chicago Press.

*Meltzer, A., and G. von der Linde.* 1960. A Study of the Dealer Market for Federal Government Securities. Materials prepared for the Joint Economic Committee, 86th Cong., 2nd Sess. Washington, D.C.: U.S. Government Printing Office.

*Osenton, E.* 1987. "The Need for a Uniform Classification of Repurchase Agreements: Reconciling Investor Protection with Economic Reality." American University Law Review 36, spring: 669-91.

*Roosa, R.* 1956. Federal Reserve Operations in the Money and Government Securities Markets. New York: Federal Reserve Bank of New York.

*Schroeder, J.* 1996. "Repo Madness: The Characterization of Repurchase Agreements Under the Bankruptcy Code and the U.C.C." Syracuse Law Review 46: 999-1050.

———. 2002. "A Repo Opera: How *Criimi Mae* Got Repos Backwards." American Bankruptcy Law Journal 76: 565-622.

*Simmons, E.* 1947. "The Position of the Treasury Bill in the Public Debt." Journal of Political Economy 55, no. 4 (August): 333-45.

———. 1951. "The Structure of the Postwar Money Market." Southern Economic Journal 17, no. 4 (April): 409-21.

———. 1952. "Federal Reserve Discount-Rate Policy and Member-Bank Borrowing." Journal of Business 25, no. 1 (January): 18-29.

———. 1954. "Sales of Government Securities to Federal Reserve Banks Under Repurchase Agreements." Journal of Finance 9, no. 1 (March): 23-40.

*Smith, W.* 1978. "Repurchase Agreements and Federal Funds." Federal Reserve Bulletin 64, no. 5 (May): 353-60.

*Sollinger, A.* 1994. "The Triparty Is Just Beginning." Institutional Investor 28, no. 1 (January): 133-5.

*Stigum, M.* 1978. The Money Market: Myth, Reality, and Practice. Homewood, Ill.: Dow Jones-Irwin.

———. 1983. The Money Market. Revised ed. Homewood, Ill.: Dow Jones-Irwin.

*U.S. Treasury and Federal Reserve System.* 1959. Treasury-Federal Reserve Study of the Government Securities Market, Part I.

———. 1960. Treasury-Federal Reserve Study of the Government Securities Market, Part III, Supplementary Studies.

## References (Continued)

*Walters, G.* 1984. "Repurchase Agreements and the Bankruptcy Code: The Need for Legislative Action." Fordham Law Review 52, April: 828-49.

*Welles, C.* 1982. "Drysdale: What Really Happened." Institutional Investor, September: 73-83.

*Willis, P.* 1970. The Federal Funds Market. Boston: Federal Reserve Bank of Boston.

## Back Issues, 2001-05

All articles and papers are available at **www.newyorkfed.org/research/epr/index.html**.

### Economic Policy Review, 2001

*Volume 7, Number 1, March 2001*

#### The Challenges of Risk Management in Diversified Financial Companies
*Christine M. Cumming and Beverly J. Hirtle*

In recent years, financial institutions and their supervisors have placed increased emphasis on the importance of measuring and managing risk on a firmwide basis—a coordinated process referred to as consolidated risk management. Although the benefits of this type of risk management are widely acknowledged, few if any financial firms have fully developed systems in place today, suggesting that significant obstacles have led them to manage risk in a more segmented fashion. In this article, the authors examine the economic rationale behind consolidated risk management. Their goal is to detail some of the key issues that supervisors and practitioners have confronted in assessing and developing consolidated risk management systems. In doing so, the authors clarify why implementing consolidated risk management involves significant conceptual and practical difficulties. They also suggest areas in which additional research could help resolve some of these difficulties.

#### Using Credit Risk Models for Regulatory Capital: Issues and Options
*Beverly J. Hirtle, Mark Levonian, Marc Saidenberg, Stefan Walter, and David Wright*

The authors describe the issues and options that would be associated with the development of regulatory minimum capital standards for credit risk based on banks' internal risk measurement models. Their goal is to provide a sense of the features that an internal-models (IM) approach to regulatory capital would likely incorporate, and to stimulate discussion among financial institutions, supervisors, and other interested parties about the many practical and conceptual issues involved in structuring a workable IM regulatory capital regime for credit risk. The authors focus on three main areas: prudential standards defining the risk estimate to be used in the capital requirements, model standards describing the essential components of a comprehensive credit risk model, and validation techniques that could be used by supervisors and banks to assess model accuracy. The discussion highlights a range of alternatives for each of these areas.

#### What Drives Productivity Growth?
*Kevin J. Stiroh*

Economists have long debated the best way to explain the sources of productivity growth. Neoclassical theory and "new growth" theory both regard investment—broadly defined to include purchases of tangible assets, human capital expenditures, and research and development efforts—as a critical source of productivity growth, but they differ in fundamental ways. Most notably, the neoclassical framework focuses on diminishing and internal returns to aggregate capital, while new growth models emphasize constant returns to capital that may yield external benefits. This article finds that despite their differences, both theories help explain productivity growth. The methodological tools of the neoclassical economists allow one to measure the rate of technical change, and the models of the new growth theorists provide an internal explanation for technical progress.

### Actual Federal Reserve Policy Behavior and Interest Rate Rules

*Ray C. Fair*

A popular way to approximate Federal Reserve policy is through the use of estimated interest rate equations, or policy "rules." In these rules, the dependent variable is the interest rate that the Federal Reserve is assumed to control and the explanatory variables are those factors assumed to affect Federal Reserve behavior. This article presents estimates of such a rule, using data from 1954:1-1999:3 but omitting the 1979:4-1982:3 period, when monetary targets were emphasized. Although the estimated coefficient on inflation is found to be larger in the post-1982 period, the difference is not statistically significant, and statistical tests fail to reject the hypothesis that the interest rate rule is stable across these two periods.

### Leading Economic Indexes for New York State and New Jersey

*James Orr, Robert Rich, and Rae Rosen*

The authors develop indexes of leading economic indicators for New York State and New Jersey over the 1972-99 period. They find that the leading indexes convey useful information about the future course of economic activity in both states. The authors then construct separate indexes to forecast recessions and expansions in each state. The movements of the recession and expansion indexes are found to display a close relationship with the behavior of the leading indexes. Accordingly, the recession and expansion indexes allow the authors to extend the informational content of the leading indexes by estimating the probability of an upcoming cyclical change in state economic activity within the next nine months.

*Volume 7, Number 2, September 2001*
A special conference volume, "Welfare Reform Four Years Later: Progress and Prospects."
Contents include:

### How Are Families Who Left Welfare Doing over Time? A Comparison of Two Cohorts of Welfare Leavers

*Pamela Loprest*

### Declining Caseloads/Increased Work: What Can We Conclude about the Effects of Welfare Reform?

*Rebecca M. Blank*

### Changing Caseloads: Macro Influences and Micro Composition

*Robert A. Moffitt and David W. Stevens*

### Changing the Culture of the Welfare Office: The Role of Intermediaries in Linking TANF Recipients with Jobs

*LaDonna Pavetti, Michelle K. Derr, Jacquelyn Anderson, Carole Trippe, and Sidnee Paschal*

### Welfare Reform and New York City's Low-Income Population

*Howard Chernick and Cordelia Reimers*

### Using Financial Incentives to Encourage Welfare Recipients to Become Economically Self-Sufficient

*Philip K. Robins and Charles Michalopoulos*

*Volume 7, Number 3, December 2001*

### Infrastructure and Social Welfare in Metropolitan America
*Andrew F. Haughwout*

Public infrastructure investment may indirectly affect firm productivity and household welfare through its impact on the location of economic activity. Existing infrastructure policies encourage firms and households to move from dense urban environments to the surrounding suburbs. Nevertheless, several recent studies have suggested that the concentration of producers and consumers within cities results in "agglomeration economies" that are socially beneficial. In light of these findings, the author recommends the creation of infrastructure investment authorities that would have the power to select and finance projects that promote the overall well-being of a given region. Such authorities would most likely direct a larger share of infrastructure investment to the central cities.

### The Effect of Employee Stock Options on the Evolution of Compensation in the 1990s
*Hamid Mehran and Joseph Tracy*

Between 1995 and 1998, actual growth in compensation per hour (CPH) accelerated from approximately 2 percent to 5 percent. Yet as the labor market continued to tighten in 1999, CPH growth unexpectedly slowed. This article explores whether this aggregate "wage puzzle" can be explained by changes in the pay structure—specifically, by the increased use of employee stock options in the 1990s. The CPH measure captures these options on their exercise date, rather than on the date they are granted. By recalculating compensation per hour to reflect the options' value on the grant date, the authors find that the adjusted CPH measure accelerated in each year from 1995 to 1999.

### Personal On-Line Payments
*Kenneth N. Kuttner and James J. McAndrews*

The swift growth of e-commerce and the Internet has led to the development of a new form of electronic funds transfer—the personal on-line payment—that uses web and e-mail technologies to initiate and confirm payments. This article describes this payment instrument and the trends that have given rise to it. The authors explain that personal on-line payment systems are already providing a convenient alternative to checks, money orders, and cash, and may replace credit cards for some small-scale retail e-commerce. However, issues such as the interoperability of diverse systems and the systems' inherent risks will continue to be central. The authors also suggest that although personal on-line payment systems are not likely to have a great impact on monetary policy, they do raise regulatory issues associated with consumer rights and protection.

### The Effect of Interest Rate Options Hedging on Term-Structure Dynamics
*John Kambhu and Patricia C. Mosser*

Market participants and policymakers closely monitor movements in the yield curve for information about future economic fundamentals. In several recent episodes, however, disruptions to market liquidity have affected the short-term dynamics of the curve independently of fundamentals. This article provides evidence that the short-run dynamics in the intermediate maturities of the yield curve changed around 1990, with the appearance of positive feedback in weekly interest rate changes. The feedback is consistent with the effects of options dealers' hedging activity and it is found only in the 1990s, after the interest rate options market grew to significant size. The authors also show that the market liquidity/positive-feedback effects are concentrated in the weeks after the largest interest rate changes. Their results suggest that the times when market participants and policymakers are most interested in extracting from the yield curve a signal about economic fundamentals are precisely the times when changes in the curve may be distorted by liquidity effects.

## Economic Policy Review, 2002

*Volume 8, Number 1, May 2002*
A special conference volume, "Financial Innovation and Monetary Transmission."
Contents include:

*Volume 8, Number 2, November 2002*
A special theme volume, "The Economic Effects of September 11."
Contents include:

### Measuring the Effects of the September 11 Attack on New York City

*Jason Bram, James Orr, and Carol Rapaport*

The attack on the World Trade Center had an enormous financial, as well as emotional, impact on New York City. This article measures the short-term economic effects on the city's labor force and capital stock through June 2002, the end of the recovery process at the World Trade Center site. Using a lifetime-earnings loss concept, the authors estimate that the nearly 3,000 workers killed in the attack lost $7.8 billion in prospective income. Moreover, the employment impact in the key affected sectors—such as finance, air transportation, hotels, and restaurants—translated into an estimated earnings shortfall of $3.6 billion to $6.4 billion, while the cost of repairing and replacing the damaged physical capital stock and infrastructure totaled an estimated $21.6 billion. Accordingly, the authors determine that the total attack-related cost to New York City through June 2002 was between $33 billion and $36 billion. The article also examines the attack's effects on the city's most economically vulnerable residents and analyzes survey findings on the incidence of post-traumatic stress disorder and alcohol and drug use after September 11.

### What Will Homeland Security Cost?

*Bart Hobijn*

The increased spending on security by the public and private sectors in response to September 11 could have important effects on the U.S. economy. Sizable government expenditures, for example, could trigger a rise in the cost of capital and wages and a reduction in investment and employment in the private sector, while large-scale spending by businesses could hamper firm productivity. This article attempts to quantify the likely effects of homeland security expenditures on the economy. It suggests that the total amount of public- and private-sector spending will be relatively small: the annual direct costs of the homeland security efforts are estimated to be $72 billion, or 0.66 percent of GDP in 2003. In the private sector, homeland security expenses are estimated to lower labor productivity levels by at most 1.12 percent. Therefore, the reallocation of resources associated with homeland security is unlikely to have any large and long-lasting effects on the U.S. economy.

### When the Back Office Moved to the Front Burner: Settlement Fails in the Treasury Market after 9/11

*Michael J. Fleming and Kenneth D. Garbade*

Settlement fails, which occur when securities are not delivered and paid for on the date scheduled by the buyer and seller, can expose market participants to the risk of loss due to counterparty insolvency. This article examines the institutional and economic setting of the fails problem that affected the Treasury market following September 11 and describes how the Federal Reserve and the U.S. Treasury responded. The authors explain that fails rose initially because of the physical destruction of trade records and communication facilities. Fails remained high because a relatively low federal funds rate and investor reluctance to lend securities kept the cost of borrowing securities to avert or remedy a fail comparable to the cost of continuing to fail. The fails problem was ultimately resolved when the Treasury increased the outstanding supply of the on-the-run ten-year note through an unprecedented "snap" reopening. The article also suggests other ways to alleviate chronic fails, such as the introduction of a securities lending facility run by the Treasury and the institution of a penalty fee for fails.

## Liquidity Effects of the Events of September 11, 2001

*James J. McAndrews and Simon M. Potter*

Banks rely heavily on incoming payments from other banks to fund their own payments. The terrorist attacks of September 11, 2001, destroyed facilities in Lower Manhattan, leaving some banks unable to send payments through the Federal Reserve's Fedwire payments system. As a result, many banks received fewer payments than expected, causing unexpected shortfalls in banks' liquidity. These disruptions also made it harder for banks to redistribute balances across the banking system in a timely manner. In this article, the authors measure the payments responses of banks to the receipt of payments from other banks, both under normal circumstances and during the days following the attacks. Their analysis suggests that the significant injections of liquidity by the Federal Reserve, first through the discount window and later through open market operations, were important in allowing banks to reestablish their normal patterns of payments coordination.

## Has September 11 Affected New York City's Growth Potential?

*Jason Bram, Andrew Haughwout, and James Orr*

In addition to exacting a tremendous human toll, the September 11 attack on the World Trade Center caused billions of dollars in property damage and a temporary contraction in New York City's economy. This article explores the effect of these events on the longer run economic prospects for the city. For many years, growth in New York has taken the form of rising property prices, reflecting a steady transition from low- to high-paying jobs. During the 1990s, the city's expansion was built on several factors, including improving fiscal conditions, better public services, and shifting industrial and population structures that favored job and income growth. The study suggests that the effects of September 11 will not eliminate these advantages in the medium term; in fact, preliminary indications are that the city remains an attractive location for businesses as well as households. Nevertheless, New York City will face many challenges as it attempts to return to its pre-attack growth path.

## Terrorism and the Resilience of Cities

*James Harrigan and Philippe Martin*

The September 11 attacks in New York and Washington have forced Americans to confront the fact that to live or work in a large city is to be at greater risk of large-scale terrorism. What do these risks, and the public perception of them, imply for cities in general and the future of New York City in particular? In this article, the authors begin their exploration of this issue by examining why cities exist in the first place. To conduct their analysis, they simulate two key theoretical models of economic geography, using data that approximate the characteristics of a major U.S. city as well as estimates of the costs of the September 11 attacks. The authors conclude that the very forces that lead to city formation also lead cities to be highly resilient in the face of catastrophes such as terrorist attacks. They argue that New York City in particular is likely to continue to thrive despite any ongoing terrorist threat.

## Economic Policy Review, 2003

*Volume 9, Number 1, April 2003*
A special theme volume, "Corporate Governance: What Do We Know, and What Is Different about Banks?" Contents include:

### Boards of Directors as an Endogenously Determined Institution: A Survey of the Economic Literature
*Benjamin E. Hermalin and Michael S. Weisbach*

The authors identify the primary findings of the empirical literature on boards of directors. Typically, these studies have sought to answer one of the following questions: How are the characteristics of the board related to profitability? How do these characteristics affect boards' observable actions? What factors affect board makeup and evolution? Across these studies, a number of regularities have emerged—notably, the fact that board composition does not seem to predict corporate performance, while board size has a negative relationship to performance. The authors note, however, that because there has been little theory to accompany these studies, it is difficult to interpret the empirical results, particularly with respect to possible policy prescriptions.

### Executive Equity Compensation and Incentives: A Survey
*John E. Core, Wayne R. Guay, and David F. Larcker*

Stock and option compensation and the level of managerial equity incentives are aspects of corporate governance that are especially controversial to shareholders, institutional activists, and government regulators. Similar to much of the corporate finance and corporate governance literature, research on stock-based compensation and incentives has not only generated useful insights, but also produced many contradictory findings. Not surprisingly, many fundamental questions remain unanswered. In this study, the authors synthesize the broad literature on equity-based compensation and executive incentives and highlight topics that seem especially appropriate for future research.

### A Survey of Blockholders and Corporate Control
*Clifford G. Holderness*

The author surveys the empirical literature on large-percentage shareholders in public corporations, focusing on four key issues: the prevalence of blockholders; the motivation for block ownership; the effect of blockholders on executive compensation, leverage, the incidence of takeovers, and a wide range of corporate decisions; and the effect of blockholders on firm value. A central finding of this study is that there is little reason for policymakers or small investors to fear large-percentage shareholders in general, especially when the blockholders are active in firm management.

### Transparency, Financial Accounting Information, and Corporate Governance
*Robert M. Bushman and Abbie J. Smith*

Audited financial statements along with supporting disclosures form the foundation of the firm-specific information set available to investors and regulators. In this article, the authors discuss economics-based research focused on the properties of accounting systems and the surrounding institutional environment important to effective governance of firms. They provide a framework for understanding the operation of accounting information in an economy, discuss a broad range of important research findings, present a conceptual framework for characterizing and measuring corporate transparency at the country level, and isolate a number of future research possibilities.

### The Corporate Governance of Banks

*Jonathan R. Macey and Maureen O'Hara*

The study argues that commercial banks pose unique corporate governance problems for managers and regulators as well as for claimants on the banks' cash flows, such as investors and depositors. The authors support the general principle that fiduciary duties should be owed exclusively to shareholders. However, in the special case of banks, they contend that the scope of the fiduciary duties and obligations of officers and directors should be broadened to include creditors. In particular, the authors call on bank directors to take solvency risk explicitly and systematically into account when making decisions or else face personal liability for failure to do so.

### Incentive Features in CEO Compensation in the Banking Industry

*Kose John and Yiming Qian*

This article examines the incentive features of top-management compensation in the banking industry. Economic theory suggests that the compensation structures for bank management should have low pay-performance sensitivity because of the high leverage of banks and the fact that banks are regulated institutions. In accordance with this school of thought, the authors find that the pay-performance sensitivity for bank CEOs is lower than it is for CEOs of manufacturing firms. This difference is attributable largely to the difference in debt ratios. The authors also find that banks' pay-performance sensitivity declines with bank size.

### Is Corporate Governance Different for Bank Holding Companies?

*Renée Adams and Hamid Mehran*

The authors analyze a range of corporate governance variables as they pertain to a sample of bank holding companies (BHCs) and manufacturing firms. They find that BHCs have larger boards and that the percentage of outside directors on these boards is significantly higher; also, BHC boards have more committees and meet slightly more frequently. Conversely, the proportion of CEO stock option pay to salary plus bonuses as well as the percentage and market value of direct equity holdings are smaller for bank holding companies. Furthermore, fewer institutions hold shares of BHCs relative to shares of manufacturing firms, and the institutions hold a smaller percentage of a BHC's equity. These observed differences in variables suggest that governance structures are industry-specific. The differences, the authors argue, might be due to differences in the investment opportunities of the firms in the two industries as well as to the presence of regulation in the banking industry.

*Volume 9, Number 2, June 2003*
A special conference volume, "Policies to Promote Affordable Housing."
Contents include:

### State of New York City's Housing and Neighborhoods: An Overview of Recent Trends

*Michael H. Schill and Glynis Daniels*

### The Impact of Building Restrictions on Housing Affordability

*Edward L. Glaeser and Joseph Gyourko*

### Government Regulation and Changes in the Affordable Housing Stock

*C. Tsuriel Somerville and Christopher J. Mayer*

Housing Production Subsidies and Neighborhood Revitalization: New York City's Ten-Year Capital Plan for Housing
*Ingrid Gould Ellen, Michael H. Schill, Amy Ellen Schwartz, and Ioan Voicu*

Effects of Homeownership on Children: The Role of Neighborhood Characteristics and Family Income
*Joseph M. Harkness and Sandra J. Newman*

The Impacts of New Neighborhoods on Poor Families: Evaluating the Policy Implications of the Moving to Opportunity Demonstration
*John Goering*

Comparing the Costs of Federal Housing Assistance Programs
*Denise DiPasquale, Dennis Fricke, and Daniel Garcia-Diaz*

The Twenty-Fifth Anniversary of the Community Reinvestment Act: Past Accomplishments and Future Regulatory Challenges
*William C. Apgar and Mark Duda*

Preservation First
*Ronay Menschel*

The Building Blocks for Private Investment in New York City's Underserved Communities
*Richard Roberts*

*Volume 9, Number 3, September 2003*
Part 1: A special conference volume, "Economic Statistics: New Needs for the Twenty-First Century." Contents include:

Price Hedonics: A Critical Review
*Charles R. Hulten*

Remarks on the Measurement, Valuation, and Reporting of Intangible Assets
*Baruch Lev*

Productivity Measurement Issues in Services Industries: "Baumol's Disease" Has Been Cured
*Jack E. Triplett and Barry P. Bosworth*

Part 2: Articles.

### What Market Risk Capital Reporting Tells Us about Bank Risk

*Beverly J. Hirtle*

In recent years, financial market supervisors and the financial services industry have increasingly emphasized the role of public disclosure in ensuring the efficient and prudent operation of financial institutions. This article examines the market risk capital figures reported to bank regulators by U.S. bank holding companies with large trading operations to assess the extent to which such disclosure provides market participants with meaningful information about risk. It argues that when one looks across banks, market risk capital figures provide little additional information about the extent of an institution's market risk exposure beyond what is conveyed by simply knowing the relative size of its trading account. In contrast, when one examines individual banks over time, these figures appear to provide information not available from other data in regulatory reports. These findings suggest that market risk capital figures are most useful for tracking changes in individual banks' market risk exposures over time.

### Formulating the Imputed Cost of Equity Capital for Priced Services at Federal Reserve Banks

*Edward J. Green, Jose A. Lopez, and Zhenyu Wang*

According to the 1980 Monetary Control Act, the Federal Reserve Banks must establish fees for their priced services to recover all operating costs as well as the imputed costs of capital and taxes that would be incurred by a profit-making firm. Since 2002, the Federal Reserve has made fundamental changes to the calculations used to set the imputed costs. This article describes and analyzes the current approach, which is based on a simple average of three methods as applied to a peer group of bank holding companies. The methods estimate the cost of equity capital from three perspectives—the historical average of comparable accounting earnings, the discounted value of expected future cash flows, and the equilibrium price of investment risk as per the capital asset pricing model. The authors show that the current approach also provides stable and sensible estimates of the cost of equity capital over the past twenty years.

### Measuring Treasury Market Liquidity

*Michael J. Fleming*

Securities liquidity is important to those who transact in markets, those who monitor market conditions, and those who analyze market developments. This article estimates and evaluates a comprehensive set of liquidity measures for the U.S. Treasury securities market. The author finds that the commonly used bid-ask spread—the difference between bid and offer prices—is a useful measure for assessing and tracking liquidity. The spread is highly correlated with a more sophisticated price impact measure and is correlated with episodes of reported poor liquidity in the expected manner. The author also finds that other measures correlate less strongly with episodes of poor liquidity and with the bid-ask spread and price impact measures, indicating that they are only modest proxies for market liquidity. Trading volume and trading frequency, in particular, are found to be weak proxies for market liquidity, as both high and low levels of trading activity are associated with periods of poor liquidity.

## Economic Policy Review, 2004

*Volume 10, Number 1, May 2004*

### Industry-Specific Exchange Rates for the United States

*Linda S. Goldberg*

The trade-weighted exchange rates constructed for the aggregate U.S. economy do not always capture the changes in industry competitive conditions induced by movements in specific bilateral exchange rates. Exchange rates produced using information on industry-specific trade partners are often better suited for this task. This article constructs three industry-specific real exchange rate measures for the United States—one using export partner weights only, a second using import partner weights, and a third using an average of export and import weights by industry—and examines how they co-move or diverge from the aggregate economywide measures. The exercise suggests that researchers who use aggregate exchange rate indexes rather than industry-specific measures might overlook the empirical value of exchange rates for the producer profits of specific U.S. industries.

### Exchange Rate Changes and Net Positions of Speculators in the Futures Market

*Thomas Klitgaard and Laura Weir*

Traders, strategists, and other participants in the currency markets continuously seek to understand and interpret short-term exchange rate movements. One data set frequently used in those efforts is a weekly report of net futures market positions held by speculators on the Chicago Mercantile Exchange. In this article, the authors pursue a transaction-oriented line of research to track short-term exchange rate moves. They examine the data set for six currencies over a ten-year period and document a strong contemporaneous relationship between weekly changes in speculators' net positions and exchange rates. The authors find that knowing what speculators did over a given week gives one a 75 percent probability of correctly guessing an exchange rate's direction over that week. One explanation for this relationship is that these speculators—acting on their interpretation of public and private information—have some success anticipating how underlying demand will move exchange rates from their prevailing levels in the very short term.

### The Institutionalization of Treasury Note and Bond Auctions, 1970-75

*Kenneth D. Garbade*

The substitution of auctions for fixed-price offerings was expected to lower the U.S. Treasury's cost of financing the federal debt. Despite this and other potential benefits, the Treasury failed in both 1935 and 1963 in its attempts to introduce regular auction sales of coupon-bearing securities. This article examines the Treasury's third and successful attempt between 1970 and 1975. The author identifies three likely reasons why the Treasury succeeded in the early 1970s: it closely imitated its successful and well-understood bill auction process, it extended the maturity of auction offerings gradually, and it was willing to modify the auction process when shortcomings became apparent.

### Treasury Inflation-Indexed Debt: A Review of the U.S. Experience

*Brian Sack and Robert Elsasser*

This article describes the evolution of Treasury inflation-indexed debt securities (TIIS) since their introduction in 1997. Over most of this period, TIIS yields have been surprisingly high relative to those on comparable nominal Treasury securities, with the spread between the nominal and indexed yields falling well below survey measures of long-run inflation expectations. The authors argue that the low relative valuation of TIIS may have reflected investor difficulty adjusting to a new asset class, supply trends, and the lower liquidity of indexed debt. In addition, investors may have had a benign outlook for inflation and may not have demanded much, if any, of an inflation risk premium to hold nominal securities. As a result, inflation-indexed debt has not yet lived up to one of its main purposes: to reduce the Treasury's expected financing costs. More recently, though, TIIS market liquidity and the breadth of investor participation have increased considerably, and the valuation of these securities appears to have improved.

*Volume 10, Number 2, September 2004*

A special conference volume, "Beyond Pillar 3 in International Banking Regulation: Disclosure and Market Discipline of Financial Firms."

Contents include:

### Rebalancing the Three Pillars of Basel II

*Jean-Charles Rochet*

### Disclosure, Volatility, and Transparency: An Empirical Investigation into the Value of Bank Disclosure

*Ursel Baumann and Erlend Nier*

### Market Indicators, Bank Fragility, and Indirect Market Discipline

*Reint Gropp, Jukka Vesala, and Giuseppe Vulpes*

### A Reconsideration of the Risk Sensitivity of U.S. Banking Organization Subordinated Debt Spreads: A Sample Selection Approach

*Daniel M. Covitz, Diana Hancock, and Myron L. Kwast*

### Risk and Return of Publicly Held versus Privately Owned Banks

*Simon H. Kwan*

*Volume 10, Number 3, December 2004*

### Are Home Prices the Next "Bubble"?

*Jonathan McCarthy and Richard W. Peach*

The strong rise in home prices since the mid-1990s has raised concerns over a possible bubble in the housing market and the effect of a sharp price decline on the U.S. economy. This article assesses two measures frequently cited to support a bubble—the rising price-to-income ratio and the declining rent-to-price ratio—and finds the measures to be flawed and the conclusions drawn from them unpersuasive. In particular, the measures do not fully account for the effects of declining nominal mortgage interest rates and fail to use appropriate home price indexes. The authors also estimate a structural model of the housing market and find that aggregate prices are not inconsistent with long-run demand fundamentals. Accordingly, they conclude that market fundamentals are strong enough to explain the recent path of

home prices and that no bubble exists. Nevertheless, weakening fundamentals could have an impact on home values on the east and west coasts, where the new housing supply appears to be relatively inelastic. However, prices in these regions have typically been volatile, and previous declines have not had a sizable negative effect on the overall economy.

### The Historical and Recent Behavior of Goods and Services Inflation

*Richard W. Peach, Robert Rich, and Alexis Antoniades*

Since the late 1990s, the combination of relatively high services inflation and declining goods prices has produced a record-level gap in these inflation rates. Some commentators argue that if the gap between services and goods inflation continues to expand in this manner, the outcome will be either faster overall inflation or deflation. This article examines the relationship between these divergent inflation rates from 1967 to 2002. The authors find that while the level of each inflation rate is subject to permanent shifts, the gap between services inflation and goods inflation over time remains stable. Moreover, when the gap is above its long-run value, as it currently is, equilibrium is restored through a rise in goods inflation and a slowing of services inflation. Their results suggest that concerns over an imminent marked acceleration or dramatic slowing in inflation may be unwarranted.

### Origins of the Federal Reserve Book-Entry System

*Kenneth D. Garbade*

The conversion of U.S. Treasury securities from physical to book-entry form was a major event in the history of the Treasury market. The conversion, which began in 1966, resulted in an automated system that has greatly reduced market operating costs and risks. This article examines the origins and development of the Federal Reserve book-entry system for Treasury securities. It suggests that the system was the product of three important factors: the interest of the Federal Reserve Banks and the Treasury in lowering their operating costs and risks, the intention of the Reserve Banks and the Treasury to preserve the liquidity of the market, and the desire of the Reserve Banks to reduce member bank operating costs. Two critical incidents—a loss of securities at a Reserve Bank in 1962 and an "insurance crisis" in 1970-71—played major roles in the early development and subsequent expansion of the book-entry system.

### Economizing on Liquidity with Deferred Settlement Mechanisms

*Kurt Johnson, James J. McAndrews, and Kimmo Soramäki*

Credit extensions to banks using the Fedwire Funds Service—the Federal Reserve's real-time gross settlement (RTGS) payments system—can reach intraday peaks as high as $86 billion. This article evaluates the effectiveness of alternative methods of settling Fedwire payments in reducing intraday credit extensions. The authors simulate three deferred settlement mechanisms that complement RTGS systems: one-hour netting, six-hour netting, and a mechanism called a receipt-reactive gross settlement (RRGS) system. Their results suggest that in conjunction with RTGS systems, the RRGS mechanism could significantly reduce daylight credit extensions while modestly delaying the average time of payment settlement. Moreover, certain features of RRGS systems may encourage banks to submit payments earlier in the day. Further research on RRGS systems may shed light on whether they could prove to be a true liquidity-saving complement to real-time gross settlement systems.

## Economic Policy Review, 2005

*Volume 11, Number 1, August 2005*
A special conference volume, "Labor Market Developments in the United States and Canada since 2000."
Contents include:

THE WEAK JOBS RECOVERY: WHATEVER HAPPENED TO "THE GREAT AMERICAN JOBS MACHINE"?
*Richard B. Freeman and William M. Rodgers III*

ARE GOOD JOBS DISAPPEARING IN CANADA?
*René Morissette and Anick Johnson*

THE RECESSION OF 2001 AND UNEMPLOYMENT INSURANCE FINANCING
*Wayne Vroman*

*Volume 11, Number 2, December 2005*
A special conference volume, "Urban Dynamics in New York City."
Contents include:

URBAN COLOSSUS: WHY IS NEW YORK AMERICA'S LARGEST CITY?
*Edward L. Glaeser*

THE GEOGRAPHY OF ENTREPRENEURSHIP IN THE NEW YORK METROPOLITAN AREA
*Stuart S. Rosenthal and William C. Strange*

EXOGENOUS SHOCKS AND THE DYNAMICS OF CITY GROWTH: EVIDENCE FROM NEW YORK
*Andrew F. Haughwout and Bess Rabin*

THE PROMISED CITY: OPENNESS AND IMMIGRATION IN THE MAKING OF A WORLD METROPOLIS
*Kenneth T. Jackson*

IMMIGRATION TRENDS IN THE NEW YORK METROPOLITAN AREA
*George J. Borjas*

TRAJECTORIES FOR THE IMMIGRANT SECOND GENERATION IN NEW YORK CITY
*John Mollenkopf*

IMMIGRATION, HEALTH, AND NEW YORK CITY: EARLY RESULTS BASED ON THE U.S. NEW IMMIGRANT COHORT OF 2003
*Guillermina Jasso, Douglas S. Massey, Mark R. Rosenzweig, and James P. Smith*

PUBLIC EDUCATION IN THE DYNAMIC CITY: LESSONS FROM NEW YORK CITY
*Amy Ellen Schwartz and Leanna Stiefel*

FEDERAL RESERVE BANK OF NEW YORK
ECONOMIC POLICY REVIEW

Single-copy subscriptions to the *Economic Policy Review* (ISSN 0147-6580) are free. Multiple copies are available for an annual cost of $12 for each additional subscription. Checks should be made payable in U.S. dollars to the Federal Reserve Bank of New York and sent to the Public Information Department, 33 Liberty Street, New York, NY 10045-0001 (212-720-6134). Single and multiple copies for U.S. subscribers are sent via third- and fourth-class mail.



Library of Congress Card Number: 77-646559

Federal Reserve Bank of New York research publications—the *Economic Policy Review*, *Current Issues in Economics and Finance*, *Staff Reports*, *Research Update*, and the annual publications catalogue—are available at the Research Group's website.

**www.newyorkfed.org/research**