"Unconventional" Monetary Policy as Conventional Monetary Policy: A Perspective from the U.S. in the 1920s

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May 5, 2017

To implement monetary policy in the 1920s, the Federal Reserve utilized administered interest rates and conducted open market operations in both government securities and private money market securities, sometimes in fairly considerable amounts. We show how the Fed was able to effectively use these tools to influence conditions in money markets, even those in which it was not an active participant. We also provide evidence that the changes in money market conditions resulting from changes in monetary policy affected the issuance of money market securities. These results point to a channel through which monetary policy was transmitted to the rest of the economy. The tools used in the 1920s by the Federal Reserve resemble the extraordinary monetary policy tools used by central banks recently and provide further evidence on their effectiveness even in ordinary times.

Key words: monetary policy, unconventional monetary policy, central banking, administered rates, money markets

JEL codes: E52, E58, N22

In recent years, the Federal Reserve (Fed), like many other central banks, has introduced new tools to implement monetary policy; for the Fed these included large scale asset purchases and use of administered rates. Several of these tools were introduced as unconventional and temporary policy tools, but some have argued that the Fed may have to rely on them more frequently going forward. That might be the case, for example, if there has been a decline in the long-run neutral real rate of interest—that is, the inflation-adjusted short-term interest rate consistent with keeping output at its potential on average over time—as suggested by Clarida (2014) and Holston, Laubach, and Williams (2016). Indeed, scholars and policy makers have increasingly engaged in a broader debate about how central bank policy should be implemented including whether the central bank should use administered rates or target market rates and whether the size and composition of the balance sheet should be used as policy tools (Stein 2012, Goodfriend 2014, Reis 2016, and Yellen 2016). An important part of the debate about which tools might be part of the toolkit is whether these tools are effective and a growing literature has sought to evaluate their effectiveness, particularly of the asset purchases (Krishnamurthy, Vissing-Jorgensen, Gilchrist, and Philippon 2011; D'Amico, English, López-Salido, and Nelson 2012; Altavilla, Carboni, and Motto 2015; and Haldane, Roberts-Sklar, Wieladek, and Young 2016). However, such assessments are challenging given the limited number of actions and the fact that several asset purchase programs were announced following the financial crisis when market responsiveness may have been different than in normal times.

This paper provides a historical perspective on the tools available to the Fed by reviewing the U.S. monetary policy toolkit and analyzing the transmission of monetary policy to private money markets in the 1920s. During this period, the Fed implemented policy by adjusting administered interest rates and by purchasing both private and government securities, sometimes in fairly considerable amounts. These tools are similar to the tools introduced recently and understanding their effectiveness as conventional policy tools during the 1920s provides additional information on the potential effectiveness of such tools today. We find strong evidence that the Fed's policy toolkit in the 1920s, and importantly the composition of its balance sheet, had a considerable impact on determining conditions in money markets. These results reinforce the idea that the recently introduced "unconventional" policy tools essentially work in a very conventional way through money markets and can be useful even in normal times, not just once conventional monetary policy tools have been exhausted.

Our analysis starts with a review of the tools available to the Fed in the 1920s to implement monetary policy and a discussion of how they functioned. The monetary policy toolkit at this time is particularly interesting because the Fed had three policy instruments at its disposal, each of which worked in a slightly different fashion. The first tool was the discount window where banks could borrow in order to obtain reserves at a rate set by the Fed. The second tool was purchases of bankers' acceptances; the Fed set a price at which it would buy these private money market securities. This tool directly impacted the value of a particular money market instrument and affected the costs to the banks of obtaining reserves by selling the acceptances to the Fed. The third tool was open market operations in government securities in which the Fed would purchase or sell Treasury securities at the going market rate. These operations impacted the cost of reserves by changing the total supply of reserve balances.

In thinking about how monetary policy was transmitted to the economy in the 1920s, we argue that the Fed used its policy tools to influence the expected cost of reserves and through that the money market rates more broadly.[1] Banks demanded reserves to satisfy reserve requirements as well as for operational purposes. When the Fed provided an ample (scarce) supply of reserves to the banking system through its open market operations, for example, then the price of obtaining reserves was lower (higher). While there was not yet a liquid federal funds market where banks could trade reserve balances directly with a readily observed price, trading and price discovery could occur indirectly through other money markets in which many banks were active participants. We think that this indirect trading was an important channel through which monetary policy was transmitted to other financial markets. The discount window limited how high the price of reserves could rise. Borrowings from the discount window were a relatively expensive liability for banks, so they preferred not to borrow too much, but if reserves were sufficiently scarce, then banks could turn to the window. The Fed often implemented monetary policy using its tools in combination; operations in Treasuries and acceptances influenced the extent to which banks had to go to the window and changes in the discount rate affected the cost of doing so. This description of the mechanism is close to those in contemporary writings, such as those of Reifler (1930) and Burgess (1936), but also draws on research about the market for

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[1] As we discuss in more detail below, we use the term monetary policy to refer to actions taken by the Fed and the consequences of those action. We touch only lightly on the intent behind such actions.

reserves and implementation of monetary policy in the late 1990s/early 2000s (see Koeger, McGowan, and Sarkar 2017).[2]

When comparing the tools used in the 1920s to the tools introduced recently by the Fed, the similarity of using open market operations in government securities to implement monetary policy is the clearest. The large scale asset purchases of Treasuries used by the Fed recently are notably larger than the scale of the operations in the 1920s, although operations during two easing cycles in the earlier period did more than triple the Fed's Treasury portfolio. There are also parallels with respect to the administered rates and how they relate to the balance sheets of commercial banks. Both periods have an administered rate that affects the rate of return to holding a highly liquid asset: the return on holding acceptances in the 1920s was influenced by the rate on which the Fed would purchase these assets and the return on holding reserves is influenced recently by the interest rate the Fed pays on excess reserves. Both periods also featured an administered rate that affects banks' cost of obtaining short term funding: the discount window rate in the 1920s affected the costs of short-term borrowing from the Fed while the rate on the modern overnight reverse repurchase facility rate influences the rate banks much pay in money markets to borrow funds (though indirectly by offering an alternative instrument to institutions that might otherwise lend to the banks).[3]

After describing the three policy instruments and how they worked, we examine their effectiveness in influencing conditions in money markets during the 1920s. The connection between changes in the policy tools and changes in conditions in private money markets is a key link in the transmission of monetary policy. We focus on the years from 1923 until 1929—after distortions from war finance needs had diminished and before the onset of the financial distress of the Great Depression. In particular, we test whether private money market rates in New York City, where the major money markets in the U.S. were located, responded to changes in the discount window rate of the Federal Reserve Bank of New York (New York Fed), changes in the discount at which the New York Fed purchased acceptances, and changes in the System's

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[2] Research on unconventional policy tools has described other mechanisms by which these tools affect financial conditions. We discuss these channels, and how they might fit with the tools, in Section 2.

[3] Interestingly, the interest rate tools are related to quite different parts of the Fed's balance sheet. The administered rates in the 1920s affect assets held by the Fed while the modern tools affect the cost of liabilities issued by the Fed.

holding of government bonds. We find that the policy instruments were effective in influencing private money market rates in a manner consistent with the mechanism described above.

Our finding that monetary policy, and balance sheet policy in particular, mattered for money markets is in contrast to some previous work that has argued that Federal Reserve policy in the 1920s was not effective as it had minimal impact on the total level of reserves (see, for instance, Toma 1989). Instead, our findings are more in line with the narrative of Friedman and Schwartz (1963) who argue that monetary policy was quite effective in the 1920s; their discussion related monetary policy more to general macroeconomic conditions, but finding that monetary policy mattered for money markets is certainly an aspect of that bigger picture.

To further understand whether changes in monetary policy mattered for broader economic outcomes, we examine whether the changes to the monetary policy tools affected the use of money market instruments, in addition to influencing interest rates, and whether monetary policy appears to have influenced the interest rates banks charged their customers. Our analysis of the effect of the tools on the use of money market instruments uses a two-step procedure. We first capture the extent to which the monetary policy tools shaped money market rates, and then use the first stage results to measure the effect of policy on the use of money market instruments through rates. Our results indicate that a tightening of monetary policy resulted in reduced issuance of money market instruments, while an easing of policy had the opposite effect. When looking at the effect on other interest rates offered by banks, we use a similar approach as the one used when looking at the effect on money market rates. We find that it was indeed the case that changes in monetary policy affected a variety of bank interest rates. These results further support the idea that the monetary policy was being transmitted to the rest of the economy.

In addition to the literature on how central bank balance sheets can be used to implement monetary policy described above, we add to the literature focused on understanding the transmission of monetary policy to financial markets (see, for instance, Hamilton 1997; Demiralp, Preslopsky, and Whitesell 2006; Carpenter, Demiralp, and Senyuz 2016; Duffie and Krishnamurthy 2016). We find that by impacting the financing conditions of important marginal market participants, monetary policy was transmitted to money markets that were distinct from the ones in which the Fed was directly operating. These results also show that money markets in the 1920s were quite well integrated.

The paper is organized as follows. Section 2 describes the Fed's monetary policy toolkit and discusses the implications of the use of these tools for the Fed's balance sheet. Section 3 examines the empirical evidence on immediate transmission: both the connection between the administered rates and the composition of the balance sheet and the transmission of changes in these tools to conditions in private money market rates. Section 4 describes the analysis linking changes in monetary policy to the larger economy. Section 5 concludes.

Section 2. Monetary Policy Toolkit

In this section, we review the three main tools the Fed used to implement monetary policy in the 1920s—the discount window, purchases of bankers' acceptances, and open market operations in government securities—and how they shaped the Fed's balance sheet. We also discuss a mechanism through which we think that the changes in these tools may have been transmitted to private money markets. This mechanism draws on contemporary descriptions (Reifler 1930, Burgess 1936) as well as recent work on conventional and unconventional monetary policy.

Note that in this paper, our focus is the Fed's toolkit and how the monetary actions taken by the Fed affected money market conditions. We are neither focused on the reasons for the policy actions nor whether the policy makers had the correct intentions behind their actions. Wheelock (1991), Friedman and Schwartz (1963), Meltzer (2003), and Wicker (1966) provide a detailed review of the factors driving monetary policy in this period.

Nevertheless, it is worth remembering that the Fed in this period was generally operating a countercyclical monetary policy with a stated goal of accommodating commerce and business, without allowing speculative excesses to create instability. The Federal Reserve would tighten policy when they viewed credit growth as excessive, and ease when industry and trade were in need of support. Conditions in financial markets were viewed as signals about the demand and supply of credit growth. As noted by Wheelock (1991), these signals require careful interpretation; for instance, low money market rates could signal low loan demand as well as excessive supply of reserves, but the appropriate monetary policy response differs depending on the underlying reason. Wheelock also suggests that the Fed interpreted the signals correctly in the 1920s given the correlation between monetary policy and industrial production in this period.

2.1 The discount window

In the 1920s, one of the primary tools for implementing policy was the discount window, where the Fed could (re)discount paper for banks or provide advances (loans) against eligible collateral. The rates that were charged for providing credit through the discount window could be increased or decreased in order to affect credit conditions.

The operations of the discount window were overseen by the 12 Federal Reserve Banks, and the rates that were charged at the window were set by these banks subject to approval by the Federal Reserve Board. As interbank markets were not quite as integrated in this period as they are today, the Federal Reserve Banks had some scope to set discount window rates that differed across districts.[4] As our analysis focuses on the money market rates in New York, we focus on the discount window rate at the New York Fed.[5]

The rates that the New York Fed charged on its discount window loans were often fairly close to, but below, the interest rates on private money market rates in New York. These were markets in which banks were typically lenders. The discount window rate was often above the rates that the money center banks in New York banks typically paid on their deposits, including their interbank deposits. As described by the New York Clearing House Association (1920), the maximum rates that member banks were allowed to pay on interbank deposits and certificates of deposit issued to banks in the early 1920s, were both below, and a function of, the discount rate of the New York Fed.[6] While the strict relationship between rates and the New York Fed's discount window rate was relaxed in the mid-1920s, it appears that the rates the money center banks paid on many of their deposits remained below the discount window rate. The relative expensiveness of the discount window is consistent with Burgess's report that the New York

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[4] Efforts by banks to arbitrage differences in discount window rates promoted the early development of the federal funds market and the subsequent integration of interbank markets (Turner 1931).

[5] The reserve banks could, and sometimes did, have multiple discount window rates that varied with the type of collateral being used. During World War I, all the reserve banks offered a preferential rate for loans backed by government securities in order to bolster demand for such securities. By the early 1920s, the New York Fed had a single discount window rate.

[6] Specifically, the rules stated that the maximum rate that member banks could pay on such deposits was set at one percent when the 90-day discount rate for commercial paper at the New York Fed was two percent. For each half-percentage point increase in the discount rate above two percent, the maximum rate that member banks could pay was increased by one-quarter of a percentage point (New York Clearing House Association, 1920, page 16).

banks would often repay their discount window loans quickly when they received additional funds due to gold flows or Fed asset purchases (Burgess 1936, p. 235-236).

During the 1920s, the ability of the Fed to provide credit through the discount window was more limited than it is currently (Bordo and Wheelock 2013). In particular, the Fed could only rediscount short-term commercial, agricultural, or industrial paper from member banks that was used to produce, purchase, carry, or market goods. It could not discount promissory notes, such as corporate bonds or longer-maturity commercial and industrial loans.[7] The Fed could also rediscount government paper. The amount the Fed provided a borrowing bank was less than the promised payment at maturity by the discount rate.[8] In addition to discounting private paper, the Fed could also make loans (advances) to banks for up to 15 days backed by either paper eligible for discount or by U.S. government obligations. In general, during the 1920s, advances tended to be secured by government securities while rediscounts tended to be of private paper.

Even with the restrictions on the paper it could discount or make advances upon, many member banks accessed the discount window and the rate that the Fed charged on its rediscounts and advances had an important effect on banks' marginal cost of funding. Borrowing was fairly widespread with about one-third of all member banks borrowing in any given month (roughly 3,000 borrowers out of 9,000 member banks). It is uncertain how much stigma was associated with borrowing from the discount window in this period; even though we observe large numbers of banks borrowing, contemporaries note that banks were reluctant to borrow, especially in the money centers (Reifler 1930, p. 29-30).

2.2 Open market purchases of bankers' acceptances

The Fed could purchase bankers' acceptances in the open market as part of its open market authority (while the Fed could purchase a slightly broader set of securities than just bankers' acceptances, acceptances constituted nearly all the paper bought by the Fed so we use

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[7] Short-term was 90 days for commercial and industrial paper and 9 months for agricultural paper. Such restrictions grew out of the idea that the Federal Reserve should finance "Real Bills". Temporary expansions of the Federal Reserve's ability to lend against a broader range of collateral were made in 1932 and made permanent in 1935.
[8] For details of this transaction see Hackley (1961). When discounting paper or receiving an advance, the bank incurred a liability to the Federal Reserve which would increase the bank's leverage. Thus, these transactions had indirect costs to banks that open market operations in either acceptances or government securities did not.

the term bankers' acceptances to refer to all such paper).[9] The primary use of bankers' acceptances in the 1920s was as a money market instrument to finance trade, especially international trade (Beckhart 1932). When an exporter shipped goods abroad, they typically had to wait to be paid until the goods reached the market and were sold. Especially in international trade, this could have taken some time. Rather than wait, the exporter could have brought a bill indicating the shipment to his bank and received a loan against that bill. Bank financed such loans by endorsing the bills and bringing them to larger banks, usually in a money center. The money center banks would then "accept" the bill and provide money to the exporter's bank. The money center bank could hold that bill and finance it as it would any other security it held or the bank could sell the bill into the market as a bankers' acceptance. The acceptance was guaranteed by the payment the exporter expects to receive, the promise of the exporter's bank to make good on the paper if the exporter failed, and the promise of the money center bank to make good on the paper if the exporter's bank failed. Triply secured, the bankers' acceptance was low risk and short term, perfect as an instrument for money market investors.[10]

This type of instrument was little used in the United States prior to the Federal Reserve. Indeed, banks with National charters were forbidden to issue such securities. As many prominent European money markets, such as London, had large bankers' acceptance markets and the fact that these securities backed "real transactions," the founders of the Federal Reserve were keen to develop this market in the U.S., which would also help promote the U.S. dollar as an international currency (Ferderer 2003, Eichengreen and Flandreau 2012).

The Fed had a passive role in the open market operations in bankers' acceptances. Instead of directly buying a certain amount of acceptances directly from the market, the Federal Reserve banks would set the rates at which they would buy acceptances of particular maturities, where this rate was the discount relative to the face value of the acceptance; we refer to this discount as the acceptance rate. The Fed would then take all eligible acceptances that were

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[9] The Federal Reserve still has the authority to purchases bankers' acceptances, however, it has not used this authority in some time. Open markets operations in bankers' acceptances and the use of repurchase agreements on bankers' acceptances to manage reserves were ceased in 1977 and 1984, respectively. See Small and Clouse (2005).
[10] It is not clear what the maturity structure of these instruments at origination was, but at particular points in time, roughly 40 percent of the holdings of the Fed had maturities of less than 15 days, 20 percent had a remaining maturity of between 16 and 30 days, 25 percent had a remaining maturity of 31 to 60 days. The rest had a maturity of more than 60 days.

delivered to them.[11] Given the desire of the Fed to promote this market, the rate at which the Fed would buy acceptances tended to be set favorably relative to the rate at the discount window. Thus, the incentives of banks to issue acceptances and deliver them to the Fed were influenced both by the level of the acceptance rate, but also by the spread between the acceptance rate and the discount window rate. As with rates at the discount window, the 12 reserve banks could each set their own rates for purchasing these securities. Moreover, each reserve bank would often have multiple acceptance rates that depended on the remaining maturity of the acceptance. Again, given our focus on the New York markets, we use the rates offered by the New York Fed.

The maturity of the acceptances that the Fed purchased were fairly short term. In a typical month, around 40 percent of the acceptances that were purchased by the Fed had a remaining maturity of 30 days or less. The Fed was willing to purchase acceptances with remaining maturities of up to 180 days and the Fed's modest purchases of these longer maturity acceptances was sufficient to raise the average maturity of acceptances purchased by the Fed to around 50 days. The Fed bought some of these acceptances outright, but also purchased acceptances from dealers under agreements to resell at later date (repo agreements).

2.3 Open market operations in government securities

The Federal Reserve also has the authority to purchase or sell government obligations in the open market. Originally, each Federal Reserve Bank conducted open market operations in government securities independently, which at times led to challenges that underscored the need for better coordination. Efforts to coordinate operations across the System eventually resulted in the creation of the Open Market Investment Committee in 1923.

Around this time, open market operations in government securities began to be seen as a tool that could be used to manage the aggregate quantity of credit, and support the discount window policy. Some shifts in policy were associated with large swings in the holdings of

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[11] Eligibility rules covered issues such as the types of goods associated with the underlying transaction and the maturity of the loans being provided; interestingly, whether any of the banks involved in the transaction were Federal Reserve member banks did not affect eligibility. While all the reserve banks appear to have purchased acceptances, the largest acceptance markets were in Boston and New York. Purchases of acceptances by the Federal Reserve System appear to have been concentrated at the reserve banks in these cities and then apportioned to other reserve banks through a sharing agreement.

government securities. For instance, in 1924, the Federal Reserve took steps to ease monetary policy and increased its holdings of Treasury securities from $100 million in January to $600 million by October. In 1928, policy was tightened and holdings of Treasury securities fell from $600 million in January to $200 million by June. At other times, changes in holdings of government securities were modest; from January 1925 to July 1927 holding of government securities average around $350 million, with week to week changes rarely exceeding $20 million. The Fed's holdings of Treasury securities consisted largely of certificates of indebtedness (with maturities of a year or less) and notes (with maturities of between one and ten years). When the Fed engaged in substantial operations in Treasury securities, the more substantial movements were in its holdings of notes (which would imply an extension of the average maturity of its holdings) although at times there were also sizeable adjustments in the Fed's holdings of certificates.

With the Open Market Investment Committee, most purchases were conducted by the New York Fed and allocated to the accounts of the other Reserve Banks. Purchases were not announced, but could easily have been observed from the Fed's weekly publication of its balance sheet. As with acceptances, most securities were held out right, but some were bought under repo agreements.

During this period the Fed could purchase securities directly from the Treasury in some circumstances. Such purchases were rare and were used for cash management purchases, but when they occurred, they could be fairly large. See Garbade (2014) for details.

2.4 Balance sheet of the Federal Reserve

The balance sheet of the Federal Reserve for the year-end of 1926 is shown in Table 1. From this table, it is clear that the major asset of the Federal Reserve System was gold, which is consistent with the U.S. being on the gold standard.

It is also apparent that, during this period, the direct exposure of the Federal Reserve to the condition of the commercial banking sector was fairly substantial. Private credit, consisting of bills of acceptance purchased in the open market, paper rediscounted, or advances to member banks on acceptable collateral (often government securities), constituted about 20 percent of the

Federal Reserve System's assets. Advances, which were mostly secured by US government securities, were typically more substantial than discounts, which were typically of commercial and agricultural paper. Fed purchases of bankers' acceptances securities represented seven percent of the Fed's assets. Most of the acceptances held by the Fed were associated with imports or exports, though some were associated with domestic trade or inventory finance. The Fed's holdings of acceptances represented a significant share of the market, at times the Fed held nearly 40 percent of outstanding acceptances. Consistent with its large share of the market, the rate at which the Fed was willing to buy acceptances heavily influenced the market price. As shown in Figure 1, the market rate in New York and the rate at which New York Fed offered to purchase the securities were almost identical. Holdings of government securities were a smaller share of the balance sheet in this period, averaging about seven percent of total assets.[12]

2.5 Mechanism by which monetary policy operated

We argue that monetary policy was likely transmitted to private money market rates through its effects on the expected cost of obtaining reserves. Banks demanded reserves in part to ensure they were compliant with their reserve requirements, but reserves were also useful for various operational aspects of banking such as processing payment system transactions. The supply of reserves was determined importantly by the Fed through its open markets operations. Purchases (or sales/maturing) of Treasury securities would expand (contract) the supply of reserves. Open markets operations in acceptances required that the banks decide to sell such securities to the Fed, but the Fed could influence banks' incentives by changing the discount at which it purchased them. As these securities were short-term and naturally "self-liquidating," they would mature over time and tighten policy unless they were replaced. (Changes in monetary gold should have had similar effects as open market operations and we typically include such changes as a control variable. See Friedman and Schwartz (1963) for a discussion of the amount of gold on the Fed's balance sheet.) The price of reserves was determined by demand relative to supply.

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[12] At about $315 million dollars, total holdings of Treasury securities represented about 1.7 percent of all interest-bearing Treasury securities.

While there was not yet a liquid market in which banks could directly trade reserves—the federal funds market was still developing—banks could trade reserves indirectly through trading securities and through their mutual participation in other overnight money markets. We illustrate this mechanism using an example from the call loan market where brokerage firms obtained overnight funding (we describe this market in more detail below); this example also illustrates how indirect trading in reserves could transmit monetary policy to other markets. Suppose a bank is short on reserves. If that bank had lent funds in the overnight call loan market, then that bank could acquire additional reserves by demanding the repayment of its overnight loans from a broker. The broker would seek a new overnight loan from a second bank that had sufficient reserves. By repaying the funds owed to the first bank with funds from the second bank, the reserves would move from one bank to another. The interest rate the broker had to pay the second bank was related to the scarcity of the reserves. If reserves were plentiful, then there would be a larger number of banks ready to supply funds and the rates in the call loan market would be lower. If reserves were scarce, then more brokers would be competing for reserves from the fewer banks willing to provide loans and the call loan rate would rise. Of course, the call loan market was not the only market in which banks could indirectly trade for reserves. Other money markets in which short-term securities were traded, such as the commercial paper market or even the bankers' acceptance market, could fulfill this role as could liquid markets in longer-term securities, such as Treasury securities. Because of the variety of markets through which this transfer could occur and arbitrage across these markets was not perfect, it would be hard to determine precisely how much a change in reserves might change in monetary market rates, but the direction would be clear and would be consistent across markets.[13]

When reserves were scarce, the discount window could serve to cap the price on reserves. As noted above, the discount window was a relatively expensive liability for banks. In addition, there may have been some stigma associated with its use (Reifler 1930). However, when reserves were sufficiently scarce and rates in money markets sufficiently high, then banks could

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[13] We think of this tool operating in some ways like the interest rate on excess reserves used currently by the Fed. When the Fed increases the interest rate paid on excess reserves, it increases the value of this asset and provides an incentive of banks to hold onto these reserves rather than lend them to another bank unless they are offered an even higher rate. Similarly, by changing the discount at which it purchased acceptances, the Fed could affect the value of these assets and the incentives of banks to hold them or deliver them to the Fed to obtain additional reserves. Note that the tools affect different sides of the Fed's balance sheet: the modern tool affects the rate the Fed pays on one of its liabilities while the tool in the 1920s affects the rate the Fed earns on its asset purchases.

turn to the discount window to obtain reserves. Raising or lowering the discount window rate could impact rates in other money markets by affecting how high those rates would have to rise before it became advantageous for the banks to turn to the window.[14]

Changes in the acceptance rate would have changed the incentives of banks to sell acceptances to the Fed. An increase in the discount would have decreased the value of selling the acceptance, the banks would demand higher returns on their loans before selling an acceptance to fund those loans would have been worthwhile.[15] Declines in sales of acceptances to the Fed would also reduce the supply of reserves (as existing acceptances matured) which would tighten that market and pushing up money rates, as described above. Sales of Treasury securities would also reduce the supply of reserves.

The acceptance rate may have influenced money market rates in an additional, and more direct way. Certain investors held both acceptances and other money market securities, such as commercial paper, as part of their portfolios. If the Fed changed the rate at which it bought acceptances, and thus changed the prevailing market rate, then we would expect the investors holding both assets to rebalance their portfolios to equilibrate the rates. Thus money market conditions should respond to both changes in the acceptance rate itself and changes in the Fed's holdings of acceptances. We explore that idea in several places below.

Overall, the Fed could affect pricing in money markets by changing its balance sheet through open market operations or by changing the discount window rate. Moreover, these tools were often used in a complementary fashion as described above. The interaction between the open market operations in government securities and the discount window rate, for example, can

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[14] We think of this tool as operating similarly to the modern interest rate paid on the overnight reverse repurchase facility (ONRRP rate). By changing the ONRRP rate, the Fed affects the rate that important money market lenders can earn on a safe asset. That increases the rate of return the demand on other funds they provide, including the rate that banks would have to pay to borrow from these lenders overnight. By raising the discount window rate in the 1920s, the Fed was directly impacting the short-term funding rate that banks had to pay to borrow from the Fed. Note that the tools affect different sides of the Fed's balance sheet: the modern tool affects the rate the Fed pays on one of its liabilities while the tool in the 1920s affects the rate the Fed earns on its asset purchases.

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be seen in Figure 2. In general, the policy instruments moved in a complementary fashion as holdings of Treasury securities tended to increase around the time that policy rates were lowered and vice versa.

Importantly, this mechanism indicates that operations by the Federal Reserve should impact money market conditions even if the operations left the amount of reserves constant. This point is in contrast to Toma (1989) who argued that since reserves were fairly stable in the 1920s, that monetary policy was not especially effective.

This mechanism, if true, gives rise to the following testable implications:

i)   The New York Fed acceptance rate should be negatively associated with the amount of acceptances sold to the Fed, and if so, it should be positively associated with private money market rates.

ii)   The level of private money market rates should have a have a negative association with the holdings of acceptances and Treasury securities on the Fed's balance sheet.

iii)   The level of private money market rates should have a positive association with the level of the discount window rate.

2.6 Alternative mechanisms of transmission

The recent literature on unconventional monetary policy has highlighted some other mechanisms by which monetary policy might be transmitted to financial markets. One such mechanism is the portfolio balance channel (see discussion in Haldane, Roberts-Sklar, Wieladek, and Young 2016). Underlying this mechanism is the idea that investors have preferences regarding the assets they hold. If the central bank were to purchase a particular type of asset, then the investors who had held that asset would purchase other assets with somewhat similar characteristics in ways that would change the relative prices of these assets. For instance, if certain investors have preferences for assets with a particular duration profile, then when the Fed purchases large amount of longer-term Treasury securities those investors might purchase large amounts long-term corporate debt and compress the yield spreads between these asset classes. This compression in yield spreads might consequently promote issuance of corporate bonds. In

our period, the Fed was purchasing two types of assets – Treasury securities and bankers' acceptances. Under the portfolio balance channel, we might expect that effect on money market prices from purchases of bankers' acceptances might be different, and possibly stronger, than the effects from purchases of Treasury securities as the former are a more similar instrument.

Another mechanism by which unconventional policy might be transmitted is through signaling. Newspaper stories clearly indicate that market participants had expectations about actions the Fed might take. Additionally, newspaper stories and analysis of changes in the Fed's balance sheet and in the discount and acceptance rates make it clear that financial market participants were paying close attention to actions taken by the Fed. However it is not clear that the actions taken by the Fed had strong impacts on reshaping the expectations of market participants. To the extent that expectations were changed, it is more likely that the impacts would be observable in long-term yields rather than in the very short-term interest rates considered here. (Bordo and Sinha (2016) find evidence that shifts in market expectations associated with changes in the Federal Reserve's balance sheet mattered for longer-term Treasury yields during 1932 when the Fed engaged in substantial purchases of Treasury securities.)

Section 3. Testing the transmission mechanism

In this section we test our hypotheses about the transmission of monetary policy to financial markets. We start by looking at how changes in administered rates affect the Fed's balance sheet and then analyze how the rates and the balance sheet affected money markets.

3.1 Relationship between Administered Rates and Changes in the Balance Sheet

For the Fed to have been able to actively manage its balance sheet using the administered rates—the discount window rate and the acceptance rate—then those rates would need to influence the assets held by the Fed. The discussion in the previous section suggests that the

acceptance rate and the ability to manage open market purchases of acceptances would be particularly important.[16]

We analyze the impact of changes in the acceptance rate by regressing the change in the ratio of the Fed's holdings of acceptances to relative to the level of acceptances on the balance sheet in January 1923 on (lagged) changes in the acceptance rate as well as other controls. While the description of the mechanism above focused on the share of reserves backed by particular assets, we use the change in the current ratio of acceptances to initial acceptances, due to concerns about the endogeneity of reserves; banks adjust reserves in response to Fed policy, and the Fed may adjust policy in response to trends in reserves. Using acceptances on the balance sheet relative to the January 1923 level of acceptances is similar to using the total dollar amount of acceptances, just scaled in a useful way. (As the balance sheet of the Fed stayed very close to $5 billion throughout the analysis period, it turns out that the ratio we use is highly correlated with the share of the Fed's assets that consist of acceptances.) Data on acceptances held are available from the Fed's H.4.1 statistical release. While information is available weekly, the quantity data is sometimes volatile and we create monthly observations using the average of the weekly data to smooth through the noise.

The Fed had a schedule of rates at which it would purchase acceptances with that rate varying by the remaining maturity of the acceptance; we use the rate for acceptances with 16-30 days remaining maturity.[17] We average the daily interest rates to a monthly frequency. We expect that when the Fed raised the acceptance rate that the sale of acceptances to the Fed would be less attractive. Thus we would expect negative coefficients on the changes in the administered rate.

We include several control variables as well. Lagged growth in industrial production is used to account for changes in economic activity and lagged stock market returns are included to

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[16] It could still be the case that acceptances could still influence money market rates if they ended up on the Fed's balance sheet only through seasonal factors and were independent of the discount at which Fed purchases occurred. However, it would be difficult to characterize such a pattern as monetary policy as these fluctuations would not be managed by the Fed through its policy tools.

[17] In different places in this paper, the particular acceptance rate that would provide the "best" rate varies; in some cases the best rate would be that on short-term paper, 15 days to maturity, and in other cases the best rate would be on paper with a longer maturity such as 90-120 days to maturity. Rather than justify our choice each time, we use the same intermediate rate throughout the paper. The results are generally similar if we use an alternative acceptance rate.

control for other aspects of financial markets. Both of these variables should be positively associated with both dependent variables. We also include monthly dummy variables as both activity in the acceptance market and in discount window lending had a seasonal dimension associated with the harvest cycle and with year-end (see Carlson and Wheelock 2016).

The analysis uses monthly data for the period from January 1923 to September 1929. We control for first-order autocorrelation. Summary statistics for these variables (and all other variables) are reported in Table 2. (See the data appendix for sources of the data.)

The results of the analysis are in Table 3. We find strong evidence that the Fed could use the administrative rate on acceptances to influence the volume of securities that were offered to it. An increase in the rate by 25 basis points, about a one standard deviation change, resulted in a decrease in the ratio of acceptance to reserves in the following month of 8 percentage points; this ratio typically changed by 17 percentage points each month, so the impact of a 25 basis point move was economically meaningful. Our control variables have the expected signs; positive stock market returns and increases in industrial production both increased acceptances on the Fed's balance sheet. Our month indicator variables (not shown) are negative in the first half of the year and positive in the second part of the year, consistent with the seasonal factors noted earlier.

3.2 Transmission of changes in monetary policy to private money rates

In this section, we examine how private money market rates changed in response to changes in monetary policy (implemented either through changes in administered rates or through open market operations) and how the composition of the Fed's balance sheet affected conditions in money markets.

3.2.1 Review of major private money markets

There are two major private money markets that we use in our analysis. The first is the market for broker's loans, where short-term loans were extended to New York City stock brokers

and brokerage houses backed by equity securities traded on the New York Stock Exchange.[18] This was the largest money market in the 1920s. Lenders included domestic and foreign banks, corporations, and investment trusts. The domestic banks included both small banks across the country and the major banks in New York.

Loans were typically initially arranged at the money desk of the New York Stock Exchange though some were also arranged through money brokers or directly between the large banks and the brokerage houses. A large portion of the loans were demand loans and could be called by the lender at any time which resulted in the market being referred to as the "call loan market." The market was seen as a place where liquid funds could be placed and was sufficiently deep that, should a loan be called, the borrower was usually able to find another lender and repay the first lender. Most call loans were rolled over from day to day with the non-price terms of the loan being held constant. Further, there was sometimes a slight difference in the interest rate for loans that were being rolled over (renewed) and new loans. Shifts in supply and demand for funds had the most effect on the new call loans (as these would marginally add or subtract to total loans made), and interest rates on these loans tended to be more volatile than the interest rates on call loans that were rolled over. A modest share (30 percent) of loans to brokers were made on a time basis. While not available at call, these loans were considered part of the call loan market as they were to the same borrowers and secured by the same collateral.

There was also a portion of the call loan market where dealers could finance their inventories of acceptances. This market does not appear to have been particularly deep and seems to have virtually disappeared sometime in the early 1930s. Nevertheless, for the period in which quoted rates appear, they track other rates in the call loan market reasonably closely which suggests that this part of the market was fairly well integrated with the other parts.

The prime commercial paper market was a money market in which moderately sized firms could borrow on an unsecured basis (larger firms would typically issue long-term bonds).[19]

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[18] There were smaller, less formal markets for providing funds to brokers on the regional stock exchanges or the New York "curb" market.

[19] To give a sense of size, in 1926 the average monthly outstanding volumes of the different money market instruments were Bankers' acceptances: $691 million; commercial paper: $627 million, brokers' loans on call $2,288 million, and brokers' loans on time $825 million. There was an emerging federal funds market, but that was very small. There was also a repo market involving a variety of collateral, including bankers' acceptances, but the size of this market is unknown. For additional details on these markets, see Beckhart (1932).

The firms would issue short-term notes which would be purchased by a commercial paper house which would arrange to distribute the paper around the country.[20] The commercial paper houses would verify the quality of the commercial paper they were buying and selling. While the houses would not guarantee the paper they sold, there were reputational consequences to selling paper that subsequently went bad. The most common buyers of commercial paper were banks, which would use this as a place to put funds on a short-term basis. Given the structure of the market, while the borrower might refinance maturing commercial paper and the same commercial paper house might buy and distribute that paper, the purchasers of one issue were not commonly the purchasers of the refinancing issue. Banks might buy this paper directly or through their correspondent, typically located in New York City. This market was fairly deep for much of the 1920s, but started to fade by the end of that period.

Interest rates on this paper in the secondary market were determined by the quality of the firm issuing the paper. "Prime" commercial paper reflected the paper considered by the National Credit Office (a private firm affiliated with the R. G. Dun credit rating agency) to be of the highest quality and the interest rates on that paper trading in the secondary market were used to construct the prime commercial paper rate.

3.2.2 Setup of the analysis connecting monetary policy tools and money market rates

Here we study whether the interest rates in private money markets responded quickly to changes in the policy rates the Federal Reserve controlled and whether the holdings of Treasury securities affected private money market rates.[21] To get a general sense of the relationship between the policy tools and market rates, we plot two policy rates and two private money market rates at a weekly frequency in Figure 3. The two policy rates are the New York Fed's discount window rate and rate for purchases of acceptances with a maturity of 16-30 days. The

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[20] Distribution was facilitated by the tendency of these houses to be affiliates of a larger financial institution that engaged in other securities market activities, such as brokerage services or underwriting, and already had extensive relationships.

[21] As noted by Wheelock (1991), the Fed was reportedly attentive to whether its policy rates were out of alignment with market rates. Thus, there is some possibility of reverse causality in that changes in market rates could have caused the Fed to adjust its policies. However, it seems likely that any policy response would have been in reaction to more sustained changes in market rates rather than the week to week fluctuations analyzed here. Moreover, the results of Section 4.3 below using spreads between the money market rates and the discount rate should further alleviate concerns about reverse causality.

private rates are the interest rate on 90 day commercial paper and the rate on time call loans (90 days).[22] The figure suggests that, in general, policy rates seem to have moved in the same direction though they were not adjusted at exactly the same time. From Figure 2, we know that holdings of Treasury securities tended to move inversely with these rates. Using the tools in combination during a shift in policy was intentional (Burgess 1936). Figure 3 also indicates that the private market rates moved broadly at the same times as movements in the policy rates and the changes in holdings of Treasury securities. It is also clear from Figure 3 that money market spreads during this time were positive and tended to move around over time, which is different than is the case now where these spreads tend to be fairly tight and steady over time.

To more formally test whether private rates move in response to changes in policy instruments, we regress private money market rates on the policy tools. We start by using the levels of interest rates compared to the level of the policy rates and balance sheet ratios and then look at changes in money market rates and changes in the policy tools. The private money market rates we use are the interest rate on 90 day commercial paper, time call loans (90 days), the interest rate on (overnight) renewed call loans, and the call loan market rate for acceptances.

Each regression considers the effect on money market from three policy tools. The first is the discount rate, either in levels or changes. The second is the holdings of Treasury securities relative to the levels of such securities on the Fed's balance sheet in January of 1923; as noted in the previous section, this variable indicates the volume of Treasury purchases scaled in a useful way. The third tool is related to acceptances. Following the results of the previous section, we run alternative specifications using in one case, the acceptance rate for acceptances with 15-30 days left to maturity and in the other case the Fed's holding of acceptances relative to holdings on January 1923. We expect that either should matter, though with the opposite sign.

Changes in the Fed's holdings of gold should also impact money rates in a manner similar to Treasury purchases. (Hanes (2006) finds that gold flows affected monetary conditions in the 1930s; gold inflows increased the supply of reserves and lowered longer term treasury yields.) To control for the impact of gold on financial conditions, we include the ratio of the level of monetary gold relative to holdings of gold in January 1923.

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[22] The private discount rate on acceptances is almost identical to the acceptance rate set by the Federal Reserve.

We include other control variables as well. We add the ratio of the level of the Fed's industrial production index to the level on January 1923 to control for business activity and business borrowing needs.[23] To account for other financial market conditions, especially the demand for call loans, we include the level of the Standard and Poor's stock market index relative to its level in January 1923. Seasonal factors may also be important and we include monthly dummies in the regressions. (See Table 2 for summary statistics.)

The time period we use in the analysis is from January 1923 to September 1929 (just prior to the stock market crash). The level regressions using monthly observations. For changes, we use both monthly and weekly data. The regressions control for serial correlation, either first order or second order depending on the series, in the errors.

3.2.3 Results using the levels of interest rates and monthly data

The regression using the level of rates results are reported in Table 4; Table 4A has the results when we use the ratio of acceptances to acceptances in January 1923 and Table 4B has the results when we use the level of the acceptance rate. The results in these Tables indicate that the tools have the expected effects. Higher levels of the administered rates, both the discount rate and the acceptance rate, result in higher levels of private rates. Private rates were lower when the Fed held more Treasury securities or acceptances.

The control variables generally mattered as expected. When holdings of gold were higher, private interest rates tended to be lower although the effect is not always statistically significant. Periods of greater economic activity, as indicated by industrial production, tended to be associated with higher private interest rates. We do not find that the level of the stock market is strongly related to the level of private rates.

3.2.4 Results using the changes in interest rates and monthly data

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[23] We also tried a variety of other economic controls, such as Federal Reserve's index of factory employment, index of building contracts awarded, and index of wholesale distribution. Including these measures had little impact on our results. As we do not have so many degrees of freedom, we omit these measures in the reported results.

We next test whether changes in private interest rates are affected by changes in the policy tools (as well as changes in the control variables). Using changes is a better test than using levels because of reduced likelihood of spurious correlation and of issues associated with autocorrelation.

The results using monthly data are in Table 5; Table 5A has the results when we use the changes in the ratio of acceptances to acceptances in January 1923 and Table 5B has the results when we use changes in the level of the acceptance rate. We continue to find that policy mattered as changes in the policy variables resulted in changes to the private money rates. Changes in the discount window rate are associated with changes in the private market rates in the same direction. The coefficient relating changes in the discount window rate to changes in the commercial paper indicate that an increase of 25 basis points in the discount window rate would result in about a 9 basis point increase in the commercial paper rate. As the average monthly change in the commercial paper rate was about 12 basis points, we argue that this was an economically meaningful move. Increases in the holdings of Treasury securities and acceptances tended to reduce money market rates, as we expected. We find that an increase in the holdings of acceptances by $50 million, an amount that represented one percent of the Fed's balance sheet and is about an average monthly change in holdings, is associated with a reduction in the commercial paper rate of about 6 basis points. An increase in the holdings of Treasury securities of $50 million also results in a reduction in the commercial paper rate of 6 basis points.[24] The effects on other money market interest rates are even larger.[25] From Table 5B, we find that a change in the acceptance rate is also associated with a change in money market rates in the same direction. In the specifications reported in this table, the estimated effects of the other policy variables are somewhat smaller than in Table 5A, though they continue to point in the same direction.

Evidence with respect to the portfolio balance channel is mixed. As discussed in Section 2, this mechanism for this channel would lead us to expect a greater impact on money market

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[24] The holdings of Treasury securities in January 1923 were twice as large as holdings of acceptances while the coefficient relating the change in Treasury securities to the change in the commercial paper rate is about twice as large as for acceptances. Thus, the same dollar amount move in both asset holdings results in the same effect on the commercial paper rate.

[25] These estimated effects of asset purchases are larger than those found for recent Fed asset purchases. Bordo and Sinha (2016) also find stronger effects of asset purchases in the 1920s and 1930s than in modern times.

conditions from purchases of acceptances than purchases of Treasury securities as acceptances are closer substitutes for other money market securities. For commercial paper, the closest security to acceptances, we find that the effects of changes in the holdings of Treasuries and acceptances on money market rates are of similar sizes. However, for other rates, we do find slightly large impacts on money market rates from changes in acceptance holdings than from changes in Treasury holdings.

The control variables also have effects similar to those noted in the Table 4. Increases in the Fed's holdings of gold are associated with reductions in interest rates. Increases in economic activity also tended to be associated with increases in interest rates. We continue to find little relationship between the stock market and interest rates.

3.2.5 Results using the changes in interest rates and weekly data

Finally, we look at whether changes in the policy tools resulted in changes in interest rates at a weekly frequency. Here, for the balance sheet measures, we use the percent change in the balance sheet item rather than the change in the ratio of the contemporary level of the balance sheet item relative to the initial level. This applies to both the securities acquired through open market operations—acceptances and Treasury securities—as well as gold. We do not include the other control variables in the regression as the monthly changes in these variables are not correlated with the week to week changes in interest rates.

When looking at the weekly changes, we omit some weeks in 1926 and 1927 in which there are particularly sharp spikes in Treasury holdings associated with issuance of cash management bills directly to the Fed (described above and observable in Figure 2).[26] Including them marginally affects the economic and statistical significance of the coefficients on the impact of changes in holdings of Treasury securities, but does not qualitatively affect the results. As noted above, summary statistics of the variables used here are reported in Table 2.

We find that changes in all three policy instruments are followed by changes in market interest rates during the following week. As shown in Table 6A and 6B, changes in the discount window rate appear to have sizeable effects. For example, an increase in the discount window

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[26] See Garbade (2014) for details.

rate by 25 basis points is associated with an increase in the prime commercial paper rate by about 7 basis points over the next two weeks. In Table 6A, we find that an increase in holdings of acceptances is associated with a decline in market interest rates while, as shown in Table 6B, we find that an increase in the acceptance rate increase the commercial paper rate. The impact of a rise in the acceptance rate, where a 25 basis point rise is expected to increase the commercial paper rate by 5 basis points, is just a little smaller than the impact from the discount rate. In the results reported in both Table 6A and Table 6B, we find that an increase in holdings of Treasury securities is associated with a decrease in market rates. It is notable in Table 6B that increase in the administered rates tend to result in a rise in interest rates with a slight lag while the effect of increases in holdings of Treasury securities tends to impact market rates the same week. This is consistent with the notion that changes in the administered rates require changes in the behavior of the banks, which may take a few days, to permeate market rates while purchases of Treasuries by the Fed impact markets directly without requiring actions on the part of others.

3.2.6 The composition of the Fed's balance sheet and money market spreads

As an additional part of the analysis, we look at whether the spread between the market rates and the discount window rate (or the acceptance rate) is related to the composition of assets the Fed was holding on its balance sheet. Analysis of this sort provides further evidence regarding the role that open market operations played an important role in the transmission of monetary policy.[27] Based on the mechanism described earlier, we expect that when the Fed's holdings of Treasury or acceptances (or gold) are higher the spreads between market rates and the administered rates ought to be lower. We return to looking at month variables in this part of the analysis.

For money market spreads, we look at spreads between the commercial paper rate, call money rate for time loans, and the call loan renewal rate and the discount window rate. The balance sheet variables we look at are the Treasury securities held by the Federal Reserve

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[27] There has also been a suggestion that the Fed changed the discount rate to "catch-up" to market rates. While we think that weekly regressions suggest otherwise—given the rarity of changes in the discount window rate, it seems unlikely that the policy changes were in response to weekly fluctuations in the market rates so finding connections here is far more likely to be because the market rates were impacted by Fed policy—these spread regressions should further alleviate concerns about catching up.

relative to the level in January 1923, and the bankers' acceptance bills held by Federal Reserve also relative to the amount of such securities held in January 1923. We also look at the spread between the call loan rate for acceptances relative to the acceptance rate at which the New York Fed would purchase acceptances with 16-30 days to maturity; here we do not include the ratio of acceptances on the Fed's balance sheet to bank reserves out of concerns of endogeneity and limit the policy variable to the ratios of Treasury securities to securities held in January 1923.

We continue to include a variety of control variables. For instance, we continue to control for the amount of monetary gold held by the Fed and include the ratio of monetary gold to the level of gold on the balance sheet in January 1923. We also control for the economic activity using the ratio of the Fed's index of industrial production (again relative to its level in January 1923). To account for other financial market conditions, especially the demand for call loans, we include lagged stock market performance indicated by the ratio of the Standard and Poor stock market index to the level in January 1923. Seasonal factors may also be important and we include monthly dummies in the regressions. (See Table 2 for summary statistics.) As before we control for serial correlation.

The results are presented in Table 7. We find that the more Treasuries and bankers' acceptances held by the Fed, the narrower the spreads in money markets over the discount rate or bankers' acceptance rate. These results are all consistent with the idea that the composition of the Federal Reserve's balance sheet mattered for monetary policy. We also find that greater holdings of monetary gold are also associated with narrower money market spreads. We find some tendency for spreads in money markets tended to be higher when industrial production was growing more quickly but little evidence that equity price movements are associated with different spreads.

Section 4. Monetary policy and other financial variables.

In this section, we explore the extent to which monetary policy impacted items more directly connected with the real economy. To do so, we first look at whether monetary policy, by impacting money market rates, also influenced the use of money market instruments. Second, we look at whether the interest rates offered by banks to their nonfinancial customers were also impacted by the stance of monetary policy.

4.1 Market conditions and use of money market securities

The changes in financial conditions could affect the usage of financial instruments. In this section, we test whether changes in interest rates had an impact on the use of different money market instruments. Analyzing these relationships provides additional evidence about the importance of monetary policy on the real economy.

To measure the change in usage of money market instruments we look at the percent change in outstanding amounts of commercial paper and broker loans (loans connected to the call loan market). Given the short maturities of these money market instruments, we expect that changes in outstanding amounts will respond fairly quickly to changes in financing conditions.

We are interested in particular in whether monetary policy mattered for use of money market instruments. To get at this, we use a two-step process. We first regress the level of the relevant money market rates on monetary policy tools—the level of the discount rate as well as Fed holdings of Treasuries and acceptances (and gold) relative to their levels in January 1923— as well as economic controls (essentially the regressions from Tables 4A). We then regress the growth rates of the outstanding amounts of monetary market securities on the predicted values from this first stage regression as well as the economic controls. This procedures isolates the impact of monetary policy on outstanding amounts that occurs from the impact of monetary policy on interest rates. This approach, which is essentially in instrumental variables approach, also alleviates concerns about regressing quantities (changes in outstanding amounts) on prices (interest rates). Our estimation period is from January 1923 to September 1929 for commercial paper and from January 1923 to June 1929 for broker loans.[28]

The results indicate that changes in financial conditions and monetary policy did indeed impact the issuance of the money market securities in question. Table 8A shows the results for the commercial paper market while Table 8B shows the results for broker's loans. The first stages, where the commercial paper rate and the call loan renewal rate are shown in the first columns, while the regressions of changes in outstanding amounts on the predicted values from the first stage and control variables are shown in the second column. In both second stages, we

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[28] The months immediately leading up to the stock market crash produce some notable outlier.

find that when interest rates were pushed higher by tighter monetary policy, the amount of outstanding commercial paper and brokers loans grew more slowly (or contracted faster).

Outside of monetary policy, we find strong evidence that a rising equity market is strongly associated with an increase in the amount of outstanding broker loans. This effect is one identified in the equity market boom and that Federal Reserve officials tried to lean against in the late 1920s (See Wicker 1966).

4.2 Impact of monetary policy on other interest rates

To further explore whether changes in the monetary policy tools were transmitted to the broader economy, we look at whether other interest rates that banks charged their customers were affected by were influenced by the stance of policy. In particular, we look at the rates that banks charged on 4-6 month commercial loans to prime borrowers, these are the loans that were later converted into the prime commercial paper traded in the money market, and the rates that banks charged on loans secured by warehouse receipts. We expect that the stance of monetary policy and its impact on the cost of reserves will impact the loan rates offered by banks on these loans though perhaps not quite as strongly as the interest rates in the money markets; borrower condition likely played a much stronger role in the rates offered by the banks than in the more impersonal money markets where the supply and demand for liquid funds is a much more prominent determinant. Interest rates changed by banks on the commercial loans and on warehouse loans were collected by the Federal Reserve through a survey of banks and published in the monthly bulletin.

We regress these interest rates on our various monetary policy tools. As has been the case, the policy variables are the discount rate, the ratio of Treasury securities held relative to the level held in January 1923, and the ratio of bankers acceptances held by the Fed to the level held in January 1923. We continue to control for the amount of monetary gold on the Fed's balance sheet, economic activity as indicated by the index of industrial production, the stock market, and seasonal factors. All independent variables are lagged one month.

We run the regressions both in levels and month-to-month changes. As above, the sample period starts in January 1923 and ends in September 1929. We continue to control for serial correlation in the error terms.

The results are in Table 9. The two columns on the left show the regressions in levels while the two columns on the right show the regression results when changes in the variables are used. Using both levels and changes, we find that monetary policy mattered here and impacted interest rates. The higher the discount rate, the higher the rates the banks charged on their loans, while when the Fed made reserves more plentiful through its purchases of bankers' acceptances and Treasury securities, the rates the banks charged on their loans tended to be lower. By showing the monetary policy impacted the interest rates charged customers, these regressions indicate that monetary policy was able to be transmitted to the real economy.

Section 5. Conclusion

In this paper, we provide an overview of the three primary tools used by the Fed to implement monetary policy in the 1920s—the discount window, purchases of bankers' acceptances, and purchases of government securities in the open market. We then show that the Fed was able to influence the private money market rates fairly effectively with each of these tools. By affecting these interest rates, the Fed appears to have been able to influence issuance of money market securities. While the details of the transmission of monetary policy tools to financial market are specific to the time period, we expect that the lessons are more broadly applicable. Finding that asset purchases and administered rates were useful as normal monetary policy tools in the 1920s supports the robustness of the finding in the recent literature that similar policy tools have been useful in extraordinary times.

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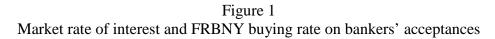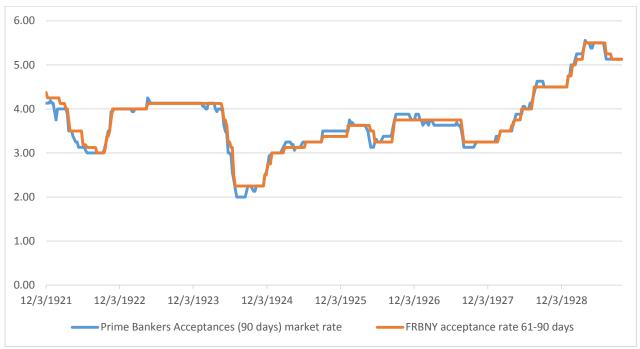
Data Appendix

The weekly Fed balance sheet is from the H.4.1 statistical release available from the Federal Reserve Bank of St. Louis FRASER website. The year-end 1926 balance sheet is from the Federal Reserve Board Annual Report for 1926.

Interest rates for commercial paper, new call loans, renewed call loans, and time call loans are from the Federal Reserve's *Banking and Monetary Statistics 1914-1941*. The interest rates on bankers' acceptances which are from the *Acceptance Bulletin of the American Acceptance Council*. Interest rates on the Fed's repo facility for acceptances are from Beckhart (1932). Interest rates on prime commercial loans and on loans secured by warehouse receipts are from the Federal Reserve Bulletins from the years 1923-1930.

Outstanding amounts of commercial paper, broker loans, and acceptances are from the Federal Reserve's *Banking and Monetary Statistics 1914-1941*.

The index of industrial production is from the Board of Governors of the Federal Reserve.

Figure 1
Market rate of interest and FRBNY buying rate on bankers' acceptances

Source: Federal Reserve, Banking and Monetary Statistics, 1943.

Figure 2
Holdings of Treasury Securities and the Discount Rate

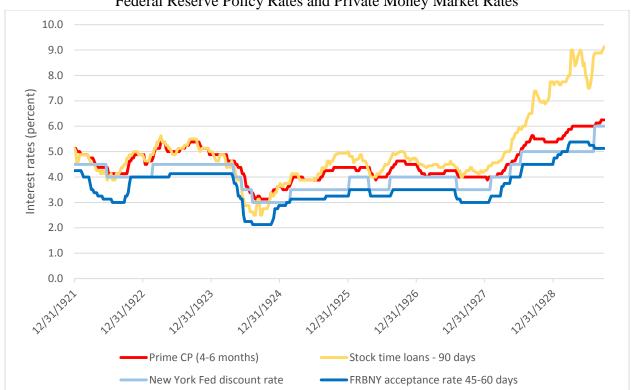Source: Federal Reserve, Banking and Monetary Statistics, 1943.

Figure 3
Federal Reserve Policy Rates and Private Money Market Rates

Source: Federal Reserve, Banking and Monetary Statistics, 1943.

Table 1
Balance sheet of the Federal Reserve
December 31, 1926

Assets		Equity and Liabilities	
Gold held against Federal Reserve notes	1,448.6	Federal Reserve Notes	1850.8
Other gold	1,369.9		
Bills rediscounted		Deposits	
Commercial and industrial paper	170.6	Member bank reserves	2194.1
U.S. Government	1.1	Other deposits	81.9
Other bills	3.1		
Advances		Other liabilities	669.7
Secured by U.S. Government	364.2		
Otherwise secured	97.6		
Bills bought in open market			
Acceptances for imports & exports	252.2		
Acceptances for domestic trade	77.7		
Other bills	51.0		
US Gov. securities bought in open market			
Certificates of indebtedness	179.5		
Notes	87.4		
Bonds	48.0		
Uncollected items	730.5	Capital	124.8
		Surplus	228.8
Other assets	268.7		
Total	5150.1	Total	5150.1

Note. All values in millions of dollars.

Table 2
Summary statistics

Monthly variables

Variable	Obs.	Mean	Standard Deviation	Min	Max
New York Fed discount window rate	81	4.09	.66	3	6
New York Fed acceptance rate	81	3.63	.78	2	5.38
Ratio acceptances Jan 1923 value	81	1.1	.43	.13	2.16
Ratio Treasuries to Jan 1923 value	81	.73	.31	.20	1.36
Ratio gold to Jan 1923 value	81	.95	.05	.84	1.03
Ratio of S&P stock index to Jan 1923 value	81	1.54	.58	.90	3.15
Ratio of IP index to Jan 1923 value	81	1.1	.11	.90	1.42
Change in discount window rate	80	.025	.19	-.5	.80
Change in acceptance rate	80	.015	.18	-.76	.59
Change in ratio Treasuries to Jan 1923 value	80	-.008	.10	-.27	.32
Change in ratio gold to Jan 1923 value	80	.0003	.23	-.56	.63
Change in ratio acceptances Jan 1923 value	80	-.0004	.01	-.04	.03
Change in ratio of S&P stock index to Jan 1923 value	80	.03	.05	-.10	.23
Change in ratio of IP index to Jan 1923 value	80	.005	.04	-.08	.07
Spread between CP rate and discount rate (pcnt pts)	81	.47	.24	0	1
Spread between call loan time rate and discount rate (pcnt pts)	81	.96	.92	-.68	3.78
Spread between call loan renewal rate and discount rate (pcnt pts)	81	.81	1.2	-1.4	5.4
Spread between call loan rate on acceptances and Fed's purchase rate on 30-day acceptances (pcnt pts)	61	.38	.45	-.75	1.9
Growth rate of CP (pcnt pts)	80	-1.3	4.3	-13.4	7.5
Growth rate of broker loans (pcnt pts)	79	1.8	4.5	-12.7	12.0
Rate on prime commercial loans	81	4.86	.50	4	6
Rate on loans secured by warehouse receipts	68	5.15	.45	4.25	6

Weekly variables

Variable	Obs.	Mean	Standard Deviation	Min	Max
Week to week change in the CP rate (basis pts)	351	.39	7.5	-38	25
Week to week change in the call loan time rate (basis pts)	351	1.2	14.8	-63	100
Week to week change in the call loan renewal rate (basis pts)	351	1.1	71	-390	435
Week to week change in the call loan rate on acceptances (basis pts)	261	.4	34.8	-200	200
Change in the discount window rate (basis pts)	351	.56	10.7	-50	100
Change in the rate on acceptances with 30 days to maturity (basis pts)	351	.32	7.4	-63	25
Change in holdings of Treasury securities (pcnt pts)	350	.23	10.2	-37.5	56.3
Change in holdings of gold (pcnt pts)	350	-.004	.6	-2.5	2.4

Table 3
Changes in Fed balance sheet items in response to changes in administered rates

Dependent variable: Change in the ratio of bankers' acceptances to level in January 1923

	Change in Bankers' Acceptances to initial level
Chance in discount on acceptances with 30 days to maturity (lagged)	-.32*** (.11)
Change in the ratio of the S&P stock index relative to its value Jan 1923	.86** (.33)
Change in the ratio of the IP index relative to its value in Jan 1923	1.67* (.90)
Intercept	-.14* (.07)
Includes monthly dummies	Yes
AR1	.45
Observations	79
F-statistic/Wald χ^2	7.1
R^2	.52

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for first-order autocorrelation in the error terms (and we find no evidence of second order serial correlation).

Table 4A
Impact of policy instruments on the level of private money rates
(monthly frequency)

Dependent variable: level of private money market rates

	Prime CP	Call loans on Time	Call loans Renewal	Call loans acceptances
Level of the discount rate	.43*** (.09)	.95*** (.16)	.61** (.28)	.47** (.21)
Current acceptances to acceptances Jan 1923	-.27*** (.10)	-.51** (.21)	-.92*** (.25)	
Current Treasuries to Treasuries Jan 1923	-.61*** (0.18)	-.55 (.37)	-1.34** (.59)	-1.3*** (.38)
Gold to gold Jan 1923	-.78 (1.25)	-2.1 (2.7)	-6.3** (2.7)	-4.1** (1.6)
Ratio of the S&P stock index to its value Jan 1923	.11 (.18)	.35 (.29)	.55 (.43)	-.03 (.32)
Ratio of the IP index to its value in Jan 1923	1.50* (.80)	5.04*** (1.45)	5.6*** (1.9)	4.0*** (1.3)
Intercept	2.6 (1.5)	-1.7 (3.2)	3.8 (3.7)	2.5 (2.4)
Includes month dummies	Yes	Yes	Yes	Yes
AR L1	.87	.95	.12	.43
AR L2		-.14	.49	
Observations	81	81	81	61
F-statistic	18.6	16.5	34.5	21.4
Adjusted R^2	.79	.77	.88	.84

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for either first or second-order autocorrelation in the error terms, as appropriate.

Table 4B
Impact of policy instruments on the level of private money rates
(monthly frequency)

Dependent variable: level of private money market rates

	Prime CP	Call loans on Time	Call loans Renewal	Call loans acceptances
Level of the discount rate	.19** (.09)	.70*** (.19)	-.15 (.30)	.47** (.21)
Level of the acceptance rate on those with 30 days to maturity	.66*** (.10)	.41* (.25)	1.4*** (.30)	
Current Treasuries to Treasuries Jan 1923	-.32** (0.15)	-.33 (.46)	-.47 (.62)	-1.3*** (.38)
Gold to gold Jan 1923	.33 (.69)	-.84 (2.5)	-3.5* (1.9)	-4.1** (1.6)
Ratio of the S&P stock index to its value Jan 1923	.07 (.12)	.43 (.28)	.71* (.43)	-.03 (.32)
Ratio of the IP index to its value in Jan 1923	-.50 (.64)	3.6** (1.7)	1.3 (2.4)	4.0*** (1.3)
Intercept	1.7* (.98)	-2.8 (3.0)	1.5 (3.3)	2.5 (2.4)
Includes month dummies	Yes	Yes	Yes	Yes
AR L1	.64	.82	-.01	.43
AR L2		-.01	.35	
Observations	81	81	81	61
F-statistic	53.8	17.9	74.9	21.4
Adjusted R^2	.92	.78	.94	.84

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for either first or second-order autocorrelation in the error terms, as appropriate.

Table 5A
Impact of policy instruments on changes in private money rates
(monthly frequency)

Dependent variable: change in the level of private money market spreads

	Prime CP	Call loans on Time	Call loans Renewal	Call loans acceptances
Change in the discount rate	.36*** (.09)	.78*** (.17)	.43 (.27)	.56** (.23)
Change in acceptances to acceptances Jan 1923	-.24** (.11)	-.48*** (.19)	-.91*** (.24)	
Change in Treasuries to Treasuries Jan 1923	-.48*** (0.18)	-.48 (.35)	-1.13* (.60)	-.78* (.44)
Change in gold to gold Jan 1923	-1.5 (1.6)	-3.6 (2.8)	-9.2** (4.1)	-5.2* (3.1)
Change in ratio of the S&P stock index to its value Jan 1923	.43 (.33)	.34 (.58)	1.5 (1.0)	-.15 (.85)
Change in ratio of the IP index to its value in Jan 1923	1.7** (.84)	5.4*** (1.3)	7.5*** (2.4)	7.2*** (2.0)
Intercept	-.21 (.07)	-.33*** (.17)	-.86** (.36)	-.51*** (.15)
Includes month dummies	Yes	Yes	Yes	Yes
AR L1	.16	.01	-.87	-.37
AR L2		-.29	-.25	
Observations	80	80	80	60
F-statistic	4.3	5.0	4.5	5.5
Adjusted R^2	.41	.46	.43	.55

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for either first or second-order autocorrelation in the error terms, as appropriate.

Table 5b
Impact of policy instruments on changes in private money rates
(monthly frequency)

Dependent variable: change in the level of private money market spreads

	Prime CP	Call loans on Time	Call loans Renewal	Call loans acceptances
Change in the discount rate	.15* (.09)	.49** (.20)	-.07 (.39)	-.25 (.25)
Change in acceptances rate	.48*** (.10)	.50* (.26)	1.13*** (.35)	1.2*** (.25)
Change in Treasuries to Treasuries Jan 1923	-.28* (0.17)	-.21 (.40)	-.38 (.70)	-.40 (.35)
Change in gold to gold Jan 1923	-.67 (1.4)	-1.9 (2.1)	-4.8 (3.2)	-2.8 (2.4)
Change in ratio of the S&P stock index to its value Jan 1923	.27 (.28)	.31 (.53)	.90 (.88)	-.53 (.65)
Change in ratio of the IP index to its value in Jan 1923	.14 (.80)	3.4** (1.6)	2.9 (4.0)	3.9** (1.7)
Intercept	2.6 (1.5)	-.23** (.11)	-.63 (.34)	-.40*** (.13)
Includes month dummies	Yes	Yes	Yes	Yes
AR L1	.11	-.15	-.93	-.54
AR L2		-.32	-.35	
Observations	80	80	80	61
F-statistic	6.25	5.2	4.9	10.4
Adjusted R^2	.53	.47	.46	.73

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for either first or second-order autocorrelation in the error terms, as appropriate.

Table 6A
Impact of policy instruments on changes in private money rates
(weekly frequency)

Dependent variable: change in the private money market rates

	90-day Prime CP	Call loans on time (90-day)	Call loans renewal	Call loans acceptances
Discount rate change				
Contemporaneous	.11***	.11	.23	.09
	(.03)	(.08)	(.37)	(.19)
Lagged one week	.18***	.21***	-.48	.25
	(.03)	(.07)	(.35)	(.19)
Acceptance holdings (percent change)				
Lagged one week	.02	.11	-.01	.21
	(.03)	(.07)	(.34)	(.17)
Lagged two weeks	-.05*	-.15**	-.40	-.48***
	(.03)	(.07)	(.35)	(.18)
Treasury holdings (percent change)				
Lagged one week	-.12***	-.30***	-1.1**	-.73***
	(.05)	(.10)	(.48)	(.26)
Lagged two weeks	-.05	.06	.45	.08
	(.04)	(.09)	(.46)	(.24)
Gold, (percent change)				
Lagged one week	-1.3**	-2.3*	-8.9	-6.9**
	(.61)	(1.3)	(6.4)	(3.4)
Lagged two weeks	.10	-1.3	13.9**	2.1
	(.58)	(1.3)	(6.03)	(3.0)
Intercept	-.01	-.02	-.37***	-.11**
	(.01)	(.03)	(.12)	(.05)
AR1	.02	.15	-.23	-.50
Observations	334	334	334	249
F-stat	4.3	2.4	2.4	2.4
Adjusted R^2	.16	.07	.07	.10

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for first-order autocorrelation in the error terms (and we find no evidence of second order serial correlation).

Table 6B
Impact of policy instruments on changes in private money rates
(weekly frequency)

Dependent variable: change in the private money market rates

	90-day Prime CP	Call loans on time (90-day)	Call loans renewal	Call loans acceptances
Discount rate change				
Contemporaneous	.10***	.10	.09	-.03
	(.03)	(.08)	(.37)	(.21)
Lagged one week	.14***	.17**	-.76**	.16
	(.03)	(.08)	(.36)	(.21)
Acceptance rate change				
Contemporaneous	.02	.01	.88	.49*
	(.05)	(.12)	(.55)	(.29)
Lagged one week	.21***	.24**	.62	-.09
	(.05)	(.11)	(.54)	(.28)
Treasury holdings percent change				
Lagged one week	-.10**	-.28**	-.96**	-.74***
	(.05)	(.10)	(.49)	(.27)
Lagged two weeks	-.05	.06	.63	.18
	(.04)	(.10)	(.46)	(.25)
Gold, percent change				
Lagged one week	-1.4**	-2.6**	-9.3*	-7.4**
	(.59)	(1.3)	(6.3)	(3.3)
Lagged two weeks	.25	-.98	16.2**	3.9
	(.56)	(1.2)	(5.9)	(3.0)
Intercept	-.01	-.02	-.38***	-.12
	(.01)	(.03)	(.12)	(.05)
AR1	-.02	.12	-.25	-.49
Observations	334	334	334	249
F-stat	5.7	2.3	2.7	2.2
Adjusted R^2	.21	.07	.09	.08

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for first-order autocorrelation in the error terms (and we find no evidence of second order serial correlation).

Table 7
Impact of policy instruments on private money spreads

Dependent variable: level of private money market spreads

	Prime CP	Call loans on Time	Call loans Renewal	Call loans acceptances
Current acceptances to acceptances Jan 1923	-.35*** (.12)	-.53*** (.21)	-.92*** (.25)	
Current Treasuries to Treasuries Jan 1923	-.15 (0.15)	-.51 (.33)	-.83* (.50)	-.46*** (.14)
Gold to gold Jan 1923	-1.5 (1.08)	-2.2 (2.6)	-7.0*** (2.7)	-4.1*** (.99)
Ratio of the S&P stock index to its value Jan 1923	-.29* (.16)	.32 (.27)	.26 (.42)	-.10 (.16)
Ratio of the IP index to its value in Jan 1923	1.6* (.9)	5.0 (1.4)	5.9*** (2.1)	2.0** (.82)
Intercept	1.3 (1.5)	-1.8 (3.1)	2.6 (3.4)	2.5* (.1.5)
Includes month dummies	Yes	Yes	Yes	Yes
AR L1	.67	.95	.12	.22
AR L2		-.15	.48	
Observations	81	81	81	61
F-statistic	1.8	5.2	15.6	10.2
Adjusted R^2	.15	.46	.75	.70

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for either first or second-order autocorrelation in the error terms, as appropriate.

Table 8A
Impact of policy instruments on issuance of commercial paper

Dependent variable: Percent changes in commercial paper

	First stage (CP rate)	Prime CP
CP rate (instrumented)		-1.4*** (.48)
Change in the ratio of the S&P stock index to its value Jan 1923 (lagged one month)	-.35 (.27)	7.7 (7.1)
Change in the ratio of the IP index to its value in Jan 1923	.06 (1.3)	-3.4* (1.8)
FRBNY discount rate	.82*** (.06)	
Current Treasuries to Treasuries Jan 1923	-.64*** (.14)	
Current acceptances to acceptances Jan 1923	-.28** (..11)	
Gold to gold Jan 1923	-.1.6*** (.61)	
Intercept	3.6*** (.85)	12.5*** (2.5)
Includes month dummies	Yes	Yes
Observations	82	79
F-statistic/Wald χ^2	58	87.0
R^2	.92	.53

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Estimated using instrumental variables (two-stage least squares); instruments are the ratios of Fed holdings of Treasury securities, bankers' acceptances, and gold relative to reserves.

Table 8B
Impact of policy instruments on issuance of loans to brokers

Dependent variable: Percent changes in commercial paper

	First stage (call loan renewal rate)	Loans to brokers
Call loan renewal rate (instrumented)		-1.1** (.2)
Change in the ratio of the S&P stock index to its value Jan 1923 (contemporary)	.30 (.93)	40.8*** (7.2)
Change in the ratio of the S&P stock index to its value Jan 1923 (lagged one month)	1.1 (.94)	57.5*** (7.2)
Change in the ratio of the IP index to its value in Jan 1923	5.9 (4.4)	22.0 (16.1)
FRBNY discount rate	1.7*** (.20)	
Current Treasuries to Treasuries Jan 1923	-.59 (2.5)	
Current acceptances to acceptances Jan 1923	-1.0*** (.36)	
Gold to gold Jan 1923	-13.7*** (.5)	
Intercept	12.6*** (2.8)	6.4 (1.7)
Includes month dummies	Yes	Yes
Observations	82	72
F-statistic/Wald χ^2	22.9	178.9
R^2	.82	.72

Note. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Estimated using instrumental variables (two-stage least squares); instruments are the ratios of Fed holdings of Treasury securities, bankers' acceptances, and gold relative to reserves.

Table 9
Impact of policy instruments on private money spreads

Dependent variable: level and changes in private loan rates

	Levels (both dependent and independent variables)		Changes (both dependent and independent variables)	
	Prime Commercial loans	Loans on warehouse collateral	Prime Commercial loans	Loans on warehouse collateral
Discount rate (lagged one month)	.19* (.10)	.28** (.12)	.17* (.10)	.24* (.13)
Current acceptances to initial acceptances (lagged one month)	-.31** (.12)	-.17 (.12)	-.33*** (.12)	-.05 (.17)
Current Treasuries to initial Treasuries (lagged one month)	-.59*** (.20)	-.39* (.23)	-.51*** (.19)	-.08 (.29)
Current gold to initial gold (lagged one month)	-2.2 (1.4)	-1.8** (.86)	-4.1*** (1.5)	-2.9 (1.9)
Current S&P stock index to initial index level (lagged one month)	.11 (.20)	.24 (.15)	.54* (.33)	.47 (.46)
Current industrial production to initial industrial production (lagged one month)	.81 (.88)	-.05 (.66)	1.4* (.84)	2.4** (1.2)
Intercept	6.0*** (1.7)	6.0*** (1.3)	-.005 (.09)	.05 (.12)
Includes month dummies	Yes	Yes	Yes	Yes
AR L1	.87	.22	-.17	-.42
Observations	80	68	79	67
F-statistic	12.9	18.2	3.5	2.2
Adjusted R^2	.72	.81	.35	.24

Note. All independent variables are lagged one month. The symbols * and ** indicate statistical significance at the 10, 5, and 1 percent levels respectively. Standard errors in parentheses. Regressions adjust for either first or second-order autocorrelation in the error terms, as appropriate.