A Simple Model of Money, Credit and Aggregate Demand

by

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Contents

Abstract

Bernanke and Blinder (1988), by relaxing the assumption of perfect bank credit/bond substitutability, identified an independent credit multiplier for monetary policy, in addition to the conventional *IS/LM* monetary multiplier. Imperfect substitutability was thus shown unambiguously to increase the leverage of monetary policy. Here we consider an alternative characterisation of imperfect substitutability, deriving from the well-documented 'specialness' of bank lending. This results in bank loan rates becoming partially insulated from the effects of monetary policy - hence *reducing* the leverage of monetary policy.

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I Introduction

A growing body of literature has ascribed financial intermediaries a key role in the transmission mechanism of monetary policy through to the real economy [see, for example, the survey in Gertler (1988)]. This key role derives principally from banks' position as an interface between the monetary authorities and the non-bank private sector (nbps). In this paper we develop a formal analytical model of the endogenous interaction between policy-setters, the commercial banks and the nbps - in short, the transmission mechanism of monetary policy.

The textbook *IS/LM* account of the transmission mechanism of monetary policy centres exclusively on the liabilities side of banks' balance sheets and, as the counterpart to this, the assets side of the nbps' balance sheet. For example, a monetary tightening, enacted through a contraction in bank reserves, leads to a shrinking of banks' balance sheets and a re-allocation of the asset portfolio of the nbps, out of money balances and into interest-bearing bonds. A raising of the yield on bonds provides the equilibrating mechanism by which this portfolio re-allocation is brought about. As yields are bid up, real activity contracts. This channel forms the basis of the *money* view of the transmission mechanism.

This interpretation of the transmission mechanism, which rests on the proposition that bank credit and bonds are viewed as perfect substitutes by both the banks and the nbps, is clearly a restrictive one. In particular, it suppresses any endogenous behaviour on the *assets* side of banks' balance sheets, and the *liabilities* side of the nbps' balance sheet. There has been a long-pursued academic debate in the United States regarding the importance of commercial bank *credit*, in addition to, or instead of, commercial bank money, as a channel through which monetary impulses might be transmitted [see, for example, Brunner and Meltzer (1968, 1972), Friedman (1983), Bernanke and Blinder

(1988, 1992), King (1986), Romer and Romer (1990)].[1] A *credit* view of the transmission mechanism might postulate that, to the extent that bank and non-bank sources of credit are less than perfectly substitutable, the contraction in bank credit induced by a monetary tightening may cause nbps borrowing to fall by more than the initial rise in interest rates would alone cause. This would in turn serve to contract output: there will be a *credit* multiplier acting over and above the conventional *monetary* multiplier [Bernanke and Blinder (1988)]. This characterisation of the *credit* multiplier suggests that the existence of imperfect substitutability between different forms of borrowing would unambiguously increase the potency of monetary policy.

This view is, however, only one possible characterisation of imperfect substitutability. An alternative - equally plausible - one is where imperfect substitutability reflects the inability of the banks and the nbps to move costlessly between the markets for bond and bank credit. This inability to access freely the two markets for credit acts to stifle the competitive forces which help ensure that bond and bank loan rates move in line following a monetary shock. The implications of such an outcome are threefold: one theoretical, one practical and one empirical.

Theoretically, the recognition that imperfect substitutability in the credit market may result in an insulation of banks' loan rate from bond rate movements - thus *reducing* the impact of monetary policy - implies that it is no longer possible *a priori* to predict the net effect of imperfect substitutability upon the potency of monetary policy. At a practical level, parallels can be drawn between our analysis and the position of individuals and small firms in the United Kingdom, where the absence of bank credit substitutes might enable commercial banks to pass on lower official (and market) interest rates less than fully or immediately. Finally, allowing for differential movements in bank loan and bond interest rates provides us with an alternative rationalisation of Stock and Watson's (1989) empirical finding that the commercial

(1) This debate has also been long-pursued at the *policy* level; for example, in the United Kingdom dating back to the Radcliffe Report (1959).

paper/Treasury bill spread has powerful leading indicator properties with respect to output in the United States.

The paper is planned as follows. In Section 2 the broad framework of the model is outlined. Section 3 presents the model formally, outlines its solution and considers the comparative statics of a monetary shock. In Section 4 an alternative definition of imperfect substitutability is put forward. Section 5 considers how this change modifies the comparative static conclusions. Section 6 summarises and concludes.

II Framework of the Model

When modelling the transmission mechanism of monetary policy it is possible to think of two behavioural relationships, which we term, respectively, the first and the second 'black boxes'.

(i) First Black Box: The first black box defines the relationship between the monetary authorities and the commercial banking system. In this paper we are less concerned with this policy-setting aspect of the transmission mechanism. As such, we take a somewhat restrictive and simplistic view of the way in which monetary policy is operated - if one which has found almost universal acceptance within the academic literature. The restrictions we impose upon the form of monetary policy-setting are essentially twofold:

- The authorities conduct monetary policy directly with the commercial banks such as to achieve a targeted level of the monetary base. That is, the model assumes that monetary policy is operated according to a form of monetary base control.

- The nbps' holdings of cash are assumed to be zero, such that the monetary base is comprised solely of bank reserves. That is, we are assumed to be operating within a 'pure chequing' economy.

Both assumptions are clearly restrictive. Taken together, however, they offer the advantage not only of simplicity, but also that the effects of monetary

policy are felt directly and exclusively through their impact upon the banking sector, and specifically bank reserves. As such, the restrictions are useful when defining the endogenous role of banks in transmitting monetary impulses to the real economy - our principal aim in the paper.

The disadvantages these restrictions offer are equally apparent. Taken together, the two restrictions are not an accurate characterisation of how monetary policy is, in practice, operated. In particular, it is the opportunity cost of holding base money - short-term interest rates - rather than its quantity, which is typically employed as the exogenous tool of monetary policy. The model presented here should be viewed as an attempt to flesh out the endogenous interactions between banks and the nbps, rather than a fully-defined model of the transmission mechanism of monetary policy.

(ii) Second Black Box: This defines the endogenous interaction between the commercial banks and the nbps. Such an interaction has been extensively studied as a microeconomic matter. But much less attention has been devoted to considering how such microeconomic behaviour aggregates into an explicitly macroeconomic framework.(2) At least part of the reason for this is that the dominant macroeconomic paradigm - *IS/LM* analysis - fails to accommodate a well-defined endogenous role for banks or bank credit. Here we take the textbook IS/LM framework and extend it to define an explicitly endogenous role for commercial banks in general, and bank credit in particular.

The *IS/LM* framework continues to attract widespread academic approbation as a characterisation of macroeconomic behaviour over the short/medium run. While not explicitly accommodative of price effects, sticky, as against rigidly fixed, prices could easily be accommodated within the existing framework [see, for example, Blinder (1987)]. Of the models developed in the literature, ours follows most closely that of Bernanke and Blinder (1988) and Kashyap, Stein and Wilcox (1991). The framework is used to consider the elasticity restrictions which determine the relative importance of the monetary and credit

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(2) Obvious exceptions here would be Patinkin (1965), and the series of papers by Stiglitz and various collaborators [summarised in Stiglitz (1992)].

multipliers. This enables us to draw points of tangency between the micro and macro literatures on the dynamics of the credit and banking markets; in particular with respect to the role of information asymmetries, which are typically given prominence in the former of these literatures [see, for example, Blinder and Stiglitz (1983), Fama (1985)].

III The Model: the Comparative Statics of a Monetary Shock

The conventional *IS/LM* model is defined over three endogenous markets: bonds, money and goods; and two endogenous sectors: the monetary authorities and the nbps. Within such a framework, the nbps has available two assets (its bond and money holdings) and one liability (the bonds it issues). In this simple model, financial intermediaries play no *endogenous* role in the transmission mechanism of monetary policy: inside and outside money are indistinguishable on the liabilities side of banks' balance sheets, as are bank credit and bonds on the banks' assets side. The conventional *IS/LM* model, in effect, assumes perfect substitutability both between inside and outside money and between bank credit and bonds. The output effects associated with a monetary perturbation are invariant to the inside/outside money mix (of bank liabilities) and the bonds/credit mix (of bank assets). The latter result is precisely the Modigliani/Miller irrelevance theorem. In such a world of perfect asset and/or liability substitutability, inside money and credit can be suppressed from the model without loss of generality. And thus banks and banking behaviour can themselves be suppressed. It is the relaxation of the substitutability restriction on bank credit which is our principal concern here: introducing an endogenously determined, and less than perfectly substitutable, credit market to the *IS/LM* framework. This extended model is defined by equations (1)-(10) below.

Sectoral Balance Sheets

(1)	NBPS	$D^S \equiv L^d + B^S$	
(2)	Banks	$B^d + L^S + (1/m)\, D^S \equiv D^d + R$	
(3)	Central Bank	$R \equiv (1/m)\, D^S$	

Credit Market

(4)	Loan demand	$L^d = L^d(i,\rho,y)$	$L^d_i > 0, L^d_\rho < 0,\ L^d_y > 0$
(5)	Loan supply	$L^S = L^S(i,\rho,R)$	$L^S_i < 0,\ L^S_\rho > 0,\ L^S_R > 0$

Deposit Market

(6)	Deposit demand	$D^d = m\,R$	$m > 0$
(7)	Deposit supply	$D^S = D^S(i,\rho,y)$	$D^S_i < 0,\ D^S_\rho < 0, D^S_y > 0$

Goods Market

(8)		$y = y(i,\rho)$	$y_i < 0,\ y_\rho < 0$

(Residual) Bond Market

(9)	Bond demand	$B^d = B^d(i,\rho,R)$	$B^d_i > 0, B^d_\rho < 0, B^d_R > 0$
(10)	Net bond issue	$B^S = B^S(i,\rho,y)$	$B^S_i < 0, B^S_\rho \gtrless 0, B^S_y \gtrless 0$

where:

$L^d, L^S, D^d, D^S, B^d, B^S$: demand and supply schedules for bank loans, bank deposits and bonds respectively

y : level of income

R : level of borrowed reserves

m : inverse of the legal reserve requirement

i, ρ : bond and bank loan interest rates respectively

X_z : denotes the partial derivative of X with respect to z

The model is now defined across *four* markets: credit, deposits, bonds and goods; and *three* sectors: commercial banks, the nbps, and the central bank. The balance sheets of the three sectors are given by equations **(1)**-**(3)**. The banking sector supplies loans to the nbps and invests in nbps bonds. As the liability counterpart to these investments, the banks hold deposits supplied by the nbps. In addition, the banks borrow reserves from the central bank in order to satisfy a legal reserve requirement, which is levied as a constant proportion of the banks' deposits. The borrowed reserves liability exactly matches the reserves requirement asset.

The nbps' liabilities comprise their borrowings from the banking sector and their *net* issue of bonds. These liabilities are balanced by their bank deposits. The central bank lends reserves to the commercial banking system, which are then used by commercial banks to meet their legal reserve requirement. The monetary authorities behave exogenously in the model; there is no reaction function. The public sector is suppressed from the model; bonds are only issued by the nbps and government expenditure is thus set to zero.

The operation of monetary policy in the model is simplistic: the central bank expands or contracts its balance sheet - and thus, via the reserve requirement, the balance sheet of the commercial banks - by injecting or withdrawing reserves. For example, when wanting to expand its balance sheet, the central bank simply lends out (as an asset) further reserves to the commercial banks. These reserves are always willingly held by the commercial banks (see below). The central bank's liability counterpart to these increased borrowed reserves (that is, by definition, the change in base money) is the increase in the legal reserve requirement levied on the commercial banks' newly created deposits.

Banks are assumed to pay zero interest on deposits. Hence, assuming that the banks' investment in either loans or bonds earns a non-zero return, the banks always have an incentive to expand their balance sheet up to the maximum level permitted by the quantity of reserves supplied by the central bank and the legal reserve requirement. This is reflected in the banks' demand for deposits (and hence their optimal balance sheet size) being written as a simple money multiple of the level of reserves [equation **(6)**].

Owing to the balance sheet constraint, the banks' supply of loans, (5), and demand for bonds, (9), will depend positively on the level of reserves supplied by the central bank. In addition, the banks' supply of loans (demand for bonds) is assumed to depend positively (negatively) on the loan rate and negatively (positively) upon the return on bonds, the alternative asset in the banks' portfolio. Importantly, the banks' portfolio preferences are taken to be non-degenerate: L^S and B^d are strictly positive. This assumption rests on the banks viewing bonds and bank credit as imperfect substitutes in their asset portfolio. This supposition is supported by a number of factors. First, the risk characteristics of loans and bonds are likely to differ since they are held (or issued) by different sets of nbps agents. As such, it may be optimal for the banks to hold both sets of assets as a means of risk diversification. Second, the secondary market in securitised bank loans is much less well developed than that in bonds; bank loans, unlike bonds, can be likened to a contractual arrangement between two parties which cannot be terminated instantaneously [Bernanke and Blinder (1992)] (see also below).

The nbps' demand for money (deposit supply) schedule, (7), is slightly unusual. In the absence of government bonds, the nbps does not have any alternative instruments - in net terms - in its asset portfolio. Hence it is not immediately clear what is the opportunity cost of the nbps' money holdings. Given the absence of net wealth, the opportunity cost of the nbps' deposits must, however, be reflected in the cost of their borrowings from the banking sector, either via bank credit or via bank holdings of the bonds they issue. By reducing their deposits, the nbps can reduce its outstanding debts, thus contracting the size of its (and the banks') balance sheet.(3) Hence, the nbps' demand for money depends inversely on the two borrowing rates: the higher the interest rates charged on borrowing, the greater the incentive to run down

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(3) Strictly, the opportunity cost is given by the interest rate *differential* between borrowing and deposit rates. However, given that the deposit rate is zero, this cost can be written simply in terms of the two borrowing rates.

money balances to reduce (more costly) gross liabilities.(4) As is conventional, money demand depends positively on income, reflecting a transactions motive.

The nbps' demand for bank loans function, **(4)**, is more straightforward. The nbps is modelled as holding non-degenerate preferences across loans and bonds as a means of borrowing. This reflects an assumption that the set of agents demanding loans are heterogeneous in respect of their size, risk characteristics *etc*, and thus it is optimal for different agents to borrow in different ways conditional upon these characteristics. Loan demand depends negatively upon the own-rate and positively on the cross (bond) rate.

Agents' expenditures are financed from their *net* borrowings, either by increasing net bond issues, or by borrowing directly from the banks. Hence, the nbps' demand for goods, **(8)**, is defined in terms of the two borrowing rates i and ρ. This demand schedule, given the assumption of a horizontal aggregate supply curve, defines goods market equilibrium. By Walras' Law, equilibrium in the bond market, equations **(9)** and **(10)**, is derived - by residual - from the other equations in the system.(5)

Note that the treatment of the behavioural equations in the model is as general as possible. We posit reduced-form demand and supply relationships, none of which impose any explicit microeconomic restrictions upon underlying behaviour. This allows us to treat the elasticity terms in these relationships as 'free' parameters.

The general equilibrium of the model is solved for the seven endogenous variables (L^d, L^s, D^d, D^s, y, i *and* ρ) by imposing credit, deposit and output market equilibrium, together with the condition that the banks' adding-up

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(4) In this respect, our model differs from that of Bernanke and Blinder (1988) in which money demand is assumed to depend upon only the bond rate. Such a formulation would be logically inconsistent in our model, where the nbps cannot hold net bond assets.

(5) The sign ambiguities on the derivatives of the bond function, **(10)**, derive simply from the fact that it is agents' *net* bond issuance which is being determined.

constraint is satisfied. When the model is solved in output, this enables us to outline the comparative statics of a monetary policy shock. These can be shown to take the form:

(11)

$$\frac{\delta y}{\delta R} = \frac{\left[y_i m(L_\rho^s - L_\rho^d) + y_\rho m(L_i^d - L_i^s) + L_R^s (y_i D_\rho^s - y_\rho D_i^s) \right]}{\left[y_i D_y^s (L_\rho^s - L_\rho^d) + y_\rho D_y^s (L_i^d - L_i^s) + D_i^s (L_\rho^s - L_\rho^d) + D_\rho^s (L_i^d - L_i^s) + L_y^d (y_i D_\rho^s - y_\rho D_i^s) \right]}$$

As under conventional *IS/LM*, an expansionary monetary policy will (for plausible parameter values) increase the level of income: $\delta y/\delta R > 0$. Consider the transmission mechanism underlying this comparative static result. Suppose the central bank induced a monetary easing by increasing the supply of reserves. The banking sector will invest the additional deposits resulting from this easing by increasing both its supply of bank credit and by demanding more bonds. This increased investment will, in turn, cause both the bank loan rate and the bond rate to fall. This in turn stimulates an expansion in the equilibrium level of income.

The expansionary impact of monetary policy is, however, partially offset by a number of second-round effects. In the deposit market, the fall in the bank loan rate implies that the reduction in the bond rate is limited by the need to ensure money-market equilibrium. Similarly, the increase in the supply of deposits associated with the rise in income will further restrict the fall in the bond rate. With respect to the credit market, the rise in income will also temper the reduction in the bank loan rate by raising the nbps' demand for loans.

An alternative representation of the transmission mechanism can be achieved by reparameterising the relationships into *IS/LM* space. This is done by substituting the equilibrium bank loan rate - given by the equation of credit demands and supplies - into the goods *(IS)* and deposit *(LM)* market equilibrium conditions. This gives a pair of credit-augmented *IS* and *LM*

curves respectively. Suitably differentiated, we can write the comparative static of a monetary shock as:

$$(12) \quad \frac{\delta y}{\delta R} = \frac{\left[\left. \frac{di}{dR} \right|_{LM} - \left. \frac{di}{dR} \right|_{IS} \right]}{\left[- \left. \frac{di}{dy} \right|_{LM} + \left. \frac{di}{dy} \right|_{IS} \right]} > 0$$

where $|_{IS\,(LM)}$ denotes the derivative of the *IS (LM)* schedule.

The first terms in the numerator and denominator of **(12)** define the (broadly) conventional *monetary* multiplier following a reserves expansion, as the *LM* curve is shifted to the right. The second terms in the numerator and denominator define the less conventional *credit* multiplier; that is, the rightward shift in the *IS* curve following a reserves expansion. The identification of a credit multiplier is the largest single difference between the conventional *IS/LM* model and the credit-augmented framework outlined here: both the *IS* and *LM* schedules are shifted by monetary policy. The shift in the *IS* curve occurs because monetary policy alters the size of the banks' balance sheets and hence influences the bank loan rate, as well as the bond rate. The effects of a monetary expansion are outlined in Figure 1. An increase in the supply of borrowed reserves leads both the *IS* and *LM* schedules to shift to the right, causing the level of income to increase from y to y^*. The credit multiplier is hence equal to $y\text{-}y_1$, and the monetary multiplier $y_1\text{-}y^*$. The offsetting second-round effects, discussed above, reduce the extent of this increase by limiting the size of the shift in the *LM* schedule, and by steepening the slope of both the *LM* and *IS* schedules.(6)

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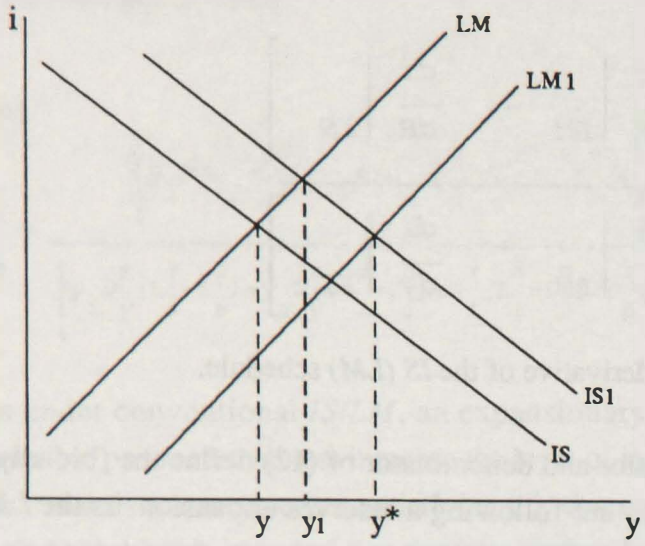
(6) The functions used in the diagram have been linearised for ease of exposition.

Figure 1: The effect of a monetary expansion



IV Defining Imperfect Substitutability

The implications of introducing an explicit credit market into the conventional *IS/LM* framework depend upon the nature of the imperfect substitutability assumed between bank credit and bonds. This can be considered in terms of the elasticities of the loan demand and supply schedules. For example, the limiting case assumed by conventional *IS/LM* requires that bank credit and bonds are perfect substitutes, either as liabilities of the nbps ($L^{d}_{\rho \to -\infty}$), or as assets of the banking sector ($L^{S}_{\rho \to \infty}$). These are the special assumptions implicit in the *money only* view of the transmission mechanism [Bernanke and Blinder (1988)].

The existing literature on the role of the credit market in the transmission of monetary shocks has concentrated exclusively on the implications of imperfect substitutability for the *absolute* size of these price elasticities [Bernanke and Blinder (1988), Kashyap, Stein and Wilcox (1991)]. The lower the degree of bond-credit substitutability, the lower the absolute size of these elasticities - and, from **(11)**, the greater the potency of monetary policy.

This characterisation of imperfect substitutability is, however, not all-encompassing. The microeconomic literature stressing the 'special' nature of bank lending has often ascribed this specialness to the informational advantages which banks have over other financial intermediaries in respect of assessing borrowers' creditworthiness [see, for example, Blinder and Stiglitz (1983), Fama (1985), Kashyap, Stein and Wilcox (1991), Friedman and Kuttner (1991), Bernanke and Blinder (1992)]. In particular, this enables banks to obviate some of the moral hazard and adverse selection problems otherwise associated with supplying credit. The comparative advantage which the banks have in screening and monitoring loans implies that it is often profitable for banks to lend to customers who might otherwise find it difficult to borrow in the bond market for reasons of creditworthiness, size *etc*. As a result, the marginal cost of accessing the bank and bond markets as a source of additional finance (in the case of the nbps), or as markets in which to invest their asset portfolios (in the case of banks), may differ.

The differing costs of accessing the bank and bond markets has implications for the *relative* size of the own and cross-price elasticities, as well as their *absolute* size. Taking the simplest case, if the marginal costs of accessing the two markets are equal, then in the two-good world in which we are working - and under conventional demand theory assumptions - we can write:

$$L_{\rho}^{d} = -L_{i}^{d}$$

$$L_{\rho}^{s} = -L_{i}^{s}$$

These restrictions are simply equivalent to imposing homogeneity upon the loan supply and demand schedules [(**4**) and (**5**)]: credit demands and supplies can be defined in terms of the *relative* price of bank versus bond credit.

But the recognition that the cost of accessing the two markets may differ causes this homogeneity condition to be violated. To see this, consider first the nbps. For agents who are small or whose creditworthiness - in the absence of banking information - is otherwise unobservable, the marginal cost of borrowing from the bond market is likely to be high. This reflects the lumpy

costs associated with providing the market with sufficient information to facilitate an assessment of their riskiness. The informational asymmetry which exists between banks and other suppliers of credit implies that, for some sectors of the economy, there is a (screening and monitoring) cost disadvantage associated with borrowing on the open market rather than from banks.

In terms of our model, this informational asymmetry means that for some sectors of the nbps, small changes in the bond interest rate will have little impact upon their (marginal) demand for funds, relative to movements in the loan interest rate. As a limiting case, consider the loan demand schedule of a small individual firm. For a certain range of relative movements in the bond rate, the lump sum costs associated with issuing bonds may imply that it is optimal for the firm not to enter the bond market when raising marginal funds. Over this range of movements, the cross-price elasticity (L_i^d) is zero. The elasticity parameter will only take a non-zero value when the bond rate moves outside this range. Aggregating across all private-sector agents, each with different 'ranges of indifference', suggests the following inequality for the nbps as a whole:

$$|L_p^d| > |L_i^d|$$

As well as affecting the absolute size of L_p^d and L_i^d, imperfect substitution may also result in the cross-price elasticity of loan demand lying below the own-price elasticity.

Consider now the position of banks. The elasticity restrictions involved here are more complex; there is no off-the-shelf model of banking behaviour upon which we can draw. More generally, it is difficult to quantify unambiguously, on theoretical grounds, the relative sizes of the cross and own-price elasticities. The behavioural characteristics of banks assumed here can be thought of as a direct analogue of the earlier characterisation of the nbps.(7) The

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(7) The comparative static conclusions which follow would still hold if the banking sector was ignored (ie homogeneity was imposed upon the loan supply schedule), and the analysis was considered purely from a nbps perspective.

informational advantages which banks have over other suppliers of credit provides the banks with economies of scale and scope when screening and monitoring loans (relative to screening and monitoring bonds). As a result, loans are likely to be the preferred habitat of banks when allocating their asset portfolio. This follows both because of the comparatively high (and lumpy) costs associated with screening and monitoring bonds, and, relatedly, because there is greater inherent uncertainty when investing in bonds (due to informational factors). The latter effect means that the signals provided by movements in the bond rate may typically be acted upon less by banks because they are intrinsically noisier and less certain: banks are less well placed to gauge whether bond rate movements are the result of demand or supply shifts, or changes in the underlying riskiness of bond market borrowers.

A further factor increasing the sensitivity of loan supply to movements in the loan rate (relative to the bond rate) is the non-interest income associated with an increase in the banks' lending base. Examples here would include charges for various transactions services, financial advice and other financial products (such as insurance, pensions, life assurance and estate agency). These subsidiary benefits will reduce the sensitivity of banks' loan supply to yield movements in the bond market. That is, bank loan supply may also be subject to a 'range of indifference', reflecting the (lumpy) subsidiary benefits associated with investing in the credit market. Hence, the inequality of the marginal benefits from investing in loans rather than bonds for the banking sector implies that the own-price elasticity may exceed the cross-price elasticity of loan supply:

$$|L_{\rho}^{S}| > |L_{i}^{S}|$$

These inequalities raise a number of issues concerning the transmission mechanism - and overall potency - of monetary policy. This follows from their impact upon the behaviour of the banks' loan rate.

V Dynamics of the Bank Loan Rate

The dynamic behaviour of the bank loan rate following a monetary shock in the general equilibrium of the model can be shown to take the following form:

$$(13)\quad \frac{\delta\rho}{\delta i} = \frac{\left\{m\left[(L_i^d - L_i^s) + L_y^d\, y_i\right]\right\} - \left\{L_R^s\left[D_i^s + D_y^s\, y_i\right]\right\}}{\left\{m\left[(L_\rho^s - L_\rho^d) - L_y^d\, y_\rho\right]\right\} + \left\{L_R^s\left[D_\rho^s + D_y^s\, y_\rho\right]\right\}}$$

The set of terms in the first parentheses (in both the numerator and denominator) reflect the influences equilibrating the credit market following a shock to the bond rate. The terms in the second set of parentheses ensure equilibrium in the deposit market is also maintained following a monetary shock.

The variety of second-round effects acting upon the two interest rates in general equilibrium means that it is not possible to sign this relationship *a priori*. This ambiguity is illustrated in Figure 1. The figure is drawn on the assumption that a monetary expansion reduces both the bond rate and the bank loan rate. However, it can be seen that if the shift in the *IS* curve following the monetary shock is relatively large, and/or the *IS* and *LM* curves are comparatively steep, it is possible that the bond rate may be forced to *rise* following a reserves expansion: the bond and bank loan interest rates may move in opposite directions.

However, if we assume - for expositional purposes - that the various second-round effects associated with a monetary shock tend to zero, (13) collapses to:

$$(13') \quad \frac{\delta \rho}{\delta i} = \frac{L_i^d - L_i^s}{L_\rho^s - L_\rho^d} > 0$$

Abstracting from second-round effects, the size of $\delta \rho / \delta i$ depends only upon the *relative* size of the own and cross-price elasticities of the loan demand and supply schedules. This simplified (partial equilibrium) expression shows the effects on the relative movements in the two interest rates of a change in the banks' (and nbps') balance sheet. If the ease of accessing the bond and bank credit markets is equal - homogeneity can be imposed upon the loan demand and supply schedules - this simplified expression suggests that the bank loan rate will move in line with the bond rate: $\delta \rho / \delta i = 1$. This is true irrespective of the degree of imperfect substitutability as measured by the absolute value of the price elasticities. If, however, imperfect substitutability between bank credit and bonds stems instead from the higher marginal cost of accessing the bond market - the homogeneity restriction is violated - equation **(13')** indicates that $\delta \rho / \delta i < 1$. That is, the bank loan rate becomes insulated from movements in the (auction market) bond rate.

The identification of an independent credit multiplier, which augments the conventional monetary multiplier, is the key comparative static finding in Bernanke and Blinder's augmented *IS/LM* model [Bernanke and Blinder (1988)]. As outlined in the introduction, it follows logically from this model that imperfect substitutability - as defined by the absolute value of the own-price elasticities of credit demand and supply - serves unambiguously to increase the potency of monetary policy. In addition to the increase in interest rates following a monetary contraction, which chokes off interest sensitive expenditure (the *monetary* multiplier), the associated reduction in the supply of bank loans further reduces the quantity of borrowing since agents cannot perfectly substitute into alternative sources of finance (the *credit* multiplier).

This result need not hold, however, if imperfect substitutability between bonds and bank credit derives instead from the inequality of costs associated with accessing the two markets. The resulting insulation of the loan rate will act to

reduce the aggregate movement in interest rates following a monetary shock, and hence will reduce the size of the *monetary* and *credit* multipliers. In contrast to the standard result in the theoretical literature, the overall effect of imperfect substitutability upon the potency of monetary policy is now ambiguous.

This ambiguity can be illustrated more formally by comparing the comparative statics of a monetary perturbation in the augmented *IS/LM* model developed here, with those from the conventional (money only) analogue of this model. This type of exercise, outlined in the Appendix, highlights the exact restrictions under which imperfect substitutability either increases or decreases the potency of monetary policy. In particular, it is clear from this analysis that the larger the extent to which the cross-price elasticity of the loan demand and/or supply schedule lies below the own-price elasticity, the greater the potential for imperfect substitutability to reduce the potency of monetary policy.

From a policy perspective, the above comparative statics can be used to provide an interpretation of one potentially important channel in the domestic transmission mechanism during the most recent recession in the United Kingdom. It is likely that some sections of the nbps - persons and small companies - are less able to access alternative sources of finance to bank credit than others - for example, large firms. This enables the banking sector to exercise a degree of leverage in the credit market over the former set of agents: the competitive forces ensuring an equilibration of relative loan and bond rate movements are lessened. As a result, the bank loan rate, relative to competitive auction market interest rates such as the bond rate, may become partially insulated from the effects of monetary policy - precisely the result reached from our model. This account may, therefore, provide a rationalisation for the commonly-expressed view that monetary policy adjustments may be akin to 'pushing on a string' for some sectors, or at some stages in the cycle. In the United Kingdom there have been claims that the rates charged by banks on their lending to small businesses were not adjusted commensurately as official and market interest rates were reduced progressively between 1990 and 1992. Two studies undertaken by the Bank of England, published in 1991 and

1993, found little evidence for these claims, although it was evident that fees and charges were being implemented more thoroughly than previously.

Lastly, at an empirical level, the recognition that imperfect substitutability between bank credit and bonds may insulate the bank loan rate from the effects of monetary policy may provide an alternative rationalisation of the leading indicator properties of the commercial paper/Treasury bill spread observed in the United States [Friedman and Kuttner (1991), Stock and Watson (1989)]. For example, if the loan rate initially lies below the bond rate, our framework suggests that the spread between bond and loan rates would rise in response to a monetary tightening and fall following a monetary easing. To the extent that the Treasury bill rate proxies - however imperfectly - bank lending rates, the indicator properties of the spread can be formally linked to the transmission mechanism of monetary policy via our model.(8)

VI Conclusions and Extensions

This paper has developed a formal analytical model of the endogenous interaction between policy-setters, the commercial banks and the nbps. The framework is used to analyse the implications of an alternative characterisation of imperfect substitutability to that typically defined. The upshot is a potential insulation of bank loan rates from monetary policy adjustments and a reversal of the standard result in the literature that imperfect substitutability unambiguously enhances the effectiveness of monetary policy.

A number of directions for future research suggest themselves. At the theoretical level, generalising our model such as to encompass the nbps' holdings of cash (and the widening differences between these cash holdings and deposits under the forces of financial liberalisation), and a policy rule which is implemented via interest rates (rather than the monetary base) would

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(8) An explanation of the predictive power of the spread based upon the transmission mechanism of monetary policy has also been put forward by Kashyap, Stein and Wilcox (1991), Friedman and Kuttner (1991), Bernanke (1990). The mechanism linking the interest rate spread to monetary policy is, however, typically different to the one outlined here.

appear to be fruitful next stages. From an empirical perspective, our framework clearly has testable implications for both financial quantities and financial prices. That the latter are often unobservable at the margin suggests that a preferred approach may concentrate upon financial quantities. Indeed, it may be most useful to decompose sectorally these money and credit data, since it is at the sectoral level where differences in degrees of liability/asset substitutability are likely to be greatest.

Bibliography

Baltensperger, E (1980), 'Alternative Approaches to the Theory of the Banking Firm', *Journal of Monetary Economics*, 6, 1-37.

Bernanke, B S (1990), 'On the Predictive Power of Interest Rates and Interest Rate Spreads', *New England Economic Review*, Nov/Dec, 51-68.

Bernanke, B S and A S Blinder (1988), 'Credit, Money, and Aggregate Demand', *American Economic Review, Papers and Proceedings*, 435-9.

Bernanke, B S and A S Blinder (1992), 'Federal Funds Rate and the Channels of Monetary Transmission', *American Economic Review*, 82, 901-21.

Blinder, A (1987), 'Credit Rationing and Effective Supply Failures', *Economic Journal*, 97, 327-52.

Blinder, A and J E Stiglitz (1983), 'Money, Credit Constraints, and Economic Activity', *American Economic Review*, 73, 297-302.

Brunner, K and A H Meltzer (1968), 'Liquidity Traps for Money, Bank Credit, and Interest Rates', *Journal of Political Economy*, 1-37.

Brunner, K and A H Meltzer (1972), 'Money, Debt and Economic Activity', *Journal of Political Economy*, 80, 951-77.

Clower, R W (1967), 'A Reconsideration of the Microfoundations of Monetary Theory', *Western Economic Journal*, 6, 1-9.

Dixit, A (1987), 'Entry and Exit Decisions Under Uncertainty', *mimeo*, Princeton University.

Fama, E F (1985), 'What's different about banks?', *Journal of Monetary Economics*, 15, 29-39.

Friedman, B M (1983), 'The Roles of Money and Credit in Macroeconomic Analysis', in J Tobin (ed.), *Macroeconomics, Prices, and Quantities*, Basil Blackwell.

Friedman, B M and K N Kuttner (1991), 'Why does the paper-bill spread predict real economic activity?', *mimeo*.

Gertler, M (1988), 'Financial Structure and Aggregate Economic Activity: An Overview', *Journal of Money, Credit and Banking*, 20, 559-89.

Greenwald, B and J E Stiglitz (1991), 'Towards a Reformulation of Monetary Theory', *mimeo.*

Greenwald, B, Stiglitz, J E and A M Weiss (1984), 'Informational Imperfections and Macroeconomic Fluctuations', *American Economic Review, Papers and Proceedings*, 74, 194-99.

Jackman, R and J Sutton (1982), 'Imperfect Capital Markets and the Monetarist Black Box: liquidity constraints, inflation, and the asymmetric effects of interest rate policy', *Economic Journal*, 92, 108-28.

Kashyap, A K, Stein, J C and D W Wilcox (1991), 'Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance', *mimeo*, Board of Governors of the Federal Reserve System.

King, S R (1986), 'Monetary Transmission: Through Bank Loans or Bank Liabilities?', *Journal of Money, Credit and Banking*, 18, 290-303.

***Report of the Radcliffe Committee on the Working of the Monetary System* (1959).**

Patinkin, D (1965), *Money, Interest, and Prices*. Second edition, New York: Harper and Row.

Romer, C D and D H Romer (1990), 'New Evidence on the Monetary Transmission Mechanism', *Brookings Papers on Economic Activity*, 149-213.

Santomero, A M (1984), 'Modelling the Banking Firm: A Survey', *Journal of Money, Credit and Banking*, 16, 577-612.

Stiglitz, J E (1992), 'Capital Markets and Economic Fluctuations in Capitalist Economies', *European Economic Review*, 36, 269-306.

Stiglitz, J E and A M Weiss (1981), 'Credit Rationing in Markets with Incomplete Information', *American Economic Review*, 71, 393-410.

Stock, J H and M W Watson (1989), 'New Indexes of Coincident and Leading Economic Indicators', *NBER Macroeconomics Annual*, 4, 351-94.

Appendix

Comparing the general equilibrium comparative statics of a monetary shock in the augmented and conventional (money only) *IS/LM* models

We have shown that the comparative statics of a monetary shock in the augmented *IS/LM* model (denoted $[dy/dR]_A$) can be written as:

$$\left[\frac{dy}{dR}\right]_A = \frac{\left[y_i m\,(L_\rho^s - L_\rho^d) + y_\rho m(L_i^d - L_i^s) + L_R^s\,(y_i D_\rho^s - y_\rho D_i^s)\right]}{\left[y_i D_y^s (L_\rho^s - L_\rho^d) + y_\rho D_y^s (L_i^d - L_i^s) + D_i^s (L_\rho^s - L_\rho^d) + D_\rho^s (L_i^d - L_i^s) + L_y^d (y_i D_\rho^s - y_\rho D_i^s)\right]}$$

Assuming perfect substitutability between bank credit and bonds causes the augmented model to collapse to a more conventional *IS/LM* model of the form:

IS Curve: $y = y^*(i)$ where: $y_i^* = y_i + y_\rho$

LM Curve: $m R = D^{s*}(i,y)$ where: $D_i^{s*} = D_i + D_\rho$

$D_y^{s*} = D_y$

From (12), the comparative statics of a monetary shock in this limiting (money only) version of the model (denoted $[dy/dR]_{mo}$) can be written as:

$$\left[\frac{dy}{dR}\right]_{mo} = \frac{m\,y_i^*}{D_y^{s*}\,y_i^* + D_i^{s*}} = \frac{m\,(y_i + y_\rho)}{D_y^s\,(y_i + y_\rho) + D_i^s + D_\rho^s}$$

From these two expressions, it is possible to derive an inequality illustrating the conditions under which the introduction of imperfect substitutability acts to increase the potency of monetary policy:(9)

$$\left[\frac{dy}{dR}\right]_A > \left[\frac{dy}{dR}\right]_{mo}$$

$$(L_i^d - L_i^s) - \frac{L_R^s}{m}\left[(y_i + y_\rho)\, D_y^s + D_i^s + D_\rho^s\right] > (L_\rho^s - L_\rho^d) - L_y^d (y_i + y_\rho)$$

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(9) The derivation of this inequality is complicated by the possibility that monetary shocks may have a perverse effect on output. This possibility is ruled out by imposing the restriction $(y_i D_\rho^s - y_\rho D_i^s) < 0$ - see equation **(11)**.

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