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Dr Paul Dalziel

Department of Economics
University of Canterbury
Private Bag 4800
Christchurch, NEW ZEALAND

E-mail: p.dalziel@econ.canterbury.ac.nz

Abstract

This paper introduces a finance channel for monetary policy. Following Black (1970) there is no money commodity in the paper's model. Instead, the medium of exchange is bank deposits supplied by the financial system in response to optimal rational expectations decisions by firms about financing investment in new capital assets, and demanded by households as part of their optimized financial portfolio of accumulated savings. The model demonstrates how central banks maintain price stability through changes in base interest rates (the Wicksell monetary policy rule) which influence the debt financing decisions of firms.

JEL Classifications: E31, E51, E52.

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A FINANCE THEORY OF MONETARY POLICY IN A WORLD WITHOUT MONEY

In a remarkably prescient paper, Fisher Black (1970) asked us to imagine a world in which money does not exist, but instead all transactions are financed by bookkeeping transfers within the banking system. Thirty years later, it is not so difficult to make Black's leap of the imagination. Not only do money substitutes such as bank balances subject to check and electronic fund transfers continue to dominate medium and large transactions in commerce, but innovations such as smart-cards, e-cash and cybermoney are changing the role of currency even in small retail purchases. At the same time, financial market integration is making banks far less reliant on central bank liabilities for inter-bank settlements than was the case even a decade ago. These trends pose important challenges for monetary theory since 'in a world where transactions take place by the transfer of loans and deposits, the quantity theory has no place' (Black 1970, p. 19). Without the quantity theory, the price level is indeterminate in standard general equilibrium models and thus there is no role for active monetary policy, two propositions that Black (1986, pp. 539-40, and 1995, p. 80) argued are applicable in the real world as well as in his imaginary one. The purpose of this paper is to address Black's challenge by presenting a model of a world without money in which active monetary policy can nevertheless maintain stable prices. Consistent with Black's insight, the model does not adopt a commodity or quantity view of money. Instead the economy's medium of exchange is a financial asset (interest-bearing bank deposits) supplied by bank loans advanced to fund a part of each period's investment expenditure. It turns out in the model that both the level of investment in equilibrium and the proportion of that investment funded by bank credit are influenced by the finance sector's base interest rate. This opens up what is called here the finance channel of monetary policy, whereby the monetary authorities can use changes in the base interest rate in order to stabilize the average price level.

The model itself is drawn from Gurley and Shaw's (1960) original analysis of what they termed 'inside money' in a theory of finance. The model has two financial assets—sharemarket equities and bank deposits. Both assets offer market rates of return to their owners, but equities also have a nominal price that is susceptible to inflation (and hence to expectations about inflation) while bank deposits are assumed to have unique liquidity characteristics that make them the chosen medium of exchange. Apart from the banking sector (which plays a relatively passive role in the model), there are also two types of agents. Firms manage the real capital stock, and decide on the level of investment each period, as well as the proportion of that investment to be funded by new debt. Households ultimately own the capital stock, but must decide how to allocate the nominal value of their accumulated savings between equities and deposits. The interplay between the funding decisions of firms and the portfolio decisions of households is what produces inflation in this model.

The finance channel presented in this paper is new, and should not be confused with the important 'credit channel' introduced into the literature by Bernanke (1983). In the credit channel model, a tightening of monetary conditions reduces the *supply* of credit to firms either because of a weakening of balance sheets (implying lower net worth available as collateral) or because of the induced reduction in the pool of funds available to bank-dependent borrowers; see, for example, Gertler and Gilchrist (1994). In contrast, the model of this paper focuses on changes in the *demand* for credit after interest rate adjustments, which then affect the supply of bank deposits. Any excess supply of deposits relative to household demand for liquidity initially generates inflation in the nominal value of sharemarket equities, which spills over into an equal increase in the price of real capital goods (assuming Tobin's q-statistic maintains its long-run value of unity). Given the required rate of return on the nominal value of capital—shown here to be related to the base interest rate set by monetary policy—and assuming that real wage growth is equal to labor productivity growth, firms must pass on capital good price inflation into higher consumption good prices, completing the transmission mechanism from the instrument of monetary policy to its target.

Although the finance channel proposed here is new, the model produces some strikingly familiar results. First, inflation is the result of an excess nominal supply of the medium of exchange relative to the real demand for liquid financial balances. Second, this inflation transfers real wealth from bank depositors to bank borrowers in a formula that is identical to the well-known inflation tax collected by governments indulging in excessive fiat money issue. Third, firms therefore maximize the value of their shareholder funds by increasing debt until the marginal impact on the nominal interest rate equals the marginal impact on the expected rate of inflation. Fourth, in a competitive market for investment goods, it is possible to derive equilibrium values for the growth rate, the marginal debt-capital ratio and the inflation rate that are all susceptible to changes in the banking system's base interest rate. Fifth, this finance channel then gives rise to Wicksell's monetary policy rule that the base interest rate should be increased (reduced) if prices are expected to rise (fall). In particular, credible policy requires that the central bank must be able and willing to adjust nominal interest rates in line with changes in the expected rate of inflation, as is standard practice in countries with inflation targets for monetary policy.

Section 1 outlines the paper's finance framework, based on two stylized aggregate balance sheets for firms and households. There are two financial assets in the model—bank deposits and sharemarket equities—and Section 2 presents a simple analysis of the optimal portfolio choice by households between these assets. Section 3 demonstrates how the funding decisions of firms for new investment expenditure can create an excess supply of bank deposits, and so cause inflation, if in the aggregate these decisions are incompatible with the portfolio desires of households. This prepares the way for Section 4 to derive optimizing conditions for investment funding by firms, highlighting the role played by nominal interest rates and the expected inflation rate in a rational expectations environment. Section 5 augments this analysis with a standard model of equilibrium investment assuming perfect competition, so that Section 6 is then able to model monetary policy based on adjusting the banking system's base interest rate in order to maintain price stability. The paper ends with a brief conclusion in Section 7.

1. AN OUTLINE OF THE FINANCE MODEL

The model is a period analysis of the investment and funding decisions made by firms and of the wealth portfolio choices made by households. Figure 1 presents the aggregate balance sheets of these two sectors at the beginning of the period. The firms manage the economy's capital stock on behalf of their shareholders. These assets, K_{-1}, are valued at the unit price, P_{-1}, and are financed by a combination of advances from the banking system, A_{-1}, and equities held by households, $P_{-1}E_{-1}$. Note that the equities are measured in the same units as the capital stock, and are assumed to share the same price level (so that Tobin's *q*-ratio adopts its long-run value of unity). Households are the ultimate wealth-holders in the model. The economy's only real asset is the capital stock, so that household net worth (or accumulated savings) is the nominal value of that capital stock, $P_{-1}K_{-1}$. Households own shares in this capital stock, E_{-1}, valued at the price of capital, P_{-1}. They also hold a proportion of their wealth in the form of nominal bank deposits, D_{-1}, which act as the economy's medium of exchange.

Firms				**Households**			
Assets			*Liabilities*	*Assets*			*Liabilities*
Capital	$P_{-1}K_{-1}$	Advances	A_{-1}	Deposits	D_{-1}	Net Worth	$P_{-1}K_{-1}$
		Equities	$P_{-1}E_{-1}$	Equities	$P_{-1}E_{-1}$		

FIG. 1. Aggregate Balance Sheets of Firms and Households

Note that the finance framework presented in Figure 1 is very different from the standard quantity theory of money. Following Black's (1970) suggestion, economic transactions in the model are not settled by using a particular *commodity* called money, but by exchanging a particular form of *title* in the economy's real capital stock.[1] Equities could perform this medium of exchange role, of course, but it is assumed in the model that bank deposits provide unique liquidity services as a result of the specialist expertise of financial intermediaries in assessing and pooling risk (so that the nominal value of bank deposits are not subject to continuous market valuation changes as is the case for sharemarket equities). Adopting Freeman and Huffman's (1991, p. 646) useful phrase, the medium of exchange in this model is 'intermediated capital', a concept that goes back at least to the work of Irving Fisher who expressed it in the following terms (1911, p. 41): 'Through banking, he who possesses wealth difficult to exchange can create a circulating medium. He has only to give to a bank his note—for which, of course, his property is liable—get in return the right to draw, and lo! his comparatively unexchangeable wealth becomes liquid currency. To put it crudely, banking is a device for coining into dollars land, stoves, and other wealth not generally exchangeable.'

The aggregate balance sheet of the banking sector is not shown in Figure 1, but is made up of advances as the only asset, and deposits as the only liability. Banks are given a generally passive role in this model; they accept deposits from households at some market interest rate, i_d, and offer advances to firms at the market interest rate, i_a. Advances are assumed to be supplied on demand as long as they are backed by adequate collateral (that is, by the real capital stock), but at an increasing rate of interest as the level of debt rises relative to the value of capital assets. It is also assumed that households do not participate in obtaining advances from the banking system, and so are unable to eliminate any excess money balances by retiring their own bank debt. This is necessary to prevent the household sector from giving effect to the 'law of reflux' (see, for example, Glasner 1992, and Tobin 1963). Instead households must allocate their portfolio of accumulated savings between deposits and equities, as is analyzed in the following section.

2. THE OPTIMAL MONEY-WEALTH RATIO

A very simple portfolio model is adopted in this section to generate a demand for liquidity function that is proportional to the nominal wealth of households. More complicated models are available, of course, but would not add to the principal insights of this model which are driven by the rational expectations and perfect competition funding decisions of firms to be examined in Sections 3 and 4. Let all households be identical, with preferences represented by a constant returns to scale Cobb-Douglas utility function defined over bank deposits, D, and equities, E. Thus the representative household is assumed to maximize:

$$U(D, E) = D^h E^{(1-h)} \quad (1)$$

where h is a parameter ($0 < h < 1$), subject to the wealth constraint:

$$D + PE = PK \quad (2)$$

It is then easily shown that the solution to this constrained optimization problem produces the following demand function for bank deposits, D^*:

$$D^* = hPK \quad (3)$$

Because bank deposits are acting as the liquid medium of exchange in this model it is tempting to call D^* the 'demand for money'. Freeman and Huffman (1991), for example, refer to deposits as 'inside money' (adopting the term introduced by Gurley and Shaw 1960, p. 73), and Black himself found it convenient to 'use the word "money" as short for "means of payment" without meaning to imply that a quantity of money exists' (1970, p. 14). Following these precedents, the parameter h will be termed the household sector's optimal money-wealth ratio.[2]

3. A FINANCE THEORY OF INFLATION

The previous section produced a simple demand function for the medium of exchange as a constant proportion of nominal wealth. In this section, growth in the supply of bank deposits is modeled as a consequence of funding decisions by firms for the period's investment, allowing changes in the nominal value of real wealth to maintain equilibrium in household financial portfolios. Assuming equilibrium at the end of the previous period, the initial demand for bank deposits, D_{-1}, is given by:

$$D_{-1} = hP_{-1}K_{-1} \tag{4}$$

Since D_{-1} must equal A_{-1} in the banking sector's aggregate balance sheet, equation (4) implies that the average debt-capital ratio of firms, $A_{-1}/P_{-1}K_{-1}$, also equals h initially. During the period of analysis, firms undertake investment expenditure to the value of $P_{-1}I$ (the determinants of this investment decision will be analyzed in Section 5). This changes their capital stock, and household net worth, by $P_{-1}\Delta K = P_{-1}I$. Let d—termed here the 'marginal debt-capital ratio'—denote the proportion of this *new* capital stock that is funded in the aggregate by bank advances, which may be different from the average debt-capital ratio, h, for the pre-existing capital stock. The determination of d will be analyzed in the following section, but for the purposes of this section note that the marginal debt-capital ratio is equivalent to the money supply growth rate in traditional fiat money models. This is because once firms have used their bank advances to pay the factors used in producing the investment goods, the supply of the medium of exchange, M, increases by:

$$\Delta M = \Delta D = \Delta A \equiv dP_{-1}\Delta K \tag{5}$$

The increase in net worth after the investment in new capital stock makes households willing to hold more deposits, but only to the value of $hP_{-1}\Delta K$ at the initial price level. If $d > h$, therefore, households find they have excess liquidity in their portfolio. To restore equilibrium, they use their excess balances to bid for the available stock of equities. This increases their price (and hence the price of capital goods), which raises nominal wealth until the deposits are willingly held.[3] The change in the demand for deposits, ΔD, required to achieve this is found by differentiating (4):

$$\Delta D = h\Delta PK_{-1} + hP_{-1}\Delta K \tag{6}$$

Set (5) equal to (6) and rearrange terms to produce the following equation, where $p \equiv \Delta P/P_{-1}$ is the inflation rate of capital good prices, and $g \equiv \Delta K/K_{-1}$ is the rate of growth in the economy's supply-side capacity:

$$p = \frac{d-h}{h} g \tag{7}$$

Equation (7) indicates that inflation will occur in a growing economy if the marginal debt-capital ratio chosen by firms is greater that the optimal money-wealth ratio of households. The intuition is straightforward. If $d > h$, the funding decisions of firms create a greater supply of new bank deposits than households are willing to hold. This creates an excess demand for equities, increasing the nominal value of the capital stock until the desired money-wealth ratio prevails, at which point:

$$hPK = A = D = M \tag{8}$$

To understand why firms might choose $d > h$, note that the price increase has a beneficial impact on shareholder funds, which increase from $(1\text{-}h)P_{-1}K_{-1}$ at the beginning of the period to $(1\text{-}h)PK$ at the end. In real terms, this increase is made up of two components (where the final transformation is obtained using equations 7 and 8):

$$\begin{aligned} \{(1\text{-}h)PK/(1+p)\} - (1\text{-}h)P_{-1}K_{-1} &= (1\text{-}h)P_{-1}(K - K_{-1}) \\ &= (1\text{-}d)P_{-1}\Delta K + (d\text{-}h)P_{-1}\Delta K \\ &= (1\text{-}d)P_{-1}I + pM_{-1} \end{aligned} \tag{9}$$

The first component, $(1\text{-}d)P_{-1}I$, is the new equity issued during the period, reflecting the increase in the real capital stock brought about by the period's investment. The second component measures the reduction in the real value of the beginning-of-period 'inside money' supply, M_{-1}, brought about by inflation, p. This is exactly analogous to the inflation tax on nominal cash balances in a fiat money economy (see, for example, Auernheimer 1974, Friedman 1971, Keynes 1923, pp. 37-53, and Phelps 1973). It represents a real transfer of resources from deposit holders (who are obliged to devote a portion of current saving to restoring the real value of their liquid balances) to shareholders (who benefit from the reduced real value of bank advances borrowed by their firms). This insight allows the next section to derive an optimal marginal debt-capital ratio, taking into account both this inflation transfer and changes in the nominal interest rate on bank advances.

4. THE OPTIMAL MARGINAL DEBT-CAPITAL RATIO

Assume a large number of identical competitive firms, so that the optimization problem can be solved with respect to a single representative firm. This firm owns the capital stock, which in a non-inflationary environment is expected to earn a real rate of return—denoted e—that is negatively related to the size of the capital stock. Given K_{-1}, this 'marginal efficiency of capital' is therefore negatively related to the amount of current investment, and hence to the current rate of growth, $g \equiv I/K_{-1}$:

$$e = e(g), \ e(0) > 0, \delta e(g)/\delta g < 0 \tag{10}$$

Perfectly competitive banks are assumed to supply advances on demand to firms, but at an increasing rate of interest above the financial sector's base interest rate, i_b, as the firms' marginal debt-capital ratio rises. This is to compensate for higher risk (see, for example, Barro 1976, Kalecki 1937, and Tobin 1982). It is further assumed that the risk, and hence the interest rate, rise more than proportionately as d increases. It is convenient to express these assumptions in the following functional form:

$$i_a = i_b + i(d), \ \delta i(d)/\delta d > 0, \delta^2 i(d)/\delta d^2 > 0 \tag{11}$$

At the beginning of the period, the value of shareholder funds is given by $(1\text{-}h)P_{-1}K_{-1}$. From equation (9), inflation is expected to create a capital gain equal to $p^e hP_{-1}K_{-1}$ (where p^e is the expected inflation rate), the capital stock will produce real returns equal to $eP_{-1}K_{-1}$, and the interest costs are expected to be $i_a hP_{-1}K_{-1}$. Bringing these components together, and dividing by $(1\text{-}h)P_{-1}K_{-1}$, the expected return to each equity on issue is:

$$e + \{h/(1\text{-}h)\}\{e + p^e - i_a\} \tag{12}$$

Differentiate (12) with respect to d and set equal to zero to obtain the value (denoted d^*) that maximizes this expected return. This produces the following equality:

$$\delta i_a/\delta d = \delta p^e/\delta d \tag{13}$$

Equation (13) is a fundamental result of this paper, and shows the importance of marginal changes in the rate of interest and the expected inflation rate in determining the optimal marginal debt-capital ratio (and hence actual inflation, given h and g). Again the economic intuition is straightforward. Starting from a low marginal debt-capital ratio, if increasing the proportion of new capital funded by bank advances raises the expected inflation rate more than it increases the interest rate on debt, then the larger expected capital gain outweighs the extra interest costs. As debt continues to increase, however, the nominal interest rate rises at a faster rate (as the risks associated with a higher debt ratio accelerate) until at the optimal d^* any marginal increase in expected inflation is exactly matched by the marginal increase in the nominal interest rate, and the benefit to shareholders is maximized.

This result has important applications. It suggests, for example, that an economy will tend to have higher inflationary pressures (in the sense that the marginal debt-capital ratio will be higher for any given real growth) the less responsive domestic interest rates are to changes in debt. Thus the model predicts that where there are binding regulatory ceilings on interest rates, for example, inflation is limited only by any quantity constraints on the banking system's ability to expand credit. Such a process was undoubtedly important in contributing to the high inflation experienced by many countries in the 1970s and may have contributed to more recent problems in South East Asia. In contrast, an economy in which nominal interest rates are anticipated to rise one-to-one with expected inflation (so that the Fisher equation holds continuously) should not be prone to inflation from this mechanism. This possibility will be considered in more detail in the discussion of monetary policy in Section 6.

Returning to the specific algebraic forms assumed in this paper, and assuming that expectations are rational in the sense that expected inflation equals the inflation rate implied by equation (7), the condition in equation (13) produces an expression for d^* defined by the following implicit equation:

$$\delta i(d^*)/\delta d = g/h \tag{14}$$

Assuming that $\delta i(0)/\delta d < g/h < \delta i(1)/\delta d$, a unique value for d^* exists. All that is now required to complete the model is an equilibrium condition for the economy's supply-side capacity growth rate, g.

5. THE EQUILIBRIUM REAL GROWTH RATE

The previous section derived an optimal marginal debt-capital ratio, d^*, that depends on supply-side capacity growth, g. In this section, the equilibrium growth rate, g^*, is derived as a function of d. The two expressions are then brought together in a single diagram to illustrate the joint determination of d^* and g^* (see Figure 2 below), setting the scene for Section 6 to explain how monetary policy produces price stability in this finance framework.

In perfect competition, firms undertake the level of investment (and hence the growth rate, I/K_{-1}) at which the marginal efficiency of capital equals the real rate of interest (Keynes 1936, Chapter 11). The real rate of interest is simply the nominal interest rate paid by firms on bank advances, i_a, less the expected rate of inflation, p^e. Adopting the same assumptions as the previous section, this means that g^* satisfies:

$$e(g^*) = i_b + i(d) - \{(d-h)/h\}g^* \tag{15}$$

Stability and uniqueness conditions for g^* are required, and since these play a part in the discussion that follows they are recorded here as an explicit assumption. The first condition ensures that some investment is profitable at $g = 0$, while the second condition states that the marginal efficiency of capital is more sensitive to changes in the rate of growth (or level of investment, given K_{-1}) than the expected inflation rate.

Assumption 1: $e(0) > i_b + i(d)$ and $-\delta e/\delta g > \{(d-h)/h\}$

To determine how g^* responds to changes in d, totally differentiate equation (15) and rearrange as follows: