Interest on Reserves, Settlement, and the Effectiveness of Monetary Policy

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Abstract

Over the last several years, the Federal Reserve has conducted a series of large scale asset purchases. The effectiveness of these purchases is dependent on the monetary transmission mechanism. Federal Reserve chairman Ben Bernanke has argued that large scale assets purchase are effective because they induce portfolio reallocations that ultimately lead to changes in economic activity. Despite these claims, a large fraction of the expansion of the monetary base is held as excess reserves by commercial banks. Concurrent with the large scale asset purchases, the Federal Reserve began paying interest on reserves and enacted changes in its Payment System Risk policy that have effectively made reserves and interest-bearing assets perfect substitutes. This paper demonstrates that these policy changes have had statistically and economically significant effects on the demand for reserves and imply that the effectiveness of conventional monetary policy has been significantly weakened.

Keywords monetary policy, interest on reserves, daylight overdrafts, settlement

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1 Introduction

Over the last several years, the Federal Reserve has conducted a series of large scale asset purchases (LSAPs) as an attempt at expansionary monetary policy due to the fact that its traditional intermediate target, the federal funds rate, is close to zero. Despite the substantial increase in the monetary base resulting from these purchases, broader measures of the money supply have not expanded as rapidly. Much of the expansion of the monetary base is being held as excess reserves on the balance sheets of commercial banks. This observation raises questions about the monetary transmission mechanism and the ability of monetary policy to achieve its stated policy goals through the use of LSAPs.

The ability of the Federal Reserve to use LSAPs to achieve its policy goals is contingent upon the monetary transmission mechanism. Bernanke (2010) has argued that the way in which LSAPs influence economic variables is through portfolio reallocation. Specifically, the quantity and the mix of assets that the public holds changes when the Federal Reserve purchases assets in the open market. The subsequent portfolio reallocation ultimately results in changes in real economic activity.[1]

The intuition of the portfolio balance channel is broadly consistent with explanations of the coexistence of money and interest-bearing assets in monetary theory. The literature on monetary theory is replete with examples that differentiate money from other assets, including differences in "salableness" (Menger, 1892), recognizability (Jevons, 1875), information costs (Brunner and Meltzer, 1971; Alchian, 1977), and transaction costs (Niehans, 1978). These differences in characteristics explain the coexistence of money and interest-bearing assets as the result of the fact that money earns a non-pecuniary yield, or liquidity premium, that offsets the difference in pecuniary yields. The portfolio balance theory of the monetary transmission mechanism would seem to imply that open market purchases cause portfolio reallocation as a result of the differences in characteristics and the corresponding relative rates of return between money and other assets.

One possible reason why reserve balances at commercial banks have risen so substantially is that the Federal Reserve began paying interest on excess reserves in October 2008. This change in policy is potentially important because it changed the relative rates of return between money, as measured by bank reserves, and interest-bearing assets. In particular, the payment of interest on excess reserves resulted in equal (or at least approximately equal) yields on reserves and short-term government securities. All

[1] A more complete outline of this view can be found in Friedman and Schwartz (1963). For a more recent discussion, see Gagnon et. al (2011).

else equal, interest payments on excess reserves increase the demand to hold reserves. In addition, Williamson (forthcoming) shows that when the rates of return on money and interest-bearing assets are equal and less than the rate of time preference, open market operations are ineffective because reserves and interest-bearing assets are perfect substitutes; no portfolio rebalancing is necessary.[2]

An empirical examination of the effect of interest on reserves on the demand for reserves relative to other assets is difficult. Such analysis suffers from the typical identification problems associated with the fact that only equilibrium quantities are observable. In addition, an analysis of the effectiveness of monetary policy in a regime in which interest is paid on excess reserves is not so much concerned with the demand for reserves relative to other assets in and of itself, but rather the question of whether or not reserves and other interest-bearing assets are perfect substitutes.

In this paper, I propose a test of the proposition that reserves and bonds have become perfect substitutes. Reserves are held both to meet unexpected withdrawals and to settle payments between banks, with the latter motive being substantially more significant. Large-scale wholesale payments processed through Fedwire are done through a real-time gross settlement system. This means that payments to and from banks are credited and debited in real-time. If the bank has insufficient reserves to cover a debit in their reserve account, the bank is extended credit that is expected to be repaid by the end of the Fedwire day. Historically, a large portion of these daylight overdrafts have been backed by pledged collateral of the bank.[3] It follows that banks can hold either highly liquid, short-term debt that can be sold quickly in the event of an overdraft or banks can hold reserves sufficient to fund payments. Prior to the paying of interest on reserves, banks faced a trade-off of holding short-term debt or reserves. If the bank held reserves it would enable more efficient settlement of payments at the cost of foregone interest on short-term debt. Holding interest-bearing assets provided a positive rate of return, but overdrafts due to insufficient reserve balances were subject to fees. With the payment of interest on excess reserves, this tradeoff is eliminated because the policy change allows banks to earn interest comparable to alternative assets while avoiding fees associated with overdrafts. The market for daylight overdrafts therefore provides an opportunity to analyze the effect of the payment of interest on reserves.

To analyze the effect of interest payments on excess reserves, I estimate a demand function for the

[2]Similar arguments have been made elsewhere. See, for example, Cochrane (2011).

[3]Coleman (2002) reports that over 90% of overdrafts are backed by collateral. In 2011, the Board of Governors of the Federal Reserve began reporting the percentage of collateralized overdrafts and the percentage. Most recently, in first quarter of 2013, the percentage of collateralized overdrafts was 99%. For more on this, see below.

average daylight overdrafts through Fedwire. Since Fedwire supplies overdrafts at a fixed rate of interest, changes in overdrafts necessarily reflect changes in demand thereby avoiding identification problems associated with observing equilibrium outcomes. The estimated demand equation for overdrafts is then used to generate counterfactual outcomes to determine the effect of interest on reserves and other changes in Fedwire policy since 2008. I find that the payment of interest on reserves has had a negative and statistically significant effect on the demand for daylight overdrafts. Other changes to Fedwire policy since 2008 have also had a statistically significant effect on the demand for daylight overdrafts. The overall policy changes have had an economically significant effect as well. For example, the results suggest that without the payment of interest on excess reserves, the average demand for daylight overdrafts in the first quarter of 2013 would have been $14.9 billion. Without payments of interest on excess reserves and other Fedwire policy changes the average demand for daylight overdrafts in the first quarter of 2013 would have been $22.2 billion. Actual average daylight overdrafts during this period were only $3.27 billion. In addition, these most recent numbers might understate the magnitude of the effects of the change in policy. The counterfactual in which reserves do not earn interest suggests that the demand for daylight overdrafts would have been as much as 20 times higher during the past two years than actually observed. These results hold even when controlling for the growth rate of the supply of bank reserves. Given that the counterfactuals control for fluctuation in the number of payments and the process by which payments are settled, the large reductions in the demand for daylight overdrafts corresponds with a direct increase in the demand for reserves. The evidence suggests that the payment of interest on reserves has increased the efficiency of settling payments potentially at the expense of reducing the effectiveness of traditional monetary policy.

2 Settlement, Credit, and Reserves

Large transfers between banks are made through wholesale payment systems. Fedwire, the wholesale payment system operated by the Federal Reserve, is a real-time gross settlement payment system. In a real-time gross settlement system transfers between banks are immediate and irrevocable. In the event that the bank is holding sufficient reserves, Fedwire debits the reserve account of the payor bank and credits the reserve account of the payee. If the bank is not holding sufficient reserves for payment, Fedwire credits the reserve account of the payee and extends credit to the payor bank through a daylight

overdraft.[4] The payor bank is then expected to sell assets to eliminate the daylight overdraft before the end of the Fedwire day.[5] Given the way in which Fedwire operates, banks can either hold reserves or highly liquid debt instruments to fund payments processed through Fedwire.[6]

Traditionally, there was a trade-off for Fedwire participants between holding reserves or highly liquid assets. Banks holding reserves for the purpose of transferring funds to other banks enabled more efficient settlement of payments at the expense of foregone interest from holding highly liquid, interest-bearing assets. Until 1994, there was no cost associated with holding interest-bearing assets rather than reserves because Fedwire did not charge a fee for daylight overdrafts. In 1994, Fedwire began charging a fee equal to 24 basis points on daylight overdrafts. In 1995, the fee was raised to 36 basis points.

It is possible to think of the demand for daylight overdrafts as the demand for collateral. Prior to 2011, collateralized and uncollateralized daylight overdrafts were subject to the same fees. However, the vast majority of daylight overdrafts were by banks with posted collateral at the Federal Reserve for the purpose of access to the discount window. Coleman (2002) reports that the fraction of collaterized overdrafts to be 94% of average daylight overdrafts. In addition, banks with uncollateralized overdrafts are expected to settle that debt before the end of the Fedwire day, which implies that banks need to hold highly liquid assets in the event of an overdraft. Even when these highly liquid assets are not posted as collateral, they effectively serve the same purpose.[7]

In October 2008, the Federal Reserve began paying interest on excess reserves. In addition, in late 2008, the Board of Governors announced revisions to its Payment System Risk policy. The change in policy eliminated fees on daylight overdrafts backed by collateral and raised the fee on uncollateralized overdrafts to 50 basis points. Changes to the Payment System Risk policy took effect in the first quarter of 2011.

The changes in policy beginning in 2008 have created an environment in which bank reserves and interest-bearing assets have become approximately perfect substitutes. The elimination of the fee on collateralized daylight overdrafts implies that the cost of holding collateral and the pecuniary cost of

[4]The participants of the Fedwire system are subject to regulatory requirements to qualify for credit.

[5]The Fedwire day begins at 9:00 p.m. on the previous calendar day and continues to 6:30 p.m. of the current calendar day. The Fedwire day therefore consists of 21.5 hours. This is important for the calculation of overdraft fees. Banks have a strong incentive to eliminate overdrafts before the end of the Fedwire day because overnight overdrafts are significantly more costly than daylight overdrafts.

[6]Note that sales here would imply something like a repurchase agreement since T-bill transactions are not settled until the following business day.

[7]In fact, most collateral posted to the discount window is illiquid. Holding short term, highly-liquid assets is likely preferable to default.

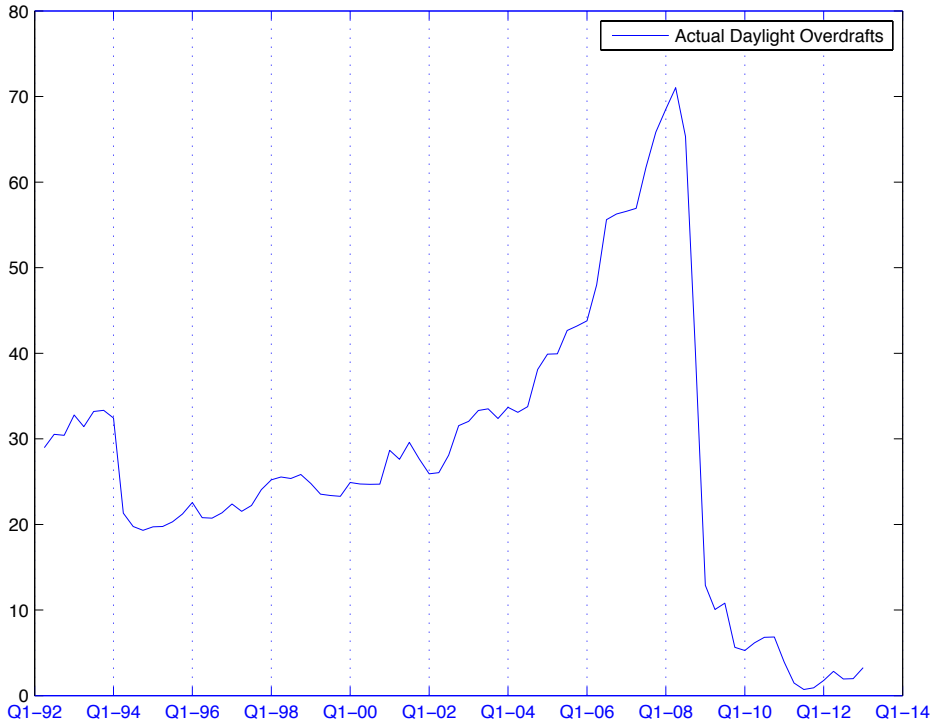

Figure 1: *Average Aggregate Daylight Overdrafts.* Source: Board of Governors, Federal Reserve System.

holding reserves is identical. In addition, the payment of interest on excess reserves equivalent to the interest rate on short-term government debt eliminates the opportunity cost of holding reserves. From the perspective of banks, these policy changes make reserves and collateral perfect substitutes for the purpose of transferring funds to other banks.

Daylight overdrafts through Fedwire are shown in Figure 1. Daylight overdrafts are defined as the average aggregate daylight overdraft during the period. Casual observation suggests that the policy changes enacted since 1994 have effected the demand for daylight overdrafts to varying degrees. For example, there are significant declines in the demand for overdrafts in the first quarter of 1994 when Fedwire began charging fees on daylight overdrafts. There is also a sharp decline in the demand for overdrafts that coincides with the payment of interest on excess reserves. Casual observation does not detect much of an effect on the demand for daylight overdrafts from the policy changes in 1995 and 2011.

One reason that the demand for overdrafts might fluctuate is due to changes in the number of payments being processed through Fedwire. Figure 2 plots the ratio of daylight overdrafts to the number

Figure 2: *Ratio of Daylight Overdrafts to Transfers.* Source: Board of Governors, Federal Reserve System.

of transfers. It is important to note that the sharp declines in 1994 and 2008 that correspond with policy changes remain evident when controlling for transfers. In addition, there now appears to be a third sharp decline that coincides with the change in the Payment System Risk policy in 2011.

The most recent policy changes are important because they are concurrent with the expansionary monetary policy adopted by the Federal Open Market Committee. As a result, it is important to examine the effects of the changes in policy on the effectiveness of monetary policy over this period. The subsequent section provides an indirect test of these effects by estimating a demand equation for daylight overdrafts through Fedwire and estimating counterfactuals.

3 An Empirical Model and Results

In order to assess the effects of the policy changes that have occurred since 2008, I estimate the following demand equation for daylight overdrafts:

$$log(RDO_t) = \alpha + \beta_1 IOR_t + \beta_2 DOF_t + \beta_3 CO_t + \beta_4 DNS_t + \varepsilon_t \quad (1)$$

where RDO is average daylight overdrafts per transfer divided by the GDP deflator, IOR is the interest rate on excess reserves, DOF is the daylight overdraft fee, CO is a dummy variable in which the value is 1 when collateralized overdrafts are not subject to an overdraft fee, and DNS is a dummy variable that takes on the value of 1 when the payment system CHIPS switched from a deferred net settlement system to a real-time settlement system.[8] Equation (1) is estimated using quarterly data from 1992:2 to 2013:1.[9] The data on daylight overdrafts and the number of transfers made through Fedwire were obtained through the Federal Reserve Board of Governors, the interest rate on excess reserves was obtained from the St. Louis Federal Reserve's FRED database, and the fees on daylight overdrafts were compiled by the author from policy announcements from the Board of Governors.

The results from estimated equation are shown in Table 1. The estimates show that the payment of interest on excess reserves has had a negative and significant effect on the demand for daylight overdrafts. Fees charged on daylight overdrafts similarly have a negative and statistically significant effect on the demand for daylight overdrafts.

In order to understand the implications of the policy changes adopted since 2008, I construct two counterfactuals using the estimated demand equation. The first counterfactual measures the demand for daylight overdrafts if the Federal Reserve had never started paying interest on excess reserves. The second counterfactual estimates the demand for daylight overdrafts under the assumption that none of the policy changes since 2008 had been enacted. These counterfactuals are shown in Figure 3 along with the actual time path of daylight overdrafts.

[8] CHIPS refers to the Clearinghouse Interbank Payment System, which is a private clearing house payment system. Prior to 2001, CHIPS was a deferred net settlement system, which meant that payment information was collected throughout the day and net payments were calculated and settled. Fedwire is a real-time gross settlement system, in which payments are processed immediately. In 2001, CHIPS switched from a deferred net settlement system to near real-time settlement. While this switch is unlikely to affect Fedwire directly, at least with regards to daylight overdrafts, this dummy variable is included to control for changes in the institutional structure of the market for clearing.

[9] Data on daylight overdrafts are available beginning in 1986. However, data on the number of transfers processed through Fedwire is only available from 1992 to the present.

Table 1: Estimation Results

Variable	Coefficient	t-stat	p-value
Constant	1.55	2.21	0.03
IOR	-1.97	-1.70	0.09
DOF	-1.52	-2.07	0.04
DNS	0.005	0.11	0.91
CO	-0.66	-1.57	0.12
RDO(-1)	0.58	3.06	0.00
R^2: 0.92			

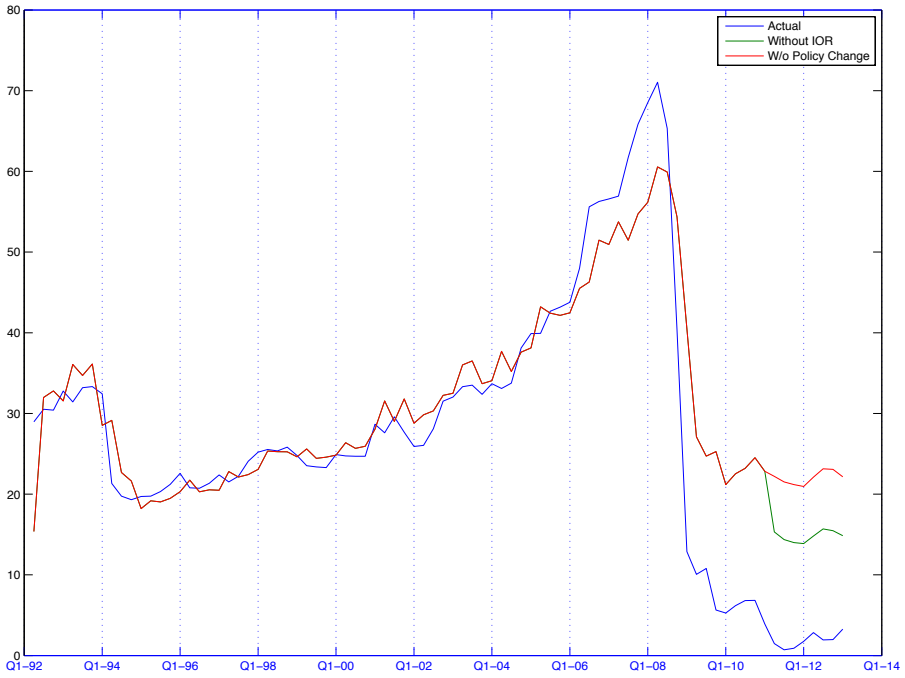

Figure 3: *Counterfactuals.* Source: Board of Governors, Federal Reserve System; Author's calculations.

As shown in Figure 3, each of the counterfactuals imply that without the changes in policy, the demand for daylight overdrafts would have been higher. Actual daylight overdrafts have fallen to as low as $710 million in the third quarter of 2011. In the most recent quarter for which data is available daylight overdrafts were $3.27 billion. In contrast, the second counterfactual implies that daylight overdrafts would never have fallen below $21 billion if policy had remained as it was prior to October 2008.

To get an idea of the drastic differences in the time paths implied by the counterfactuals, consider the following. As shown in Figure 3, the payment of interest on excess reserves had a sizable effect on the demand for daylight overdrafts. The estimated counterfactual suggests that at various points during the period from October 2008 until the present the demand for daylight overdrafts would have been 2 to 20 times greater if the Federal Reserve had not started paying interest on excess reserves. For the first quarter of 2013, the most recent period of observation, the counterfactual implies that the demand for daylight overdrafts would have been $14.9 billion whereas the actual average daily overdraft was just $3.27 billion.

The second counterfactual suggests that at various times over the period beginning in 2008 the demand for daylight overdrafts would have been 2 to 30 times higher than the actual demand if the Federal Reserve had left policy completely unchanged since October 2008. For the most recent period of observation, the counterfactual estimate of the demand for overdrafts is $22.2 billion, which is nearly 7 times the actual amount.

These results are significant because when controlling the quantity of payments reductions in the demand for daylight overdrafts correspond to a directly proportional increase in the demand for reserves. The results are therefore indicative of a very substantial increase in the demand for reserves that is a direct result of the policy changes enacted since 2008. The nature of the policy changes in conjunction with the results imply that the effectiveness of monetary policy has been weakened at the same time in which policymakers have attempted use expansionary monetary policy to meet the Federal Reserve's goals of price stability and full employment.

One potential criticism of this approach is that it ignores the quantity of bank reserves. Put differently, the Federal Reserve determines the quantity of bank reserves. Given that the Federal Reserve has conducted large scale purchases of assets, this might imply that the demand for daylight overdrafts has fallen due to the fact that the banking simply simply has more bank reserves. For example, while an individual bank can reduce their reserve balances, the banking system as a whole cannot. The quantity

Table 2: Estimation Results

Variable	Coefficient	t-stat	p-value
Constant	2.69	7.87	0.00
IOR	-6.82	-7.84	0.00
DOF	-1.96	-7.13	0.00
DNS	0.10	2.08	0.04
CO	-0.77	-3.46	0.00
Reserve Growth	-0.004	-9.66	0.00
Reserve Growth x IOR	0.02	7.87	0.00
RDO(-1)	0.19	1.88	0.06
R^2: 0.97			

of reserves is determined by the Federal Reserve. What this criticism ignores, however, is that the Federal Reserve's choice of the quantity of bank reserves is not strictly exogenous. During normal times, when the Federal Reserve is targeting the federal funds rate, the central bank can adjust the supply of bank reserves either in an attempt to change its target for the federal funds or to keep the federal funds consistent with its target given fluctuations in the demand for reserves. In the context of present policy, the Federal Reserve has conducted large scale asset purchases. To the extent that interest payments on excess reserves have increased the demand for bank reserves, it follows that the size of the asset purchases conducted by the Federal Reserves would have to be larger than they would have been in the absence of the payment of interest on reserves.

Thus, to examine the demand for daylight overdrafts in light of expansionary monetary policy, equation (1) is estimated using two additional regressors. The first additional regressor is the growth rate of bank reserves. The second additional regressor is an interaction between the growth rate of bank reserves and the interest rate paid on reserves. The addition of this latter regressor is important because the effect of supply of bank reserves on the demand for daylight overdrafts might change in an environment in which the central bank pays interest on reserves. The estimation results from the modified regression model are shown in Table 2. The t-statistics correspond to Newey-West standard errors.

As shown, the interest rate on excess reserves has a negative and statistically significant effect on the demand for daylight overdrafts. In addition, the magnitude of the coefficient is larger than that estimated in the baseline case. Consistent with intuition, the growth rate of reserves has a negative and significant effect on the demand for daylight overdrafts as well. Finally, the interaction term is also positive and statistically significant. Even taking into account the interaction term, the marginal effect of a change in

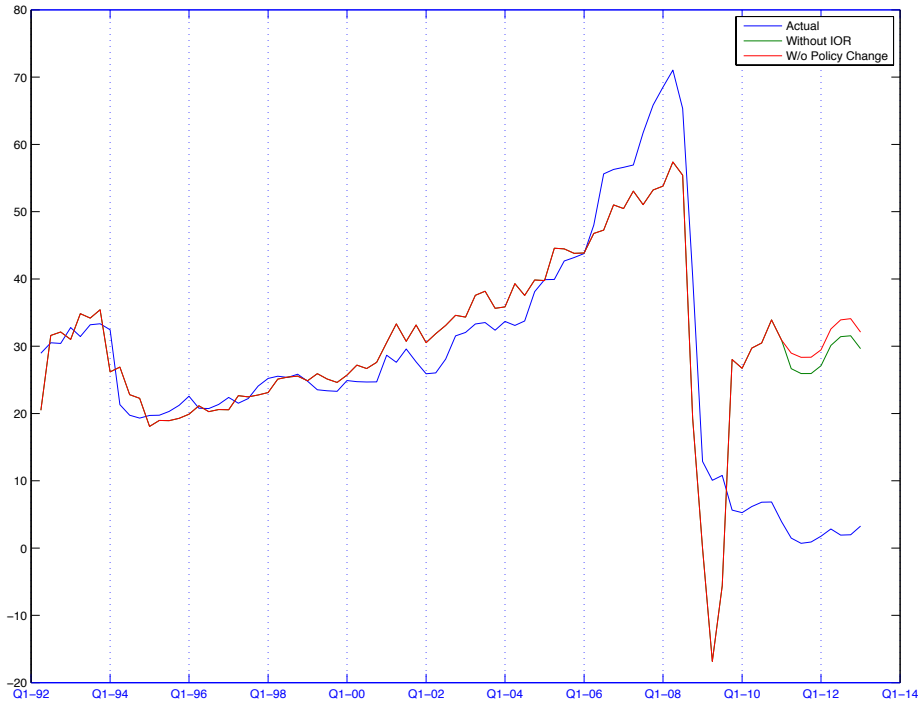

Figure 4: *Estimated Counterfactuals Using the Model with Reserve Growth* Source: Board of Governors, Federal Reserve System; Author's calculations.

the interest rate on excess reserves is of a larger magnitude than in the baseline case above.

Similar to the analysis above, one can also compute counterfactuals to estimate the demand for daylight overdrafts in the absence of interest on reserves as well as in the absence of all policy changes. These counterfactuals are shown in Figure 4. As shown, the first counterfactual suggests that the demand for daylight overdrafts would have been over 9 times higher in 2013:Q1 had the Federal Reserve not paid interest on excess reserves and as high as 36 times higher in 2011. In terms of dollar value, the predicted demand for daylight overdrafts in 2013:Q1 is $29.64 billion, whereas the actual value of daylight overdrafts was only $3.27 billion. The second counterfactual suggests that in the absence of any policy change since 2008, the demand for daylight overdrafts would have been $32.1 billion, nearly 10 times higher than that actually observed. These figures are consistent with those shown above and provide further support to the hypothesis that the payment of interest on excess reserves has enhanced the efficiency of settlement at the expense of the effectiveness of monetary policy. In fact, once one takes into account the growth of bank reserves, the effects of paying interest on reserves appears much larger than in the baseline case.

4 Implications and Conclusion

Since October 2008, there have been two major policy changes that effect the demand for daylight overdrafts through Fedwire. The first is the payment of interest on excess reserves. The second is the two-tiered pricing structure for daylight overdrafts in which uncollateralized overdrafts were subject to a higher fee and fees on collateralized overdrafts were eliminated. The demand equation estimated in this paper shows that both policy changes had a statistically significant effect on daylight overdrafts. These effects are economically significant as well. The results suggest that the demand for daylight overdrafts in the absence of interest on reserves would have been 2 to 20 times higher than the actual total over the last two years. Without all policy changes since 2008, the demand for daylight overdrafts would have been 2 to 30 times higher. Once one controls for the growth rate of bank reserves, the counterfactual estimates are even larger. These results suggest two major implications.

The first implication is that the changes in policy since 2008 have made the settlement of payments more efficient. The changes in policy have significantly reduced daylight overdrafts thereby implying that payments are being settled with reserves. This implies quicker and more efficient settlement of payments. Recent evidence by Bech et. al (forthcoming) supports this conclusion.

The second implication is that despite making the settlement of payments more efficient, the changes in policy have come at the cost of the effectiveness of traditional monetary policy. Open market operations in which the central bank exchanges reserves for interest-bearing government debt is likely ineffective in the current environment. The evidence suggests that with the payment of interest on reserves, reserves and short-term debt are near perfect substitutes. Critics might suggest that the purchase of long-term government debt and other non-traditional asset purchases by the Federal Reserve might circumvent the problems associated with traditional open market purchases of short-term government debt. However, at least in the case of purchases of long-term government debt, this would require significant segmentation in the market for U.S. government debt. Overall, the results reported in this paper suggest that the effectiveness of monetary policy has been significantly weakened in the aftermath of the policy changes that began in late 2008.

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