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THE CAPITALIZATION OF INCOME STREAMS AND THE EFFECTS OF OPEN-MARKET POLICY UNDER FIXED EXCHANGE RATES

Maurice Obstfeld

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ABSTRACT

This paper investigates the long- and short-run neutrality of open-market monetary policy in a world of fixed exchange rates and imperfect substitutability between bonds denominated in different currencies. Using an illustrative portfolio-balance model, it shows that when the public discounts the future tax liabilities associated with the national debt and the central bank supports the exchange rate by trading non-interest-bearing foreign assets, open-market policy has a short-run effect, but no long-run effect, on the domestic price level and interest rate. When the foreign-exchange intervention assets earn interest that is rebated to and capitalized by the public, open-market policy loses even its short-run efficacy--the capital-account offset to monetary policy is complete.

Maurice Obstfeld
Department of Economics
Columbia University
New York, NY 10027
(212) 280-5510

1. Introduction

This paper examines the efficacy of open-market monetary policy in a world of fixed exchange rates and imperfect substitutability between bonds denominated in different currencies. While portfolio balance models postulating limited international asset substitutability have received considerable attention in the literature,[1] it is not generally recognized that their predictions about both the short- and long-run effects of central-bank operations in domestic debt rest on a crucial pair of assumptions. These concern the degree to which the public capitalizes the stream of tax liabilities associated with the government debt, and the degree to which it capitalizes the stream of interest earnings associated with the central bank's foreign exchange reserves.[2]

To demonstrate the importance of these assumptions, we argue, using a standard open-economy model, that the following two propositions are valid even in a setting of imperfect asset substitutability: (i) When the domestic public fully anticipates and discounts the future tax liabilities connected with the government debt and the central bank supports the exchange rate through operations in non-interest-bearing foreign assets, open-market operations have a short-run effect on the domestic price level, interest rate, and current account, but no long-run effect. The cumulative current-account imbalance gives a long-run change in tangible or marketable

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[1] The papers of Boyer (1975, 1979), Branson (1976), Dornbusch (1977), Girton and Henderson (1976), and Kouri and Porter (1974) emphasize the short-run efficacy of open-market policy when home and foreign bonds are imperfect substitutes, while those of Henderson (1977) and Obstfeld (1980) draw attention to the possible long-run non-neutrality of money.

[2] Stockman (1979) has also addressed these questions, deriving the results of section 4, below, in a manner different from ours. He employs a stochastic

wealth just equal to the change in the capitalized value of future tax liabilities to the government, so that total wealth, inclusive of non-marketable liabilities, returns asymptotically to its initial level. (ii) When, in addition, the central bank's foreign-exchange intervention assets earn interest that is distributed to and capitalized by the domestic public, open-market policy has no effect even in the short run. An open-market purchase of domestic bonds, say, is offset completely and instantaneously by a transfer of foreign bonds from the central bank to the public, just as it would be in the world of perfect capital mobility studied by Mundell (1963).

The argument that government bonds need not represent net wealth goes back, of course, to Ricardo, and has been formalized recently by Barro (1974). Mundell (1960) has emphasized that the macroeconomic effects of open-market operations depend on the public's ability to capitalize or internalize the concomitant change in the government's future revenue requirements. This paper extends these considerations to the open economy, illustrating their relevance for the capital-account offset to monetary policy and stressing the important role of central-bank wealth.

The paper is organized as follows. Section 2 presents a brief description of the basic illustrative model. Section 3 discusses the effects of an open-market purchase of domestic debt when government bonds are not net wealth and the central bank's medium of intervention earns no interest. Section 4 shows how monetary policy can lose its short-run potency when the central bank intervenes with interest-earning foreign assets. Section 5 presents some concluding remarks.

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model in which agents maximize utility over a three-period lifetime. Frenkel and Rodriguez (1975) touch on capitalization issues in a setting of perfect asset substitutability. The issues, of course, are those raised by Metzler's (1951) celebrated discussion of financial policies in closed economies.

2. An illustrative model

We illustrate the importance of capitalization effects in the open economy with an aggregative, dynamic, fixed-exchange-rate model.[3] The real output of the economy, y, is constant, and domestically-produced goods are imperfect substitutes in consumption for goods produced abroad. The money price of foreign output is a fixed parameter from the standpoint of the home country, and is taken to equal 1. All goods are perishable, but domestic residents may hold wealth in the form of three financial assets. The first two are domestic- and foreign-currency bonds, which are imperfect substitutes in portfolios and need not offer the same rate of return in equilibrium.[4] The third is domestic money, consisting entirely of central-bank liabilities backed by domestic government bonds and foreign assets. To simplify our discussion of the consolidated budget constraint of the government and monetary authority, we assume that the government does not pay interest on domestic securities in the central-bank portfolio. The central bank's foreign assets may earn interest, however.

The model is described by the following equations:

$$L(r,r^*,Py/W)W = M, \qquad L_1,L_2 < 0,\ L_3 > 0, \tag{1}$$

$$B(r,r^*,Py/W)W = B^*, \qquad B_1,B_3 < 0,\ B_2 > 0, \tag{2}$$

$$H(r,r^*,Py/W)W + F(r) = D, \qquad H_1,F' > 0,\ H_2,H_3 < 0, \tag{3}$$

$$M = C + R, \tag{4}$$

$$\alpha(P)E(y^d, r - \pi) + X(P) = y, \qquad \alpha',X',E_2 < 0,\ 1 > E_1 > 0, \tag{5}$$

$$y^d = y - T + (rH(...)W + r^*B^*)/P, \tag{6}$$

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[3] A more detailed exposition will be found in Obstfeld (1980).

[4] Imperfect substitutability is assumed to arise from devaluation risk, political risk, or both.

$$P\sigma = r^*B^* + r^*\gamma R - rF(r), \qquad 1 \geq \gamma \geq 0, \tag{7}$$

$$\dot{W} = PX(P) + (\alpha(P) - 1)PE(y^d, r - \pi) + P\sigma, \tag{8}$$

$$PT = rD - r^*\gamma R, \tag{9}$$

where

L = share of money in domestic private wealth

r = nominal interest rate on domestic bonds

r^* = foreign-bond interest rate, taken to be fixed

P = money price of domestic goods

W = domestic nominal wealth, assumed positive

M = nominal stock of high-powered money

B = share of foreign bonds in domestic private wealth

B^* = private domestic holdings of foreign bonds, measured in domestic currency units

H = share of home bonds in domestic private wealth

F = foreign demand for bonds denominated in domestic currency

D = stock of government bonds held by the non-central-bank public

C = stock of government bonds held by the central bank

R = foreign exchange reserves of the central bank, measured in domestic currency units

α = share of domestic expenditure falling on domestic goods

E = aggregate domestic expenditure, expressed in terms of domestic goods

y^d = disposable income, expressed in terms of domestic goods

π = expected rate of domestic price inflation

X = foreign demand for domestic goods

T = gross lump-sum taxes, expressed in terms of home goods

σ = net interest inflow, measured in home goods

γ = fraction of central-bank foreign assets held in interest-bearing form.

Both types of bond carry a fixed nominal face value.

Equations (1) and (2) stipulate that the domestic public willingly holds the stocks of money and domestically-owned foreign assets, while equation (3) is the equilibrium condition for the home bond market. [5] Equation (4) asserts that central-bank liabilities equal central-bank assets, and describes the division of the asset side of the bank's balance sheet between domestic credit and foreign reserves. Equation (5) ensures that the domestic goods market clears; we assume that demand for domestic output is positively related to home disposable income and negatively related to the home real interest rate and price level. [6] The service account, decribed by (7), encompasses both private and official interest earnings, and equation (8) links the rate of increase of domestic marketable wealth to the current-account surplus, on the assumption that there is no government borrowing and no investment. Finally, (9) gives the consolidated public-sector budget constraint when there is no government spending. Since the government does not borrow, taxes must be levied to finance any interest payments on the public debt not covered by interest earnings on foreign-exchange reserves. Using (3) and (9), disposable income y^d may be written as the sum of output and the real service account,

$$y^d = y + \sigma(r,P,W).$$

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[5] It is worth noting that the functions B, H, and F are net demand functions, and may assume negative values. Thus, $B < 0$ means domestic residents are net borrowers in foreign currency.

[6] The expenditure function could be made more general by allowing wealth to influence spending, and by altering the definition of disposable income to include expected real capital losses on wealth due to price-level inflation. Neither extension would affect the paper's conclusions.

An important clarification is in order at this point. The wealth variable W appearing in the model is interpreted, for the moment, as tangible wealth, defined by $W \equiv M + B^* + D - F$. W is thus the sum of the monetary base and all marketable net claims owned by domestic residents: it does not encompass either the capitalized value of future tax liabilities to the government or that of the central bank's future foreign-exchange earnings. We postpone until section 3 the modifications necessary when individuals discount their future domestic-currency liabilities to the government. Section 4 shows how the model must be changed when residents also capitalize the stream of foreign-currency payments associated with the central bank's reserves.

When condition (3) holds, conditions (1) and (2) are redundant, for any portfolio imbalance can be eliminated through trades with the central bank, and so, requires no change in the home interest rate or price level. We may solve (3) to obtain the nominal domestic interest rate $\rho(P,W,D)$ that clears the asset markets; substituting this formula for r in (5), we express π as a function of P and W:

$$\pi = \pi(P,W;D).$$

Imposition of the perfect-foresight assumption that $\dot{P}/P = \pi$ yields the first differential equation of the system,

$$\dot{P}/P = \pi(P,W;D), \tag{10}$$

which describes the motion of the price level.[7] The second differential

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[7] The precise form of (10) depends on the extent to which the central bank intervenes in the foreign exchange market with non-interest bearing reserves. But the qualitative nature of the economy's dynamic behavior is independent of the rule chosen by the central bank.

equation, describing the evolution of domestic wealth, is derived by substituting (10) for π and $\rho(P,W,D)$ for r in (8) to obtain:

$$\dot{W}/P = \omega(P,W;D). \tag{11}$$

Figure 1 depicts the dynamic system described by equations (10) and (11). Under mild assumptions, one can show that $\pi_P > 0$, $\pi_V < 0$, $\omega_P < 0$, and $\omega_V > 0$. Thus, the locus along which $\dot{P}/P = 0$ and the locus along which $\dot{W}/P = 0$ both have positive slope. Figure 1 is drawn on the assumption that the $\dot{P}/P = 0$ or internal balance schedule is steeper than the $\dot{W}/P = 0$ or external balance schedule. This assumption guarantees that the system has the saddlepoint property of a unique path converging to $(\bar{W},\bar{P})$, the long-run or stationary equilibrium.

3. Future taxes and the government debt

The system consisting of equations (10) and (11) is one in which the real equilibrium of the economy is affected by open market operations, for these alter the parameter D. In this section we ask how the previous model must be modified when the public debt D does not represent net wealth because individuals anticipate the associated stream of taxes that they or their descendants must pay to the government. For simplicity, it is assumed until section 4 that $\gamma = 0$, so that the central bank must intervene in the foreign exchange market with reserves that bear no interest.

When anticipated tax liabilities to the government are capitalized at market value, total nominal wealth, which includes the value of non-marketable assets and liabilities, can be expressed as tangible wealth, W, minus the value of the stock of government debt in private portfolios, D. Residents now allocate their net wealth W-D among the three assets, taking

into consideration their domestic-currency indebtedness to the government. Equation (3) describing bond-market equilibrium becomes

$$H(r,r^*,Py/(W-D),D/(W-D))(W-D) + F(r) = D, \tag{12}$$

which differs from (3) in that the share of total wealth allocated to holdings of marketable domestic bonds depends on the ratio of capitalized future tax liabilities to total wealth.

When government bonds are not net wealth, the experiment of a "helicopter drop" of government bonds to the public can have no effect on the price level or the domestic bond rate, r, for total wealth, W - D, and the public's net position in domestic currency are unaffected.[8] From (12), this implies that H must have the form

$$\tilde{H}(r,r^*,Py/(W-D)) + D/(W-D).$$

$\tilde{H}(r,r^*,Py/(W-D))(W-D)$ can be interpreted as the domestic public's desired net claims denominated in domestic currency vis-à-vis both foreigners and the domestic government.

Using the definition of $\tilde{H}$, the condition that the domestic bond market clear is just

$$\tilde{H}(r,r^*,Py/(W-D))(W-D) + F(r) = 0, \tag{13}$$

and it is evident that the unique interest rate r satisfying (13) can be written in the form $\rho(P,W-D)$. Noting that domestic demand for foreign

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[8] This is the experiment considered by Barro (1974).

bonds (equation (2)) is now written as $B(r,r^*,Py/(W-D))(W-D)$,[9] we may proceed as before to derive differential equations in P and W, this time of the form

$$\dot{P}/P = \pi(P,W-D), \tag{14}$$

$$\dot{W}/P = \omega(P,W-D). \tag{15}$$

The dynamic system can again be portrayed by figure 1. The important difference now is that the system's endogenous variables are r, P, and W-D rather than r, P, and W. This means that in the long run, any change in D must be offset exactly by an equal change in W, with the nominal interest rate and domestic price level returning to their original levels.

The adjustment process following an open-market purchase of domestic government debt is depicted in figure 2. The monetary expansion leaves tangible wealth W intact, for the decline, ΔD, in bonds held by the public is financed by an equivalent issue of central-bank money. However, the government's discounted future revenue requirements also decline by ΔD, and thus total wealth--tangible plus intangible--increases. Looking at (14) and (15), we see that the change in D shifts both schedules horizontally by the amount ΔD, as shown in figure 2. Thus, the open-market purchase has no long-run effect on total domestic wealth (inclusive of capitalized future taxes), the price level, or the interest rate. A long-run decline in tangible wealth just offsets the fall in the public's anticipated, discounted tax liabilities.

This eventual decline in tangible wealth is a consequence of the current-account deficit occasioned by the open-market purchase. In fig. 2,

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[9] This also follows from the "helicopter" experiment. When government bonds are not net wealth, an increase in D has no effect on the public's demand for foreign bonds, for it involves no change in total wealth or portfolio composition.

the economy, on impact, jumps vertically to the stable arm of the system associated with the lower level of D. The nominal and real interest rates fall, inducing an increase in spending, a rise in the home price level, and a current-account deficit. The fall in the bond rate and rise in the price level are necessary because the increase in total wealth associated with the cut in future taxes would otherwise result in excess demand for domestic debt. An outflow of capital--and so, a fall in central-bank reserves--accompanies the monetary expansion, but does not offset it completely in the short run. It is important to note that because reserves earn no interest, the transfer of foreign assets from the central bank to the public entails a net increase in the stream of foreign-currency interest earnings reaching domestic residents.

Over time, however, the initial capital outflow is reversed, and the domestic-goods price, the interest rate, and total wealth return to their original levels. Since the money stock must do the same, the long-run offset to monetary policy is complete, and provides the mechanism through which the required fall in tangible wealth is accommodated. The initial increase in the central bank's domestic assets is eventually matched by a decline in its foreign assets. Part of this decline occurs at the moment the central bank intervenes to support the currency when the interest rate first falls. The balance of the reserve loss occurs during the adjustment to long-run equilibrium, for the capital inflow accompanying the current-account defict is not sufficient to finance it.

To summarize, when government bonds are not net wealth and the central bank intervenes in the foreign exchange market with non-interest-bearing assets, expansionary monetary policy has a short-run effect on the economy. This short-run effect involves a current deficit that returns the economy to a stationary position characterized by an unaltered interest rate and price level but a lower level of tangible wealth. The decline in tangible wealth

just equals the decline in discounted future tax liabilities. Private holdings of money and foreign assets are unchanged in the long run.

4. The role of interest-bearing reserve assets

The previous section's finding that open-market policy can affect the short-run equilibrium of the economy when government bonds are not net wealth depends on the assumption that the monetary authority's intervention medium earns no interest. We now argue that when the central bank intervenes with foreign bonds earning interest at the market rate r*, this short-run effect of monetary policy disappears if the public capitalizes the stream of central-bank foreign-exchange earnings at market value.

To show this, we write total wealth, inclusive of the discounted value of future tax payments to the government and payments in foreign currency from the central bank, as $W - D + \gamma R$, where γR, again, is the stock of interest-bearing foreign exchange reserves. γR of course equals the present value of the stream of central-bank interest payments, discounted at rate r*. As before, we assume that residents allocate their total wealth $W - D + \gamma R$ among the three available assets, taking into account the capitalized value of anticipated central-bank foreign-exchange payments, which are regarded as perfectly substitutable for interest earnings on privately-held foreign bonds.

With this modification, equation (2) takes the form[10]

$$B(r, r^*, Py/(W-D+\gamma R), \gamma R/(W-D+\gamma R))(W-D+\gamma R) = B^*. \qquad (16)$$

A conceptual experiment similar to the one performed in the previous section allows us to derive the form of B(....). Suppose that the central

[10] See note 9 for the justification.

bank confiscates a portion of the stock of privately-owned foreign bonds, adding these to its own interest-bearing reserves and continuing to distribute all earnings to the public. If the public capitalizes the monetary authority's foreign exchange disbursements, the confiscation leaves both total (capitalized) wealth and the net foreign asset position of the public unchanged. Thus, B simply falls by $\Delta(\gamma R)/(W - D + \gamma R)$, implying that

$$B(r,r^*,Py/(W-D+\gamma R),\gamma R/(W-D+\gamma R)) = \tilde{B}(r,r^*,Py/(W-D+\gamma R)) - \gamma R/(W-D+\gamma R).$$

As a consequence, (16) assumes the form

$$\tilde{B}(r,r^*,Py/(W-D+\gamma R))(W-D+\gamma R) = B^* + \gamma R, \tag{17}$$

showing that $\tilde{B}(r,r^*,Py/(W-D+\gamma R))(W-D+\gamma R)$ can be interpreted as the public's total demand for claims on future payments denominated in foreign currency. Under the present assumptions, (13) becomes

$$\tilde{H}(r,r^*,Py/(W-D+\gamma R))(W-D+\gamma R) + F(r) = 0, \tag{18}$$

which yields the reduced-form interest rate $r = \rho(P,W-D+\gamma R)$. The conceptual experiment of a central bank confiscation of foreign assets again shows that no term of form $\gamma R/(W - D + \gamma R)$ can be an argument of $\tilde{H}(...)$.

We can now consider the effect of an open-market purchase of domestic debt when the central bank supports the exchange rate through operations in interest-bearing reserves. Total discounted wealth rises momentarily thanks

to the fall in future tax liabilities to the government. This leads to an incipient excess demand for foreign exchange and domestic debt, and, by (18), to downward pressure on the domestic bond rate. The excess demand for foreign exchange can be accommodated with no change in the exchange rate only through official intervention. As in section 3, the central bank's interest-earning reserves decline and the money supply shrinks as capital flows abroad.

However, the reserve loss is now matched by an equal fall in interest payments from the central bank to the public and a corresponding decline in total capitalized wealth. Because the increase in the public's foreign bond holdings can be no greater than the reserve loss of the central bank, the aggregate stream of foreign currency payments to the public cannot increase. This is the crucial point for our analysis, for it implies that residents can never succeed in extending their net foreign-exchange position by trading newly-created money for central-bank reserves.

What happens? As (17) and (18) show, asset-market equilibrium will be re-established only after the fall in interest-bearing reserves just equals the fall in D, so that domestic wealth, inclusive of capitalized transfer payments, is at its initial level. This leaves the domestic bond rate, and so the national stock of foreign-currency bonds $(B^* + \gamma R)$, unaltered. The end result of the open-market purchase is a transfer of foreign bonds from the monetary authority to the public that exactly offsets the initial increase in the money supply. It must be emphasized that the central bank is forced to buy back instantaneously all the money it has created in spite of the fact that it has no formal obligation to peg the home interest rate.

We see that when the central bank intervenes with interest-bearing foreign securities and all income streams are capitalized by the public,

open-market policy has no effect even in ths short run, for it leaves total wealth and the perceived portfolio composition unchanged. Only the composition of the asset side of the central bank's balance sheet is affected. An open-market purchase, say, causes an equal transfer of reserves from the central-bank portfolio to private portfolios, with no net increase in the money supply. The increase in the central bank's domestic assets is thus offset, fully and instantaneously, by a fall in its foreign assets. The reserve loss entails a decrease in total discounted wealth as perceived by the public, a decrease that just offsets the increase in wealth due to the fall in future tax liabilities to the government. This mechanism, which allows the asset markets to remain in equilibrium at the initial interest rate and price level, is absent when the central bank pegs the exchange rate through transactions in foreign assets that earn no interest. For a fall in reserves, in that case, involves no fall in the stream of foreign currency payments from the government to the public. A transfer of foreign assets from the central bank to the public enables the latter to escape the tax that the central bank imposes by holding official reserves in an unproductive form.

The analysis, so far, has assumed that the home country is small, in the sense that shifts in its behavioral relations exert no influence on the world interest rate or price level. The assumption may be relaxed with no change in this section's conclusions regarding the effects of open-market policy. Even when a country is large in the above sense, open-market monetary expansion leads only to a transfer of foreign securities from the central bank to the domestic public; and this leaves the equilibrium of home and foreign bond markets undisturbed. The conclusion is at variance with Mundell's (1964) finding that the central bank of a large country will alter the level of economic activity at home and abroad through its open-market policy.

5. Conclusion

This paper has studied the conduct of open-market policy in a world in which individuals fully capitalize or internalize all income streams. We have found that even when assets denominated in different currencies are imperfect substitutes in portfolios, open-market monetary policy has no long-run effect and possibly no short-run effect when the central bank holds the exchange rate fixed. Under these circumstances, the neutrality propositions of the portfolio-balance model of international asset markets are much stronger than those of the "capital-flow function" model it has supplanted.

The results have implications for a world of managed floating as well as for a world of rigidly fixed rates. An extension of our arguments shows how sterilized intervention in the foreign exchange market will be a self-defeating policy when intervention assets bear interest. A sterilized purchase of foreign exchange, for example, entails a transfer of interest-earning foreign assets from the public to the central bank, a rise in domestic holdings of government debt, and an equal increase in the present value of future taxes--an operation that leaves the asset markets unperturbed because all central-bank interest earnings are returned to, and capitalized by, the public. Only when the public fails to capitalize the relevant income streams, or when the government taxes its citizens by holding the intervention medium in barren form, is it possible to attain independent exchange-rate and money-stock targets in the short run through domestic debt management.

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Figure 2

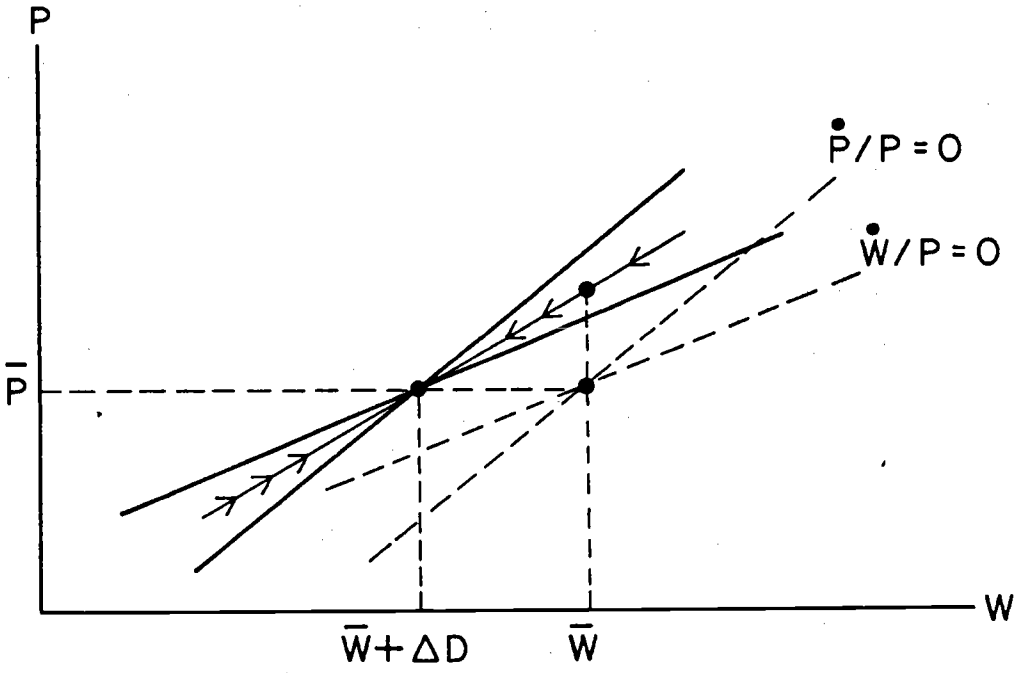

Figure 1