Monetary Transmission Without Sticky Prices

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The deregulation of banking and integration of financial markets have fundamentally changed the landscape within which central banks operate. One intellectual accommodation to this change has been a shift toward price rather than quantity targets (interest rate rather than money supply) in the formulation of monetary policy (Taylor 1999). The deeper theoretical question mooted by institutional change remains however unresolved, namely what is the role for central banks in a modern financially developed economy?

One possible answer is that real asset prices are determined (efficiently) in private exchange, so that the only thing left for a central bank to do is to provide a nominal anchor. In this view, given the real interest rate, the central bank sets the nominal interest rate (or equivalently the nominal exchange rate) to determine the path of future nominal prices, and that is all. I call this answer the Challenge of Finance, and associate it especially with the work of Fischer Black (1970).

Most economists are not content with this answer, and neither are central bankers. Possibly we are all operating under shared delusion, but experience seems to tell us that control of nominal interest rates involves some degree of control over other economically important variables as well. Just so, Woodford points to structural VAR evidence that real GDP responds to unanticipated interest rate reductions (2004, pp. 174-175). Central bankers might instead point to the way that discount policy has apparently been able to stem incipient financial crises such as the one that laid low the hedge fund Long Term Capital Management (McDonough 1998). The problem is that mere experience doesn't tell us how that control works. What is the mechanism?

One answer relies on the idea that prices are sticky in the short run, so that control of the nominal interest rate implies also control of the real interest rate, which then influences aggregate demand through a variety of channels: the wealth channel, broad credit channel, interest rate channel, and exchange rate channel (Kuttner and Mosser 2002, p. 16). I take this to be the dominant view in academic economics at the moment, and have had occasion to discuss Woodford's (2004) version of it in another venue (Mehrling 2004).

There is also a second answer that relies instead on the idea that central bank reserves are in some sense special, so that changes in their quantity might affect aggregate demand directly, perhaps by affecting bank lending through a narrow credit channel, or perhaps by affecting relative asset prices though a monetarist channel (Friedman 2002). This emphasis on a quantity channel is apparently a minority view at the present time, mainly because of the aforementioned institutional changes. I shall however have occasion to return to it in my concluding remarks.

My more immediate purpose is to explore a third possible answer that does not rely on sticky prices. Investigation is yet at a very preliminary stage, so I do not offer any formal model, much less econometric estimation of it. My starting point is with the mechanism of price formation in fixed income markets generally, and in the money markets more particularly. I rely on Marcia Stigum's account of how those markets work in practice, and build from Jack Treynor's non-equilibrium account of the economics of the dealer function (Stigum 1990, Treynor 1987).

Price Formation in Fixed Income Markets

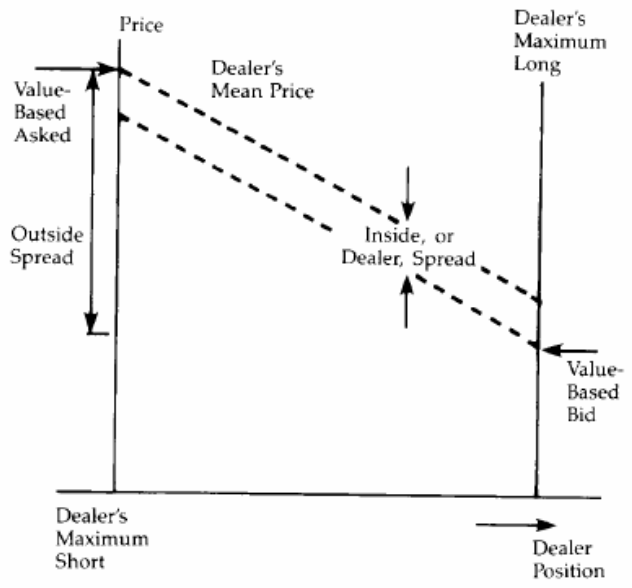
Treynor paints a picture of a market in which different agents trade for different reasons, but in which all orders to buy or sell a particular security get sent (anonymously) to a single dealer who acts as "market maker" in that security by standing ready to buy from or sell to all comers. The dealer's bid price (to buy) is less than his ask price (to sell). The spread compensates the dealer for the risk that comes from trading with people who know more than he does about the true underlying value of the security. The dealer makes money by trading with uninformed Liquidity Based Traders (LBT), but loses to everyone else. In particular, the dealer loses to Information Based Traders (IBT) who make their money by trading on information that is not yet in the price.

To protect himself from such losses, the dealer regularly changes the level of his bid and ask in an effort to avoid holding any substantial position in the security, either short or long. If positive inventories accumulate he lowers price in an attempt to lay off excess inventory, and if negative inventories accumulate he raises price in an attempt to buy in sufficient supply to cover. The key to the dealer's ability to lay off is the Value Based Trader (VBT) who takes the other side of such trades. The Value Based Trader is a market maker just like the dealer but with a much wider "outside" spread. In effect, the Value Based Trader acts as "market maker of last resort." Like the dealer, he loses to the Information Based Trader, but he makes money whenever dealers hit their position limits merely because of an accumulation of random liquidity-motivated sell or buy orders.

One consequence of all this is that the price of a security is not a single number, nor is it even the two numbers quoted by the dealer that represent the inside spread.

Rather the true price is the two numbers representing the bounds of the outside spread. Although these two numbers are not generally observable, they are nonetheless key because they represent the trading behavior of the agents who have the capital to trade in volume and so support the ultimate liquidity of the market for the security. As Treynor emphasizes, the real depth in the market comes not from the dealer but from the Value Based Trader. Indeed, it could be said that the Value Based Trader determines the price of the security, while everyone else determines the volume of trade. Figure A below is Treynor's diagrammatic representation of his theory.

Figure A Dealer's Spread and Maximum Position



Apply this framework now to the market for government securities where specialized dealers act as market makers. Although government debt comes in very many different maturities, there is really only one market because arbitrage relations

spread the excess demand or supply for any given instrument across the entire yield curve. In this market the principle source of systemic risk involves fluctuation of the future short term rate of interest. Current expectations about the future path of interest rates, combined with the current premium (if any) for exposure to such systemic risk, determine the current term structure of interest. Because of arbitrage relations, dealers are able to make deep and resilient markets without much recourse to the massive pool of capital invested in fixed income portfolios, but that capital nevertheless remains in the wings as a potential source of value based trading. (It is perhaps possible to get a sense of the outside spread relative to the inside spread by comparing the market for on-the-run bonds where the dealer spread dominates to the market for off-the-run bonds where the outside spread dominates.)

Security dealers finance their operations largely with credit, not capital, and the credit instrument they use is the repurchase agreement, which is a very short term loan (over) collateralized by the security itself.[1] When dealers need money to pay for securities they have purchased at the bid, they obtain it by borrowing, using other securities as collateral. When dealers need securities to deliver against sales at the ask, they borrow them by lending money. Securities themselves are neither created nor destroyed in this process; the expansion of the dealer's balance sheet is an expansion of credit.

Says Stigum (1990, 446): "the dealer takes in securities on one side and hangs them out on the other side at a slightly more favorable (lower) rate; or to put it the other way around, the dealer borrows money from his repo customers at one rate and lends it to

[1] Legally, the repo is constructed as a simultaneous current sale of securities and future repurchase at a higher price. Both prices are below the current market price by an amount known as the 'haircut'. The difference between the two prices is the rate of interest.

his reverse customers at a slightly higher rate. In doing so, the dealer is acting like a bank, and dealers know this well." Stigum's point is that dealers are financial intermediaries just like banks. My point is just the reverse, that banks are market makers just like security dealers.

Because the security dealer finances his operations with credit, his bid-ask spread for government securities is simultaneously a bid-ask spread for overnight money. But in the money market, the security dealer qua security dealer is a liquidity based trader, his purchases and sales of money being directed by his market making activity in government securities. A true market maker in money would have to stand ready to buy or sell money to all comers at a given bid-ask spread. Such a market maker we might call a bank.

Banks as Dealers in Liquidity

The security dealer thinks of his balance sheet as a collection of promises to deliver securities.[2] Some of these are his clients' promises to him, and some are his own promises to his clients. A bank by contrast thinks of his balance sheet as a collection of promises to deliver money. Some of these are his clients' promises to him, and some are his own promises to his clients. Just as the security dealer does not create any securities, so too the expansion of the bank's balance sheet does not create any money; it is an expansion of credit.

[2] The thinking in this section owes its origin to Garber and Weisbrod (1990).

Security Dealer		**Bank**	
Assets	Liabilities	Assets	Liabilities
Securities lent	Securities borrowed	Money lent	Money borrowed
Securities inventory	Capital	Money inventory	Capital

So far we conceptualize the bank as a market maker in overnight funds, different from a dealer in government securities only in that it operates at the very short end of the maturity spectrum. The two markets are however linked by arbitrage, and so are the two kinds of dealers. The security dealer may finance himself in part by borrowing money from the bank, and the bank may treat such money loans as part of its portfolio of bank assets. This balance sheet link turns out to be a crucially important source of liquidity in the securities market.

To understand how this works, observe that in its other balance sheet relations the dealer is borrowing securities and money (lending securities) from people who might want them back. The ultimate holders of securities and money do not intend to give up their use of the underlying asset permanently, and may with due notice decide not to extend their loans. The security dealer thus faces a daily problem of meeting its obligations at the clearing, and the bank can help.

Suppose the dealer needs money. One way to obtain it is simply to borrow it from the bank, perhaps by using securities as collateral. The balance sheet below shows how dealer and bank balance sheets both expand to finance a dealer's purchase of a bond. (Note that the balance sheet now treats a dealer promise to pay securities as an asset of the dealer because it is also a client's promise to pay money.) The dealer finances its

purchase of the bond by issuing a promise to deliver a bond in the future, a promise that amounts (from the bank's point of view) to a money loan. The bank finances its purchase of the money loan by issuing its own promise to deliver money in the future, a promise that amounts to a bank deposit.

Initial Credit Creation

Bond Holder		Dealer		Bank	
A	L	A	L	A	L
-bond		reverse	repo	repo	deposit
+deposit					

Suppose now that the dealer needs securities. One way to obtain them is to allow some of his repos with the bank to expire. In effect this involves merely reversing the process by which the dealer financed his initial purchase of the security. Reversing this process involves the bank coming up with the bond to repay the bond holder, presumably from its own security inventory. In effect, the bank helps the dealer by taking over the position abandoned by the bond holder, disgorging a bond while at the same time shrinking the quantity of outstanding deposit liabilities. Both dealer and bank balance sheets contract.

The balance sheets show what can be done, abstracting from the question of why the owners of the balance sheets find it in their interest to behave thus, but the answer to

the latter question is clear enough. Follow the inventories. A credit expansion to finance the purchase of a bond amounts to an increase in dealer bond inventory, which will cause the security dealer to reduce the quoted price of bonds. The same credit expansion stretches bank money inventories and so amounts to a relative decrease, which will cause the money dealer to raise the price of money. In both cases the consequence is an increase in the rate of interest. Both effects are reversed in the credit contraction that comes from the sale of a bond.

Banks thus provide liquidity to security dealers, but the reverse is not the case. The bank can help the security dealer with its clearing problem because it can create on its own balance sheet promises to pay money that bond holders will accept as payment. But the kind of promise that security dealers can create on their own balance sheets is no good for a bank facing its own problem at the clearing. There is thus a fundamental asymmetry in the relationship between the two kinds of dealers, indeed even a natural hierarchy. Bank credit can solve the clearing problem of security dealers, but security credit cannot solve the clearing problem faced by banks. When a bank faces a clearing problem, it needs federal funds.

Central Banks as Dealers in Liquidity

In providing liquidity to a security dealer, a bank faces one important constraint, namely the requirement to maintain its own deposits at par (one for one) in terms of current funds, which is to say in terms of federal funds.[3] In other words, banks make markets not only in overnight funds, but also in current funds. From a market-making

[3] Here I abstract from any legal requirement to hold reserves.

point of view, the former is a great deal easier than the latter. In the overnight market you can adjust the level of prices, and you can also adjust the spread between bid and ask. In the current market, neither of these degrees of freedom is available. The price is fixed at one, and the spread at zero.

The difficulty is asymmetrical. Any shift of demand toward deposits and away from federal funds (an incipient upward pressure on the relative price of deposits) can easily be absorbed simply by expanding the bank balance sheet, and building up inventories of cash. The problem comes when the shift goes the other way, and existing inventories of cash get drawn down. The incipient downward pressure on the relative price of deposits shows up as a classic bank run, in which the bank contracts its balance sheet until there is no more cash to pay out, and then closes its doors. The only way to avoid such a consequence is to raise additional cash. Since we are talking about the banking system as a whole, the only source of additional Federal Funds is the Fed.

Suppose there is a sudden shift in portfolio preferences in favor of money and against securities. (We might think of such a shift as a preference for final settlement over delayed settlement.) We have seen how the selling pressure in securities markets leads to a build up of inventories at security dealers, which dealers finance by repo borrowing from banks, and which banks finance by expanding deposits. But if the portfolio shift is truly in terms of money, banks themselves may find that their money inventories are drawn down not just relative to their expanding deposits but in absolute terms as well. They will be willing (and able) to help dealers with their own liquidity only if they can depend on receiving help with their own liquidity, which let us suppose

takes the form of discount window borrowing at the Fed. Thus we could have the following set of balance sheet relationships.

Bank Refinance

Dealer		Bank		Central Bank	
A	L	A	L	A	L
bond	repo	repo	deposit		
		Fed Funds	discount	discount	Fed Funds

In this picture, dealers are induced to expand their bond inventories by a slight fall in bond prices, and banks are induced to expand their repo lending by a slight rise in money interest. These are market prices. What is not a market price is the discount rate that the central bank charges, and the central bank can therefore use that discount rate to influence the behavior of everyone upstream. If it raises discount rates sharply, then banks will accordingly rein in their lending to dealers, and dealers will accordingly cut back their inventories. Interest rates will rise sharply and bond prices will fall sharply. Alternatively, if it lowers discount rates sharply, then the whole dealer system is thereby encouraged to absorb the portfolio shift onto its own balance sheet. Interest rates will still rise and bond prices fall, but much less.

Note that whatever stance the Fed decides to take, it may not have to expand its own balance sheet by very much. By letting it be known to banks that their liquidity needs will be met at a certain price, the central bank is in effect behaving as a Value

Based Trader, revealing the outside spread at which dealers can be sure of financing their positions. There is money to be made by market makers prepared to absorb liquidity based trading fluctuations, provided they can be sure of surviving to the end of the fluctuation. By providing that assurance, the Fed can rally the banks to its own purpose.

Indeed, the Fed has the ability to act not only in the market for current funds, but also in the market for government securities. (It is thus positioned, one might say, on both sides of the dealer system, both below it and above it in the hierarchy.) By supporting the pricing of government securities, the central bank acts a second time as a Value Based Trader revealing its outside spread. The result is that profit-maximizing dealers will again be encouraged to establish their own inside spreads, secure in the knowledge that they can always lay off excess inventories.

The central bank thus acts as a Value Based Trader, but is otherwise unlike other VBTs. For one, what gives the central bank its leverage is not its capital; the central bank is, like the dealers it supports, essentially a credit-financed operation. What gives the central bank its leverage is the fact that it is the supplier of Federal Funds, so that it can in principle expand its balance sheet with impunity. In practice however it will usually not have to do so. By revealing its outside spread, the central bank in effect offers a free option to dealers. Anyone who posts a bid only slightly higher than the central bank's, or an offer only slightly lower, can depend on trading with the central bank to reverse his trade at only a small loss if the market moves against him. It is a game of "Heads I win, Tails the central bank loses," so naturally it attracts a lot of eager participants.

Further unlike other Value Based Traders, the central bank has the freedom to choose its outside spread on criteria other than profit maximization, or even survival,

since it faces no danger of a short squeeze (at least not from internal sources). It is therefore free to establish its outside spreads in money and bonds to encourage either liquidation or accommodation, contraction of balance sheets or expansion, as it sees fit. It is free, in other words, to implement a monetary policy. The result is monetary transmission without sticky prices. It works not so much on the level of asset prices as on the bid-ask spread, which then has consequences for the level of asset prices. And because it works on liquidity directly, the consequences for the level of nominal interest rates can be sure to imply consequences also for the level of real interest rates.

Having emphasized the freedom of the central bank relative to other VBTs, it remains to note the limits of that freedom. Like all VBTs, the central bank always faces the risk of getting bagged by a true Information Based Trader who is able to trade aggressively and win over other VBTs to its conception of where the equilibrium lies. In this respect, it is important to remember that the leverage the central bank enjoys comes from the dealers who operate on credit, but the ultimate source of capital is the other VBTs. Once the price hits the central bank's outside spread, the dealers lay off to the central bank and suddenly the bank is all alone against the entire market. Indeed, the dealers who have been helping the central bank to support the market (and profiting handsomely by doing so) may well find it in their own interest to switch sides, and to control their risk by depending now on the outside spread established by the other VBTs.

The second important constraint on implementation of monetary policy is analogous to the par clearing constraint faced by individual banks. What kind of thing are federal funds? Most economists apparently think of Federal Funds as a form of fiat money, but from a higher point of view they look more like a form of credit. It is easiest

to conceptualize the central bank as a dealer if we think of it making markets in some form of international money, say gold for concreteness, so federal funds are current domestic funds but only a promise to pay current international funds. In such a world, the constraint that central banks face in making markets comes from the requirement that domestic current funds trade at par (say $35 ounce) in international current funds. More generally, of course, federal funds are a promise to pay international funds at the current rate of exchange, which may fluctuate. Interest parity arbitrage ties together interest rate differentials and exchange rate expectations, but uncertainty about the appropriate risk premium leaves room for the central bank to maneuver.

Conclusion

In a financially developed economy, with a highly developed dealer system providing deep and resilient markets, there are only three roles that the Fed can play. One, the Fed can be a Liquidity Based Trader, in the sense that its decisions to trade are guided neither by genuine information about value nor by genuine analysis about deviation of price from value. In this case, its trades should have no economic effect, even though they may have some effect on interest rates by influencing dealer inventories. Expansionary open market operations can be expected to raise the price of bonds while lowering the money rate of interest, but it is not clear that this effect has any economic significance. From the point of view of the dealer model, the significant prices are the outside spreads established by the VBTs.

Two, the Fed can try to be an Information Based Trader, in the sense that its decisions to trade are guided by information that is not yet in the price. In this case, open

market operations may have large effects by helping to get new information into the price. The question is what systematic information advantage the Fed might conceivably have over the market. Perhaps the most compelling argument for an information advantage would emphasize the Fed's knowledge of its own future policy actions. But trading is unlikely to be the best way to get that information into the price, given that the Fed has no profit motive to delay full revelation of its private information. The burgeoning literature on inflation targeting and credible policy rules suggests that a more public avenue may be more effective (Bernanke 1999). And even if the Fed were to announce a perfectly credible policy rule for nominal interest rates, the question remains why such an announcement would have any effect on real interest rates and hence real activity.

Three, the Fed can try to be a Value Based Trader, in the sense that its decisions to trade are directed by an outside spread reflecting analysis about deviation of price from value. In this case, the Fed may well set the price that matters, even if it does very little actual trading. In a world where massive volumes of capital are pursuing their own Value Based Trading strategies involving their own outside spreads, it is the innermost outside spread that matters. If the private sector outside spread is very wide, perhaps as a profit maximizing response to uncertainty, there is room for a public sector outside spread to move markets.

In this way of thinking about the world, the opportunity for the Fed to play a positive role stems ultimately from its position at the top of the natural hierarchy of money, which may be summarized in the following table.

Financial Asset	**Market Maker**	**Price of Money**
International Money		
	Central Bank	Exchange Rate
Federal Funds		
	Banking System	Par
Deposit Accounts		
	Security Dealers	Interest Rate
Securities		

The left hand column shows the hierarchy of financial assets, with the most moneylike at the top of hierarchy. The middle column shows the market makers whose function it is to knit one layer of the hierarchy together with the layer lower down. The right hand column shows the price that links the two layers quantitatively.

In suggesting that liquidity thus has a naturally hierarchical character, I find myself echoing the older view in monetary theory that emphasized the special character of central bank reserves. The dealer model suggests however that that special character is not an artificial product of state law or monopoly power, but rather arises naturally in systems of monetary exchange. And the transmission mechanism through which changes at the top of the hierarchy influence matters at the bottom operates not so much through the asset side of the bank balance sheet (the credit channel) nor through the liability side (the monetarist channel). Rather, the transmission mechanism works by influencing the capacity of the dealer system as a whole to support the depth and resilience of markets as

a whole. In this regard, the dealer model may be viewed as one way to implement the suggestion of John Hicks, in his last book, to move toward a market theory of money (Hicks 1989).

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