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ECONOMIC GROWTH: A FEEDBACK MECHANISM.

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THE BALANCE OF PAYMENTS, MONEY, AND ECONOMIC GROWTH: A FEEDBACK MECHANISM

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By

Won-Key Kwon

Dissertation Committee:

H. Robert Heller, Chairman
Raburn M. Williams
Youngil Lim
James E. T. Moncur
Yeong-Her Yeh

ABSTRACT

On one hand, post-War writings on economic growth and the balance of payments have concentrated on the effects of growth on international payments accounts. On the other hand, literature on monetary growth theory, initiated by Tobin's (1965) seminal article, has been concerned with the role of money in the growth paths of real variables of a closed economy. In these models money is created costlessly through government budget deficits (outside money creation) and/or credit creations of the commercial banking system (inside money creation).

In an open economy under a regime of fixed exchange rates, however, the balance of payments position can affect the money supply through a change in foreign reserve holdings which is an important component of the monetary base of the economy. Recognition of the monetary effect of the balance of payments may enable us to integrate the current two separate theories of monetary growth and international payments of an open economy in the growth context.

In this dissertation, I formulate a feedback mechanism through which the balance of payments and economic growth interact with each other in a small open economy under a fixed exchange rate system. Such an integration is argued to bridge the gap that exists in the current literature on the two separate theories and thereby gives richer implications for the growth policy.

Our open model of the synthesized monetary growth theory is an extension of the existing closed model to a small economy open to international trade and capital movements with the introduction of additional factors pertinent to a small open economy: (1) monetary effect of imbalances in international payments; (2) inflationary pressure in the commodity market resulting from trade imbalances; and (3) the role of international capital inflows in capital accumulation.

In this framework, it is shown that capital mobility is crucial in the determination of the short-run stability and the effect of a change in the growth rate of foreign reserve holdings on the steady state capital intensity. Under perfect capital mobility, the loss of freedom to change the nominal rate of interest is the main source of short-run instability.

In the open model of the synthesized monetary growth theory, compared with closed model, the degree of the "openness" of the economy is also crucial for the short-run stability. Under capital immobility monetary growth resulting from the foreign source of monetary assets has the same steady state effect on capital intensity as under a closed model; whereas under capital mobility the steady state effect of such monetary growth on capital intensity is ambiguous, depending, to a significant degree, on the real balance effect in domestic expenditures.

On the basis of a general equilibrium model, we used portfolio adjustment theory of international payments in order to generalize and extend the Komiya-Mundellian analysis of the effect of economic growth on the balance of payments accounts. In sharp contrast to the results obtained from traditional Keynesian analysis, it is shown that economic growth, as a process of capital deepening over time, tends to improve both the overall and the trade balances in per capita real terms with deterioration on the capital account. The assumption on capital mobility is not crucial in the qualitative determination of this "impact" effect of economic growth on international payments accounts, but is significant only for the quantitative measurement of the intensities of the effect.

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CHAPTER I

INTRODUCTION

Recent developments of monetary growth theory have examined the role of money in economic growth and have attempted to integrate monetary and growth theory in the context of the closed economy. The formal literature on economic growth has until recently been mainly non-monetary in nature. In these models, patterns and levels of economic growth are determined largely by such non-monetary factors as productivity and thrift. Money plays, at most, a negligible role, and usually an implicit one.[1]

Beginning with Tobin's (1965) article, the Neoclassical approach[2] assumes that: (a) the rate of capital formation is identically equal to planned savings and (b) markets are always in equilibrium regardless of the rate of price change. This approach attempts to introduce monetary variables into the growth model of the closed economy developed by R. M. Solow (1956, pp. 65-94).

On the other hand, the Keynes-Wicksell approach[3] assumes that: (a) there are independent savings and investment functions and

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[1]Money does not appear to be conceptually absent from these models. They are not founded on any non-monetary theory of transactions, but rather on the function of money as a medium of exchange which is conceived as being produced costlessly by some outside agency.

[2]See Tobin (1965), Johnson (1967), Sidrauski (1967), Levhari and Patinkin (1968), Marty (1968), Foley and Sidrauski (1970), and (1971).

[3]See Stein (1966), (1969), Hahn (1969), Stein and Nagatani (1969), Rose (1969), Tsiang (1969), Stein (1970), (1971), and Fischer (1972).

(b) price changes are related to an excess demand for or an excess supply of goods and services. During inflationary periods, when all demands cannot be satisfied, capital formation may differ from planned savings. The object of this approach is to formulate a general macro-economic model which contains money regardless of whether it is a liability of the government or of a privately owned banking system. If the inputs of labor and capital were arbitrarily fixed, then it would be similar to the dynamic version of Don Patinkin's (1965) short-run aggregative model. Alternatively, this growth model would be the generalization of post-Keynesian macro-economics to a growing economy where the input of capital is endogenously determined and growing over time. The long-run dynamic equilibrium is the steady state solution of the short-run dynamic model with endogenous capital.

A model which synthesizes the Neoclassical and the Keynes-Wicksell model is called the Synthesis model.[1] It is Keynes-Wicksellian outside the steady state, but becomes a Neoclassical model in the steady state. In this method it is assumed that the rate of price change is affected directly, as well as indirectly, by price expectations. In other words, prices may change not only because of excess demand but also because they are expected to change, that is, prices are assumed to change even if the market is cleared.

In these monetary growth models of a closed economy, money is created exogenously through government budget deficits and is injected into the economy. A change in the rate at which the monetary

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[1]See Stein (1970), (1971), and Fischer (1972).

authority is increasing the costless money supply (fiat money) can affect the rate of capital accumulation, and so the growth path of the economy. They neglect, however, money creation through the foreign sector; that is, they do not pay attention to the effects of the balance of payments on the monetary growth path. New money can be created from the balance of payments position, particularly in a "small" open economy.[1] The new money created from the country's balance of payments imbalance may be used as one of the possible sources of economic growth. However, the process through which this new money is injected into the economy differs from the channeling process of government deficit-created money into the closed economy.

The recent literature on growth and the balance of payments, on the other hand, has concentrated on the effects of growth on the balance of payments in a "small" open economy[2] and neglected the process through which the balance of payments position affects the growth path of an open economy through its monetary effects. Contentions on the relationship between economic growth and the balance of payments have not taken into consideration the balance of payments effect on capital accumulation and growth.

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[1]In an open economy under a regime of fixed exchange rates, money supply would become an exogenous variable given by the balance of payments. For this, see Mundell (1968), Chapters 11 and 15. Unless there is complete sterilization of international payments imbalance, a balance of payments disequilibrium will have the monetary effects under fixed exchange rates.

[2]See Mundell (1968), Chapter 9, Komiya (1969), Dornbusch (1971), and Laffer (1972).

Here we will attempt to integrate the balance of payments theory into the Synthesis model of monetary growth and formulate some feedback mechanism through which growth and the balance of payments interact with each other.[1] This integration of the balance of payments theory with the synthesized monetary growth model will bridge the gap which exists in the current literature on separate two theories of monetary growth in a closed economy and the balance of payments in a growing economy.

The analysis proceeds as follows. Chapter II reviews briefly the three variants of the moneatry growth models in a closed economy. Chapter III develops a simple model of the money supply process in a small open economy. In Chapter IV the role of the balance of payments in the growth of a small open economy is analyzed in the framework of the Synthesized monetary growth model. Effects of economic growth on the balance of payments are investigated in Chapter V. Chapter VI contains final conclusions and comments.

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[1]The brief sketch of the static (stationary) feedback relationship between the foreign sector and domestic economy is presented in Branson (1972), Chapter 15.

CHAPTER II

A SURVEY OF MONETARY GROWTH THEORY IN A CLOSED ECONOMY[1]

Monetary growth theory has been concerned with the role of money in a growing, closed economy. Money is a medium of exchange and a store of value which may or may not be costless to create. Furthermore, money is a liability of either government (outside money) or the private banking system (inside money).

As was appropriately pointed out by Stein (1970), the central issues in closed models of monetary growth theory are: (1) To what extent can monetary policy and other financial policies together with institutional arrangements affect the time profiles of the capital-labor ratio, the real wage, and the rent per unit of capital? (2) Can variations of the rate of growth of money affect the time paths of, and steady state solutions of, these real variables in a growing, closed economy? (3) How can we attain an optimum growth or supply of the various types of money, if such an optimum growth exists?

There are several different ways of analyzing the effects of monetary and other financial policy[2] in a growing closed economy. In this chapter we shall critically review the present state of knowledge of money and economic growth in a context of a closed economy, but we make no pretense of completeness.

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[1]For this survey of literature on monetary growth theory, I heavily depend on excellent review articles by Stein (1970), (1971), and Fischer (1972).

[2]Here monetary policy is regarded as changes in the rate of monetary expansion rather than changes in the money rate of interest.

Underlying the various approaches is a simple framework for the analysis of economic growth in a single sector economy. It is assumed that full employment always prevails and the labor force, N_t, grows exponentially at a constant rate of n.[1] If technological change is of the Harrod-neutral type, then n may be interpreted as the growth of "effective" labor: the natural rate of growth plus the rate of Harrod-neutral technical change. Output, Y_t, depends upon the inputs of capital services, which are assumed to be positively related to the capital stock, K_t, and of effective labor services, i.e., $Y_t = Y(K_t, N_t)$. This production function is assumed to be linearly homogeneous and smooth and concave, and capital and labor are assumed to be essential for the production of output.

It is assumed that all money is costless to produce. As to the role of money in a single sector economy, the following arguments can be made: To avoid the complication of a multi-sector model, assume that the relative prices of a vector of goods are fixed. Thereby, we act as if the economy produced a single composite good. Insofar as the elements of the composite good are produced in different firms, there is a need for a medium of exchange to avoid having to pay the workers in kind. The output produced by a worker consists of an element of the composite good, but his consumption consists of the composite good. It is assumed that each household or firm is directly aware of the advantages of having the medium of exchange.

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[1]Labor forces is measured in terms of efficiency units and $N_t = N_o e^{nt}$.

2.1 Neoclassical Monetary Growth Models

I. The Logical Structure

Neoclassical real growth models of the Solow-Swan and Meade variety do not incorporate money into their analyses. Recently there have been a number of attempts [Tobin (1965), Sidrauski (1967), Johnson (1967), Lavhari and Patinkin (1968), and Marty (1968)] to extend these real models by assuming that wealthy owners can hold both physical capital and real money balances in their portfolios.

The seminal article by Tobin (1965) shows how a change in the rate at which the monetary authority is increasing the money supply (M^s) can affect the rate of capital accumulation, and so the growth path of the economy. A rise in the rate of expansion in the money supply eventually increases the rate of inflation ($\dot{p}/p$).[1] Money would then depreciate in real terms, so that the opportunity cost of holding money would have risen.

With a reduced stock of real money balances, the money increments which people would be absorbing into their portfolios must fall in real terms. Consequently, a greater quantity of real resources would then be available to be channeled into accumulation of the alternative asset, capital.

Alternatively, to the extent that the real value of the new money people receive is considered as part of their disposable income, savings (S^*) would also increase under Tobin's assumption of

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[1] . is the time derivative of a variable in question ($^d/dt$), e.g., $\dot{p} = dp/dt$ where p is the domestic general price level.

proportional savings function.[1] The Neoclassical monetary growth theory in a closed economy assumes that the rate of capital formation ($\dot{K}$) is identically equal to domestic savings (à la Solow) and all markets are always in equilibrium (Equilibrium Model), regardless of the rate of inflation. Monetary policy affects the consumption function in this model, even in the steady state.[2] In this manner, monetary policy could affect the equilibrium capital intensity.

Changes in the rates of growth of nominal stock of money produce expected rates of inflation which are reflected in the opportunity cost of holding real money balances. The higher the expected rates of inflation, the smaller the stock of real money balances people are induced to hold, and when a real balance affect is assumed in the savings function, the higher will be the ratio of investment to income. It follows that the higher the expected rate of inflation the larger will be the capital-output ratio, the capital-labor ratio, and output per capita.

This conclusion represents a simple extension of Mundell's (1963) analysis of the effects of alternative rates of price change in a short-run model to long-run balanced growth paths. Mundell (1963)

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[1] $S^* = s\ Y^d$ where s is the marginal propensity to save out of real disposable income (Y^d) ($0 < s < 1$) and $Y^d = Y + (M^s/p)(\dot{M}^s/M^s - \dot{p}/p)$.

[2] Sidrauski (1967) derived a long-run consumption function which is independent of monetary influences. His money-neutral consumption function was derived from the two assumptions of utility maximization over an infinite horizon by immortal family and constant rate of time preference.

showed that the presence of a real balance effect in the savings function would cause a fully anticipated rate of inflation to be split between a rise in the nominal rate of interest and a fall in the real rate of interest--the fall in the real rate is a consequence of a rise in the ratio of net investment to income. Projected into the long-run context, the rise in the ratio of investment (I*) to income changes the real variables of the balanced growth path: Non-neutrality Theorem of Money.

Therefore, in any version, monetary policy is able to affect the time profile of capital intensity and its steady state solution as long as monetary policy can shift the savings function even if money is costless to produce. This change in equilibrium capital-labor ratio, however, can also be brought about by shifts in production function (i.e., changes in real income) which change savings, also affecting the time profile of the capital intensity as well as its steady state solution.

The Neoclassical model considers how and under what conditions monetary policy (variations in the rate of monetary expansion) can shift savings function (Real Balances as a Consumer Good) or production function (Real Balances as a Producer's Good) within a fully employed closed economy. Accordingly, a dichotomy is made concerning the role of real money balances in the growth model.

The significant features of money are that it is a medium of exchange and a store of value. An important question arises as to the role of money as an argument in savings function if savings depend on

monetary wealth.[1] Another important question is: Does the real balances, regardless of who issues the money, affect the productive capacity of the economy (money as a producer's good)?

II. Money as a Consumer Good

Furthermore, Johnson (1967) and Levhari and Patinkin (1968) view the services of real money balances as a component of real disposable income which is consumed, but they take different measures of this imputed value of money services.

Johnson (1967) tried to generalize Tobin's conclusion to the case of a savings function which depends on the ratio of wealth to income, and he also introduced an additional factor into the model: Money must provide some flow of (direct) utility or "convenience services" to the holder; otherwise, it would not be held.[2] He argues that this flow of services is a component of real disposable income which is consumed, and it is arbitrary to exclude, as Tobin does, the imputed value of services from real disposable income. He measures the imputed value of flow of services of real balances as the integral (area) under the demand curve for real money balances per worker.[3]

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[1]This problem is more serious if we distinguish a real balance effect on outside money from that on inside money.

[2]Johnson does not consider here productive services of money. For this services, we shall discuss later.

[3]In this respect, Johnson's approach is sometimes called as the utility approach toward the imputed value of services of real money balances.

This new factor renders ambiguous the effect of a change in monetary policy on the rate of capital accumulation. If a higher rate of inflation reduces the stock of real money balances, it must also reduce the imputed income received from this stock. When the savings function is positively proportional to real disposable income, saving would fall as well. This would be somewhat offset by the diversion of resources from money accumulation. There would no longer be any presumption, however, that this effect would dominate.

The ambiguity arises from the existence of offsetting changes in two important factors: (1) the proportion of material (non-monetary) income which is saved, and (2) the amount of savings which is channeled into real money balances.[1] Within this special institutional framework, the impact of monetary policy on capital accumulation would depend only on any induced changes in the proportion of material income which is saved.

Levhari and Patinkin (1968) take a different approach. They measure the imputed value of flow services of real balances by the opportunity cost of holding real money. In the presence of positive

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[1]Johnson (1967) postulated that money supply is increased through government transfers rather than through open market operations. If money supply could be increased only through the purchase of capital goods, then all savings would be channeled into capital accumulation, either private or government.

nominal rate of interest, ρ, the opportunity cost of holding real money balances represents the value of money services at the margin.[1]

By analogy with national income accounting principle, the imputed value of flow of services of real money balances per worker, which is a component of the real disposable income, would then be ρ_m, where m is the stock of real balances per worker.[2]

There are serious criticisms to both approaches of measuring the imputed values of flow services derived from real money balances. First, the usual definition of real national income accounting is violated. Real output is presumably measured in constant prices. Each item in the bundle of output is valued at constant prices, and the total is summed. This is not done for the services for the real money balances.

Marty (1968) rejected the inclusion of both utility yield (à la Johnson) and the increment in real money balances received by money holders in real disposable income. He claims that money as wealth provides a flow of income solely in the form of services and it would be double counting to include "an independent source of variation in disposable income."[3]

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[1]The expected yield on real balances, when there is the expected rate of inflation and there is no bond market such that ρ is the nominal rate of interest on deposits, is $(\rho - \pi^*)$. The expected (real) yield on physical capital is the current rent, r(k), if the expected rent is equal to the current level. Therefore, the opportunity cost of holding real balances is $r = (\rho - \pi^*)$ or $(r + \pi^*) = \rho$ in equilibrium.

[2]This approach is, therefore, called as a national income accounting approach.

[3]See Marty (1968), p. 865.

For example, according to Levhari and Patinkin, a fall in the opportunity cost would increase the stock of real money balances, but the imputed income from this increased real balances would nevertheless fall under their approach. Furthermore, if there existed a saturation of real money balances at which opportunity cost of holding money is zero, then the imputed income from the real balances would be zero under Levhari-Patinkin definition. Real income would be the same as in a barter situation. Such paradoxical results occur because the national income accounting approach of money services excludes the consumer's surplus accrued from these services under the utility approach. Second, there is a difficulty in interpreting the real balance effect under both approaches. Since total real consumption, consisting of two components (consumption of goods and the consumption of the services of real balances), is a constant and positive fraction (the marginal propensity to consume) out of real disposable income, the consumption per worker is directly derived from each definition of real disposable income.[1]

III. Money as a Producer's Good

To the extent that real resources are diverted from the search for the double coincidence of wants required by a barter economy, money is also viewed as a producer's good generating a productive services, regardless of the types of money (whether inside or outside type of money).[2] Money as a producer's good is complimentary (or cooperative)

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[1]This was pointed out by Stein. See Stein (1970), p. 95.

[2]Inefficiency of a barter economy and the implication of this role of money in a closed model of Neoclassical monetary growth theory are clearly expounded by Levhari and Patinkin (1968) and Marty (1968).

with labor and capital in a given production function. An explicit medium of exchange increases the productivity of the economy by permitting more efficient means of distribution with given endowments of non-monetary resources (labor and capital).

There may be a real loss to society resulting from a reduction in real balances below a certain level.[1] Either there must be more frequent payments, involving additional bookkeeping and other administrative expenses, or part of one's wage will be paid in kind entailing the use of some barter. For these reasons, aggregate production function may be a monotonic nondecreasing function of real money balances.[2] A rise in real balances would permit an increase in real output, and so a rise (shift) in savings would take place. If this increase is large enough to outweigh the rise in the accumulation of real money balances, the capital accumulation would rise as well.

Compared with money as a consumer good, money as a producer's good applies equally to both outside and inside types of money since both types of money serve equally as a medium of exchange. Consequently, there is no problem of distinction between both types of money when money is at work in the production function as a productive service.

At the same time, the expected return on real money balances has now two components: the expected marginal product of real balances and the expected appreciation (the negative of the expected rate of

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[1]This also partly gives the importance to the problem of optimal quantity of money supply.

[2]$Y_t = Y[K_t, N_t, (M^s/p)_t]$; $\partial Y/\partial(M^s/p) \geqq 0$.

inflation, $-\pi^*$) in terms of its command over goods and services.[1] Consequently, we can derive the portfolio equation (money market equilibrium condition in a two assets model) by setting the expected return on capital, which is assumed to be equal to current rent on capital, equal to the expected return on real money balances since portfolio balance equilibrium requires the net expected yields from each type of private assets to be equal.

2.2 Characteristics of Keynes-Wicksell Model

The Neoclassical model has been extended in the context of the so-called Keynes-Wicksell model.[2] In sharp contrast to the Neoclassical model, this class of models introduces several new elements--for example, independent investment and savings functions that give the models a Keynesian nature. The Wicksellian feature of the model also lies in the specification of the investment function in which an increase in the difference between nominal return on capital and the nominal rate of interest raises domestic investment.[3]

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[1]Stein (1970) introduces "liquidity" yield of money which reflects feeling that usually real money balances are safer to hold than real capital, but this liquidity yield is different from the direct utility of services of real balances *à la* Johnson.

[2]The major references here are Stein (1966), (1969), and (1970). See also Rose (1966), (1969), Hahn (1969), Stein and Nagatani (1969), and Tsiang (1969).

[3]Real investment function is assumed to depend on real output, nominal return on capital $(r + \pi^*)$, the nominal rate of interest (ρ), and real monetary wealth (W/p): $I^* = I^*(Y, r + \pi^*, \rho, W/p)$; $I_1^* > 0$, $I_2^* > 0$, $I_3^* < 0$, $0 < I_4^* < 1$. From the investment function, $[r(k) + \pi^*] - \rho = r(k) - (\rho - \pi^*)$ where $k \equiv K/N$ and $r(k)$ is the natural rate or marginal product of capital, and $(\rho - \pi^*)$ is the real rate of interest. Real savings are assumed to depend on real output and real monetary wealth: $S^* = S^*(Y, W/p)$; $S_1^* > 0$, $S_2^* < 0$.

The really critical innovation is the allowance of disequilibrium in the commodity market and thus of Walrasian price dynamics. The Keynes-Wicksell model aims to integrate the dynamic short-run macro-economic model into the growth process. If the inputs of labor and capital are fixed, then it would look like a dynamic version of short-run Keynesian IS-LM model. This Keynes-Wicksell growth model has been argued to be the generalization and extension of the usual Keynesian macroeconomic model to a growing economy, where the capital stock is endogenously determined and growing over time. Long-run equilibrium is nothing but the steady state solution of the short-run dynamic model with endogenous capital; and the short-run dynamic model is a special case of the general growth model.

There are two versions of Keynes-Wicksell models: (1) a full-employment model [for example, Stein (1966), (1969), (1970), and Tsiang (1969)] and (2) and unemployment model [for example, Rose (1966), (1969), and Nagatani (1969)].

The fundamental assumption of this class of models concerns the price dynamics over continuous time in which prices are changing if, and only if, there exists domestic excess demand for commodities (Dynamic Walrasian Tatonnement Process).[1] It is assumed that the

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[1]In the dynamic Walrasian system $\dot{p} = \zeta G(p)$; where ζ is a coefficient vector of price adjustment $(0 < \zeta < \infty)$ and p is a vector of prices $(p_1, p_2, \ldots, p_n)$, and G(p) is a vector of excess demand (supply) in the n markets. The equilibrium price vector p_e is such that $G(p_e) = 0$. In the Neoclassical model $\zeta = \infty$ such that equilibrium in all markets is always maintained.

actual rate of price change (π) is positively proportional to excess demand for commodities, as was shown by Tobin (1955). Therefore, by invoking the Walrasian dynamic process of price adjustment, they extend the Neoclassical equilibrium model of growth, where instantaneous equilibrium in all markets is always implied, to the disequilibrium model of growth theory. Price expectations, working through investment and through excess demand in commodity markets, produce price changes, but they do not raise prices by themselves.

When the market does not immediately adjust to disequilibrium, the actual rate of capital accumulation need no longer to be reconciled to saving plans. If, for example, excess demand is created in the commodity market, forced saving could occur, so that additional capital accumulation would take place even if saving plans were to remain unchanged. A natural bridge is created between the short-run and long-run equilibria in this set of models. The Patinkin (1965) model is a special case of the first version of Keynes-Wicksell model, where there exists forced savings during inflationary periods and the actual rate of capital accumulation exceeds savings but is less than planned domestic investment, i.e., $S^* < (dK/dt) < I^*$. The second version stands on a variable rate of productive capacity utilization. The rate of utilization varies positively with the rate of price change.

Both versions of Keynes-Wicksell model imply the non-neutrality of monetary policy on the behaviors of real variables over time, even if there is no real balance effect in the savings function. That is, monetary policy can affect the equilibrium capital-labor ratio, even if

the marginal propensity to save is independent of the rate of monetary expansion, as long as monetary policy can affect the equilibrium actual rate of inflation.

The rise in the rate of monetary expansion is interpreted by economic agents as an overture of a greater rate of inflation. This price expectations give rise to an increase in investment. Excess demand in commodity market tends to raise the actual rate of inflation. Thus the chain of causation has run from the expected to the actual rate of inflation.

In Keynes-Wicksell models, market disequilibrium is generally a permanent state, compatible even with steady state growth. We are able to, then, permanently raise the capital-labor ratio by inducing a permanent excess demand in the commodity market. As a result, the Keynes-Wicksell model is far richer than the Neoclassical model in the conclusions which may be derived from it. The speed of price adjustment in response to the pressure of excess demand (inflationary gap) in commodity market and price expectations (whether elastic, inelastic, or unitary) are critical in the determination of the effect of monetary policy on the equilibrium values of long-run capital intensity and other real variables.

If prices respond slowly to the inflationary gap such that the actual rate of inflation rises at a slower rate than the rate of monetary expansion, several effects are possible: (1) the stock of real balances must rise since the rate of monetary expansion has increased relative to the rate of price change; (2) there will be an increase in excess demand since the aggregate demand has increased relative to aggregate supply in the commodity market.

As a result of the rise in real money balances, both consumption and investment will increase, and the inflationary gap will be aggravated. Since the actual rate of inflation is proportional to the inflationary gap, there will be a rise in the rate of inflation. There are two stabilizing forces: (1) rigidity of price expectations [$\pi^* = \dot{M}^S/M^S - n$ or $\dot{\pi}^* = \beta(\pi - \pi^*)$] and (2) real balance effect. As long as the actual rate of inflation is lower than the rate of the monetary expansion per worker (or expected rate of inflation), real balances per worker increase and this encourages a further rise in the actual rate of inflation. Eventually, the growth in real balances raises the rate of inflation until it is equal to the growth rate of the money supply per worker. At that point there will be no further rise in the rate of inflation.

The increase in the stock of real balances has two mutually counteracting effects on the rate of capital accumulation: (1) lowering capital intensity by decreasing savings through real balance effect; and (2) raising capital-labor ratio by encouraging investment through real balance effect.

If the actual rate of capital accumulation is primarily determined by planned savings (or if the former real balance effect dominates), there will be a decline in capital intensity, contrary to the Neoclassical model. If the actual rate of capital formation is primarily determined by the planned investment (or if the latter real balance effect dominates), capital intensity will rise due to an

increase in capital formation through a rise in investment, that is, the Neoclassical result is obtained.

In fact, one of the problems of Keynes-Wicksell model is that, once the basic premise of permanent disequilibrium is accepted, a wide variety of assumptions can be reasonably made about the nature of equilibrium.[1]

Moreover, under this basic premise of permanent disequilibrium, the long-run equilibrium (steady state) has little meaning. The implication is that people fail to learn from their experience or are unable to apply the lessons of experience. Not even continuous failure to fully realize saving and/or investment plans would lead people to revise these plans.

Very little is known about the behavior of people in disequilibrium situations and the question of output allocation between investment and savings in periods of excess demand or supply has not yet been resolved, as was shown above. It would be unfair to expect too much from the Keynes-Wicksell model in this respect. At the same time, a permanent

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[1]For example, in disequilibrium, is the investment or the savings plan to be realized? Hahn (1969) assumes the former, Stein (1966) and Nagatani (1969) the latter, while Rose (1969), Stein (1969), and (1970) assume that actual investment is a linear combination of the two plans, i.e., $dK/dt = a\ S^* + (1 - a)\ I^*$, where a is a constant and $0 < a < 1$. Similiarly, when the commodity market is not in equilibrium, this must also be true of some other market (by Walras' law). In Stein (1966), this is the bond market, while in Stein (1969), it is the money market.

disequilibrium state must imply the failure of the competitive market system to establish a stable Walrasian equilibrium which Keynes-Wicksell model tries to attain through dynamic groping process. These criticisms apply equally to the second version of unemployment models.

When money wages are not perfectly flexible, the real wage can be forced down by increased inflation and thereby it may lower the capital-labor ratio. This change, however, could not be permanent unless money wages were prevented from adjusting to a higher rate of inflation.

In conclusion, at the present state of the theoretical development it might be inappropriate to introduce permanent market disequilibrium into a long-run analysis. The major problem in this set of models is the absence of its analytical conception derived from microeconomic foundation. As a result, we may frequently find an excessive degree of *ad hoc* theorizing in many of these models.

2.3 Synthesis Model of Monetary Growth Theory

In the set of Keynes-Wicksell models a steady state with inflation requires persistent excess demand and accordingly individuals are continuously frustrated in obtaining the commodities they demand, even though their demands are based on correct expectations and perception of price level. This is an unsatisfactory property of the steady state, as was indicated in our criticisms on Keynes-Wicksell models.

Regarding the price dynamics, if we postulate that prices could be expected to change in response to expectations, we could fortunately resolve the basic premise of Keynes-Wicksell model, that of permanent disequilibrium.

As was suggested by Stein (1970) and Fischer (1972), a possible synthesis of Neoclassical and Keynes-Wicksell monetary growth models in a closed economy could be made if the price adjustment equation is revised to include the direct effect of price expectations on the actual rate of inflation. Keynes-Wicksell models use the dynamic price adjustment equation relevant to a perfectly competitive market and price expectations were assumed to affect the actual rate of inflation indirectly through their effect on domestic investment.

However, in somewhat less-than-competitive markets, some firms can set the prices of their products. Since the existence of permanent disequilibrium is inconsistent with assumptions of perfectly competitive market, we may expect price-setting by firms in industries for which the competitive model is adequate for comparative static analysis.

The actual rate of price change, then, may be the sum of the two components: the price setting firms' expectation of inflation and the actual state of excess demand for commodities. Thus, we are able to show this new dynamic price adjustment process by use of the following equation: $\pi = \pi^* + \lambda(I^* - S^*)/N$ where λ is the speed of price adjustment in response to the pressure of excess demand per effective worker.

Therefore, in the Synthesis model, market disequilibrium prevails only when the actual and expected rates of inflation differ from each other. A change in the monetary expansion may produce a temporary market disequilibrium, that is, a temporary deviation between planned domestic investment and savings.

Once price setting firms fully anticipate the new rate of inflation, they will change prices at this rate without any concomitant excess demand or supply. The really critical difference between the Synthesis and Keynes-Wicksell monetary growth models is created by the direct effect of the price expectations by price setters on the actual rate of inflation.

The actual rate of price change, therefore, tends to be cumulative due to the existence of this direct effect of the expected rate of price change in addition to the indirect effect working through the expenditures. This, however, produces more unstable short-run and long-run equilibria compared with the Keynes-Wicksell model.

Yet the Synthesis model retains all other characteristics of the Keynes-Wicksell model. In this Synthesis model, monetary policy always generates the Neoclassical result in the steady state. A rise in the steady state rate of inflation will lower real money balances per worker and thus planned savings per worker increases. The steady state capital intensity, therefore, will rise.

It is assumed that the decline in real balances does not significantly reduce the output produced from fully utilized resources. Since all markets are in equilibrium in the steady state, the ambiguity of the Keynes-Wicksell models no longer arises in the Synthesis model.

The long-run capital intensity of the economy will be affected by financial variables in this model only if they affect planned savings per worker. If there is a negligible real balance effect in the savings function, a rise in the rate of monetary expansion (monetary policy) will only exert an ephemerial effect on capital intensity.

To sum up: As in the Neoclassical model, there are no longer disequilibria in commodity market in the steady state of the Synthesis model. The reformation of the dynamic price adjustment equation by introducing the direct effect of the expected rate of price change by price setting firms on the actual rate of inflation is sufficient to remove the most prominent unsatisfactory feature of the Keynes-Wicksellian disequilibrium monetary growth models. However, we need further developments and extensions of the Synthesis model to resolve the still lingering problems of allocation of output between savings and investment in periods of inflation and/or deflation.

CHAPTER III

A SIMPLE MODEL OF THE MONEY SUPPLY PROCESS IN AN OPEN ECONOMY

Under the present international monetary system of fixed exchange rates and capital movements, countries with a balance of payments deficit lose foreign reserves (gold and foreign currencies) and those with a surplus acquire foreign reserves. Such flows of foreign reserves may affect the growth of a nation's money stock. A controversial issue for each open economy, particularly for a small open economy with a relatively large foreign sector, is whether its monetary authorities can neutralize the impact of an outflow or inflow of foreign reserves on the money stock, or whether the present system of fixed exchange rates constrains the domestic monetary policy of these economies. This question is especially relevant to some Western European countries and Japan which have accumulated very large U. S. dollar reserves over the last decade, and are also confronted with substantial swings in their dollar flows.

This chapter briefly reviews the controllability of the money supply in a country whose economy is both highly dependent upon foreign trade, and well integrated into international financial markets, and analyzes how changes in a nation's trade balance and/or net capital flows influence its stock of foreign reserves and growth of its monetary base.[1] Thereby, this chapter develops a model of the money

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[1]For the definition and analytical usefulness of the monetary base in money supply process, see Jerry Jordan (1969).

supply process for an open economy. By arranging the chapter in this manner, the interrelationship between the balance of payments and the money supply is developed step by step. First, the balance of payments influences on the stock of foreign reserves at the central bank are described; then the impact of foreign reserves on the creation of base money is discussed; and finally the influences of changes in base money (or high-powered money) and of the money multiplier on the money stock are analyzed.

3.1 Two Alternative Views on the Controllability of Money Supply in an Open Economy

There are two alternative hypotheses concerning the controllability of the money supply in an open economy under a regime of fixed exchange rates.

I. Uncontrollability Hypothesis

Those who suggest this first hypothesis argue that monetary authorities of a country with continuous balance of payments surpluses, are unable to control the money supply and hence are unable to escape inflation without an adjustment in the exchange rate.[1] Economists of this group are generally in favor of more flexible exchange rates as a means of permitting greater national autonomy in the determination of the money supply and the price level. They blame fixed exchange rates for preventing national economies from adjusting to one another and

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[1]This view was put forth by McKinnon and Oates(1966), pp. 4-6 and Sohmen (1969), pp. 36-37.

from reconciling internal employment and price level objectives with external balance of payments objectives by using "sound" policy decisions.

To illustrate this viewpoint let us assume that world market prices for a country's major export goods are rising relative to prices in that country. Exports of this country will increase as foreigners direct their demand to the relatively cheaper source. The country realizes a trade surplus and receives foreign reserves which, unless offset by central bank actions, increases the stock of monetary base and hence exert an expansionary effect on the money stock. The outflow of goods and the expansion of the money stock increase the demand pressure in the country and lead to an increase in its general price level. If a country introduces a restrictive monetary policy in the short-run, domestic nominal interest rates will increase relative to interest rates in other countries. This will attract international capital, which will increase the stock of base money and hinder attempts of the monetary authorities to slow the growth of the money stock and curb inflation.

A critical point in this argument is that capital flows between countries are highly responsive to changes in international interest rate differentials. Any restriction of the growth of a country's money stock which causes a deviation in its domestic interest rate from the international rate results in an increased inflow or outflow of foreign reserves until the previous interest rate differential is restored. Therefore, the degree of independence of national economic

policy would be rather small. Due to its impact on interest rates, monetary policy is considered to be of particularly limited effectiveness in a system of fixed exchange rates.

Since the interest effect can be weakened if fiscal policy is used, restrictive fiscal actions are considered to be more appropriate than monetary policy in controlling aggregate demand in a country with balance of payments surpluses.[1] In order to achieve this effect fiscal policy actions must meet the following two conditions: (1) they must restrain domestic aggregate demand; and (2) they must reduce interest rates which will result in capital outflow and reduce the balance of payments surplus. These conditions may be met if a tax increase is used to repay the government debt held by the private sector or if government spending is reduced. However, as long as domestic prices are not adjusted to prices in the world market, a growing volume of domestic goods is absorbed by other countries. Foreign demand merely replaces domestic demand without any reduction in total aggregate demand pressure.

According to this hypothesis, under a regime of fixed exchange rates monetary and fiscal policies can have only a short-run effect in restricting domestic demand in countries with balance of payment surpluses. Sooner or later the domestic rate of inflation will reflect the price level trends in the world market. Only for a very limited period can an economy, which is highly open and integrated in the

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[1]For more analytical exposition of this statement in terms of internal and external balance problems, see Mundell (1968), Chapter 18. See also McKinnon and Oates (1966), particularly pp. 20-29.

world economy, control its money stock and resist inflationary pressures from abroad. Moreover, the money multiplier is unpredictable; the commercial banks and non-bank public can change it and therefore can change the money stock to some degree, even if the monetary base (high-powered money) is constant. The influence of monetary forces is not very predictable.

II. Controllability Hypothesis[1]

Assuming that the amount of foreign reserves attracted by a rise in domestic nominal interest rates caused by monetary contraction is smaller than the reduction of the monetary base by monetary authorities, there will be a net restrictive effect on the growth of base money and the money stock. According to this hypothesis, short-term international capital flows will not quickly react to the observed interest rate differentials between two countries. Moreover, transaction costs and risks also affect the capital mobility and thus the interest elasticity of short-term capital movements does not seem to be high. Therefore, the money multiplier, which is critically dependent upon the interest elasticity, is stable and thus the monetary authorities can control the money stock by changing its monetary base in an open economy even under a system of fixed exchange rates.

The above discussion indicates that the main difference between the two hypotheses is that the first (uncontrollability) argument assumes a relatively high interest-elasticity for capital movements.

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[1]This hypothesis is based on empirical studies. See Scott and Schmidt (1964), Baffi (1968), and Willms (1971).

Therefore, the money supply multiplier is highly unstable and thus an open economy cannot control its money stock through a change in monetary base. Which viewpoint is more realistic or tenable must be decided by empirical evidence.

In a relatively open economy foreign reserves are a more important component of the monetary base than in a relatively closed economy. Moreover, if an open economy is relatively small and its domestic capital (or credit) market is not highly developed, then international reserve holdings tends to be an even more dominant component of the monetary (source) base. Consequently, if there is a large inflow of foreign exchange, in order to stabilize the economy (or to curb the high rate of inflation therefrom) there might be such drastic adjustments in the domestic monetary policy (for example, a large volume of open market sales) that neutralize the impact of changes in the source base originating from foreign sector. Such adjustments might be intolerably costly by reducing production or the level of employment.

The offsetting behavior of the monetary authorities with respect to changes in international reserve holdings gives the key to the controllability problem of the monetary base in a small open economy.[1]

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[1]This domestic monetary policy measures taken to neutralize the effect of the imbalance in international payments on monetary source base is called a sterilization policy.

III. The Balance of Payments and the Central Bank's Foreign Reserve Position

The simplest relationship between the balance of payments and the money stock is given by the classical gold standard mechanism of price-specie flow. Whenever a country's exports of goods and services exceeds its imports, its gold stock tends to increase. Since there is a close relationship between the gold and money stocks, an increase in gold leads to an increase in the country's money stock. On the other hand, a country which imports more than it exports, loses gold, and its money stock is reduced. Under such a mechanism, the money stock would be primarily a function of the country's balance of payments.

However, under the present international monetary arrangements, such a close relationship between a nation's gold stock and its domestic money supply is broken. A country's stock of base money can be altered quite independently from changes in the stock of foreign reserves at the central bank.

Changes in foreign reserve holdings at the central bank are the result of the overall balance of payments situation. They are the joint reflection of conditions in domestic and foreign markets for goods and services and financial assets as well as of the domestic economic policy actions.

Changes in stock of foreign exchange reserves at the central bank occur within the following balance of payments equation:

(3.1) $\dot{R} = (X^* - M^*) + \dot{B}^*$

where $\dot{R} = dR/dt$: Domestic currency value of the increment of the stock of foreign reserve holdings

X^*: Domestic currency value of flow of exports of goods and services

M^*: Domestic currency value of flow of imports of goods and services

$\dot{B}^*$: Domestic currency value of net capital inflow (a net increment of stock of real and financial foreign assets)

A surplus in the current account does not necessarily lead to an increase in the stock of foreign reserve holdings at the central bank. Changes in foreign reserves also depend on the capital account. Foreign reserves at the central bank can increase with a balance or even a deficit in the current account. These situations require a surplus in the capital account (net capital inflow), and in the latter case this capital inflow has to be greater than the current account deficits.

3.2 Foreign Reserves, Base Money, and a Model of the Money Supply Process

In the preceding section, the impact of the balance of payments on changes in the stock of foreign reserves at the central bank was described. Now the relationship between foreign reserves and base money will be examined.

Abstracting from the peculiar institutional arrangements to individual countries, the monetary (source) base or high-powered money[1] is generally defined as the net monetary liabilities of the monetary authorities held by the public (commercial banks and non-bank public). More specifically, the monetary (source) base is derived from a consolidated balance sheet of the central government (treasury) and the central bank monetary accounts. A consolidated monetary (source) base for West Germany is illustrated in Table 1. The left hand side of the balance sheet shows the different sources of base money. The right hand side shows the uses of it.

I. Sources of the Monetary Base

The different terms of the source base reflect the impact of the foreign sector, the behavior of the central bank, the behavior of the government, the behavior of the commercial banks or a combination of these influences.

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[1]For further discussions of this concept, see Anderson and Jordan (1968). Here we treated monetary base has the same magnitude as the source base. The reserve adjustment is later treated as a factor of affecting money supply multiplier rather than as an adjustment component to obtain monetary base _à la_ Anderson and Jordan.

Table 1. Monetary Base in West Germany[a]

Sources of the Base			Uses of the Base	
Foreign reserves (R)		50.6	Currency held by the nonbank public (CC)	36.9
Gold (AU)	14.3			
Foreign Currency (FX)	28.4		Commercial bank reserves (CR)	29.8
Others[b] (UR)	7.9			
Domestic monetary assets (D)		16.1		
Discount borrowings (DB)	18.7			
Government securities (GS)	1.2			
Government advances (GA)	2.0			
Government deposits (GD)	-6.7			
Special anticyclical deposits	-5.4			
Others	-1.3			
Coin (CN)	3.0			
Others (UD)	-2.1			
Source Base (A = R + D)		66.7	Base (A = CC + CR)	66.7

[a]December 31, 1970; Billions of Deutsche Marks. Source: Monthly Report of the Deutsche Bundesbank.

[b]Mainly non-bank foreign assets, plus the reserve position at the International Monetary Fund adjusted for SDR.

Figure 1. Base Money and

its Main Sources in West Germany

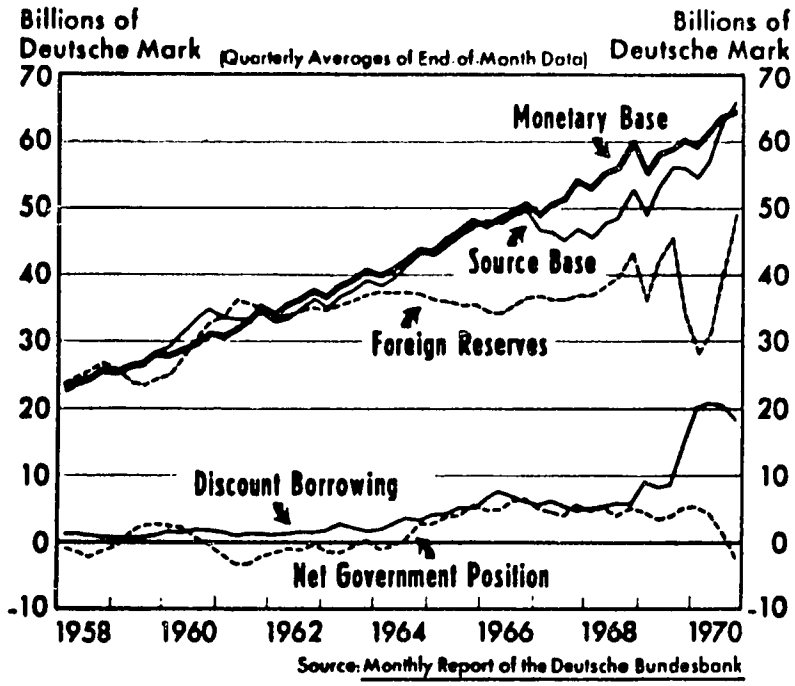
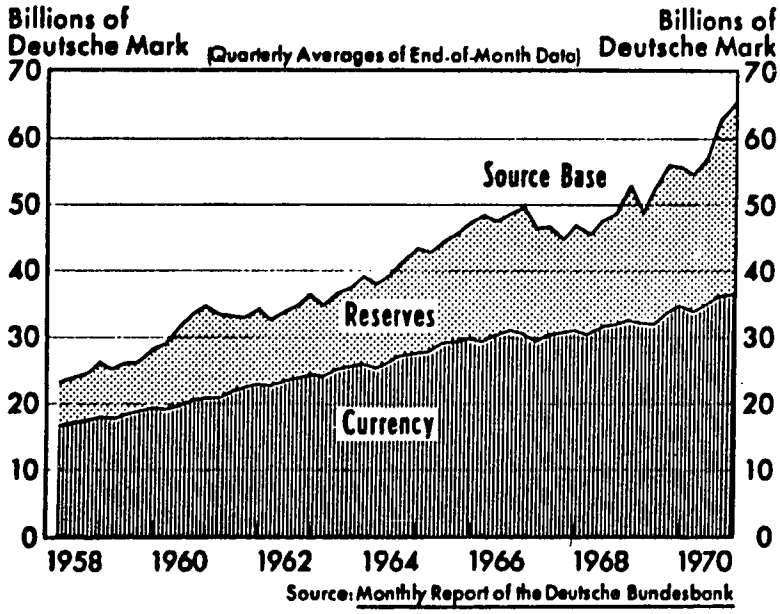


Figure 2. The Uses of Base

Money in West Germany



As indicated above, the stock of foreign reserves at the central bank is equal to the accumulated sum of net balance of payments surpluses of preceding periods. The growth of the source base is determined by foreign reserve holdings (R) and domestic monetary assets (D) held at the central bank. The central bank can control the domestic sources of monetary base by using traditional quantitative monetary policy measures: (1) changes in the discount rate or the discount quota for commercial banks indirectly affects the base money; (2) open market policy directly influences the domestic monetary assets.[1] However, changes in required reserve ratios, which do not influence the stock of the source base, can affect the money stock through changing the ability of commercial banks to create inside money, that is, through a change in the money supply multiplier. Government advances and government deposits can be considered as exogenous variables to the central bank, both of which are under the control of the government (Treasury). The quantitative impact of changes in these two policy measures (open market operations and discount rate or quota policy) are reflected in the monetary base.

Figure 1 illustrates the growth of the monetary base and its dominant source components for the period 1958-1970 in West Germany. According to these two illustrations, it is obvious that foreign

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[1]For the description of the Bundesbank's monetary policy measures taken during this period, see Manfred Willms (1971).

reserves were the largest component of the source (reserve) base, constituting on the average 76.7 percent of the source (reserve) base (the corresponding figure for the U. S. economy is 26.4 percent).[1] Changes in foreign reserves were at times greater than the corresponding changes in monetary base in West Germany, and during these periods the impact of changes in foreign reserves was partly offset or reinforced by adjustments in domestic sources of monetary base.

At this juncture, it might be instructive to consider the main sources of a change in monetary (source) base and the main components of base money in a relatively open economy. Because an open economy is relatively heavily dependent on the foreign sector, in the sense that exports and imports represent a relatively large portion of total income and that external shocks will represent a major source of disturbance,[2] it is quite natural that changes in foreign reserves

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[1]This is the simple average ratio of foreign reserves to the reserve base. This is calculated from the International Financial Statistics, published monthly by the International Monetary Fund.

[2]Relatively small open economies differ from relatively closed ones both in the sources of the disturbances which impinge on them and in the nature of their responses to these disturbances. In a small open economy, fluctuations in exports will tend to be large relative to fluctuations in domestic investment as sources of disturbances to the domestic economy. Such disturbances to the export sector may originate from the changes in the level of income abroad or from such structural shifts as changes in foreign tastes or technology. Disturbances in the export, of course, can also originate internally in the form of domestic technological or other changes which shift the supply curve of exports.

of a small open economy should a fortiori be the largest contributing factor to the change in the economy's monetary base and that foreign reserve holdings are a relatively important component of the economy's base money. In such a small open economy controlling of money supply is likely to be more difficult, mainly due to: (1) flows of foreign exchanges tend to be large relative to its domestic money supply and (2) the instrument of monetary control that has the powerful (swiftest) effect on the monetary base (for example, open market operations) is of limited usefulness to the central bank of the economy with thin markets for short-term credit.[1]

In many countries, international payments surpluses or deficits are said to force expansion or contraction of money supply. It is argued, therefore, that this makes countries vulnerable to "imported inflation"--especially inflation imported from the United States.[2]

II. Uses of Base Money

The demand side or uses of the monetary base, or net monetary liabilities of the monetary authorities, is shown in Table 1 to be currency in circulation, CC, plus commercial banks' deposit at the central bank, CR. Part of the currency in circulation is held by the public, part is held as legal reserves (vault cash) by commercial banks. If we assume that the amount of currency held by the non-

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[1]For this point, see Meigs and Wolman (1971), pp. 19-22.

[2]Meigs and Wolman (1971), op. cit.

bank public follows a relatively stable growth path, then the major fluctuations in the base money are related to changes in the reserve position of commercial banks. Both the total amount of base money and its distribution between currency and reserves plays an important role in the determination of the money supply. The relationship between these variables is derived in the model presented below.

III. A Model of the Money Supply Process in an Open Economy[1]

We analyzed above how monetary source base is influenced by the balance of payments and the domestic policy measures. Now we shall formulate a simple model of the money supply process in a small open economy. The definitional relationships are as follows:

(3.2) $W = DD + CC$

(3.3) $A = CC + CR = R + D$

(3.4) $CC = CP + VC$

(3.5) $CR = \delta_d\ DD + \delta_t\ TD + \delta_s\ SD + \delta_e\ (DD + TD + SD)$

$= \delta_r\ (DD + TD + SD) + \delta_e\ (DD + TD + SD)$

$= (\delta_r + \delta_e)\ (DD + TD + SD) = \delta\ (DD + TD + SD)$

(3.6) $\alpha = W/A = (DD + CC)/(CC + CR) = (1 + CC/DD)/(CC/DD + CR/DD)$

$= (1 + q)/q + (1 + t + s)\delta = \alpha(q,\ t,\ s,\ \delta)$

(3.6)' $W = \alpha A = A(1 + q)/q + (1 + t + s)\delta = (R + D)(1 + q)/q+(1+t+s)\delta$

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[1]Our model owes much to Jordan (1968), Willms (1971), and Burger (1971).

where W = money supply narrowly defined

DD = demand deposit

CC = currency in circulation

A = monetary base[1]

CR = commercial bank reserves held at the central bank

R = foreign reserve holdings (including gold)

D = domestic source of monetary base

CP = currency held by the non-bank public

VC = vault cash of commercial banks

δ_d = required reserve ratio on demand deposits (DD)

δ_t = required reserve ratio on time deposits (TD)

δ_s = required reserve ratio on savings deposits (SD)

δ_e = excess reserve ratio to total deposits

δ_r = required reserve ratio which is the weighted average of δ_d, δ_t, and δ_s [$\delta_r = (\delta_d DD + \delta_t TD + \delta_s SD)/(DD + TD + SD)$]

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[1]In this model monetary base implies the source base, not monetary base with reserve adjustments. In order to have a more exact model of money supply process, we have to use the monetary base with reserve adjustment to allow for the effects of changes in reserve requirements and for changes in the proportion of deposits subject to different reserve requirements. The monetary base as the sum of source base and reserve adjustment is necessary to maintain comparability over time because adjustment must be made in the source base in order to allow the above-indicated effects of changes in laws and regulations. However, source base is by far the main part of the supply of the monetary base, we may not suffer any loss of generality, even if we neglect this adjustment.

$\delta = CR/(DD + TD + SD) = (\delta_r + \delta_e)$: ratio of total reserves to total deposits

q = currency-demand deposit ratio (CC/DD):

$q = q(\rho, i, Y', K' + W)$

$t = TD/DD = t(\rho, i, Y', K' + W)$

$s = SD/DD = s(\rho, i, Y', K' + W)$

ρ = money rate of interest or nominal rate of return on bonds

i = weighted interest rate on deposits

Y' = money income

$(K' + W)$ = non-human wealth (the sum of capital stock and money stock in money terms)

α = money multiplier: $\alpha = \alpha(q, t, s, \delta) = \alpha(\rho, i, Y', K' + W, \delta)$[1]

In current monetary arrangements of inside-outside money, the quantity of narrowly defined money supply is expressed as the product of the monetary base and the money multiplier. The factors that can cause changes in the monetary multiplier are all of the factors which affect the currency (q), time deposit (t), savings deposit(s), and reserve(δ) ratios, that is, the behavioral parameters.[2] Money

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[1] If money is defined to include time and savings deposits ($W = CC + DD + TD + SD$), then $\alpha = (1 + q + t + s)/\delta(1 + t + s) + q$.

[2] t-ratio, s-ratio, and q-ratio are here assumed to depend on the money rate of interest, weighted average interest rate on deposits, money income, and non-human wealth. Since commercial banks and non-bank public affect these ratios through their assets and liabilities adjustments according to changes in relative prices of financial assets, these ratios are influenced by opportunity costs-nominal returns on alternative earning assets such as loans and securities.

supply is determined by the joint behavior of the monetary authorities, the commercial banks, and the non-bank public.

Changes in q, δ, t, and s ratios reflect the actions of the monetary authorities, commercial banks, and non-bank public which influence the money stock. The behavior of the central bank is mainly reflected in the movement of the monetary base.[1] The behavior of commercial banks and non-bank public with respect to the allocation of their funds between currency and demand deposits and the allocation of their deposits between demand deposits, time deposits, and savings deposits is primarily reflected in money multiplier.

Particularly, two ratios are critical here in determining the money multiplier: the weighted average reserve ratio (δ) and currency-demand deposit ratio (q).[2] The reserve-deposit ratio (δ) determines the total volume of commercial bank deposits. Much of the literature on the difficulty of controlling the money stock assumes that this ratio is highly variable and unpredictable partly because of the variations in bank's demand for cash or excess reserves.

The public's currency-demand deposit ratio, q, may also be quite volatile and have a pronounced cyclical pattern. However, this ratio, q, can be observed and predicted well enough that changes in it can be prevented from changing total money stock. The monetary authorities

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[1]Of course, required reserve ratio policy will affect the money multiplier.

[2]In an economy with well-developed forward exchange market, the forward exchange market policy will also have effect on the money multiplier.

may have good information on flows of currency into and out of hands of the public and so can promptly offset any change in the q ratio that may threaten to produce undesirable change in money supply.

The degree of accuracy that can be achieved by the central bank in controlling the money stock is a function of their ability to determine the domestic monetary source base, given foreign source of base, and predict the net influences of the public's and commercial banks' behavior as summarized by changes in the money multiplier.

If the monetary authorities want to control the growth of the money stock, they have to forecast the value of the money multiplier. Once the multiplier is predicted, the amount of base money which is needed to achieve the desired money stock is determined.[1] Therefore, controllability of money supply (which is the monetarist's view) crucially depends on the correct prediction of the money supply multiplier.

According to the monetarist's view, the money multiplier is steady over time, and the monetary base is the main determinant of the money stock and a good indicator of the thrust of the monetary forces. Therefore, the monetary base is the proper measure of the central bank's monetary actions. Changes in the monetary base are held as ultimately leading to changes in the growth of aggregate demand for goods and services.

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[1]For a further analysis of a control process of the money supply along with this line, see Lionel Kalish (1970), pp. 761-776.

$$W = \alpha A = \alpha(R + D) = \alpha\theta R \text{ where } \theta = (R + D)/R = A/R^{1}$$

$$\dot{W} = \alpha A(\dot{\theta}/\theta + \dot{R}/R)^{2} \tag{3.7}$$

or

$$\dot{W}/W = (\dot{\theta}/\theta + \dot{R}/R) \tag{3.7'}$$

In a small open economy with a relatively thin market for short-run credit, the supply of the money stock is substantially beyond the direct control of the central bank, even if the money multiplier is highly stable and predictable. Inflows and outflows of foreign exchange inevitably tends to show up in the monetary base of the economy. To prevent it, the central bank should have offset their purchases of foreign exchange with sales of other assets. Immediately there arises the question of the relative strength of domestic vs. foreign influences on the monetary base of the country.

Now there also arise two interesting empirical questions: (1) why does the supply of high-powered money change? and (2) are the two ratios of δ and q so relatively stable over time that the money

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[1] θ is considered as a monetary policy parameter representing the adjustment of the domestic component of the base money by the central bank to a change in the stock of foreign reserves. That is, θ represents the monetary authorities' defensive and dynamic policy actions to a change in exogenous component of the monetary base, resulting from the international payments disequilibrium.

[2] From $W = \alpha(\delta, q)\ A = \alpha(\delta, q)\ \theta R$, we can derive $dW/dt = Ad\alpha/dt + \alpha(\delta, q)\ dA/dt$. Under the monetarists' view of money supply process in which money multiplier is stable and predictable, $d\alpha/dt = \alpha_1 d\delta/dt + \alpha_2 dq/dt = 0$. Therefore, $dW/dt = \alpha dA/dt$ and $dA/dt = A(d\theta/\theta dt + dR/Rdt) = A(\dot{\theta}/\theta + \dot{R}/R)$.

multiplier is steady and predictable with a high degree of accuracy? Cagan (1965) gave the long-term answer for the U. S. economy over the period 1875-1955 to the first question. He found that increases in high-powered money accounted for 90 percent of the growth of the narrowly defined money stock. Increases in high-powered money came from two sources--growth of the gold stock and, after the Federal Reserve System was established in 1914, growth in domestic sources of monetary base--credit extended by the Reserve banks.[1] The counterparts of these in other countries would be growth of foreign exchange reserves (including gold) and growth in domestic assets of the central banks.

The two critical ratios do not behave in a totally erratic manner. In addition to these, evidence on the stability of the commercial banks' reserve ratio and currency-demand deposit ratio is remarkable. Jordan (1969) has found that the ratio of total reserves (required reserves plus excess reserves) to total commercial bank deposits is the least volatile of all ratios that determine the overall money supply and also the currency-demand deposit ratio is relatively stable over the period 1950 through 1969 for the U. S. economy.[2]

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[1]See Cagan (1965), pp. 18-21 and Table 2, F-4.

[2]See Jordan (1969), pp. 14-19, especially Chart II and p. 19.

By using quarterly data, Willms (1971) also provided some empirical observations of the money supply process in West Germany during the period 1958-1970. He showed the critical two factors in the determination of the German money multiplier had not fluctuated significantly within this period of time. Consequently, the money multiplier had been stable and 80 percent of the variance of quarterly changes in the German money stock was resulted from changes in the monetary base.[1]

In view of the long-run significance of the variations in the quantity of high-powered money in accounting for the largest source of the growth of the money supply, we shall ignore the variations in money multiplier (α) or variations in the two critical ratios, δ and q, in our model of monetary growth theory in Chapter IV, along with the monetarists' view evidenced by the above empirical findings. Assuming that the ratio of monetary base to foreign reserves, θ, is likely to be constant over time in a small open economy, changes in foreign reserves are the major source of new money supply of the economy.[2] Therefore, we have the following approximation:

(3.8) $\dot{W}/W \simeq \dot{R}/R$

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[1]See Willms (1971), pp. 20-24.

[2]From $\theta \equiv (R + D)/R = 1 + D/R$, θ is likely to be close to unity if D/R is very small. In a limiting case in which $D/R = 0$, $\theta = 1$ and $d\theta/dt \equiv \dot{\theta} = 0$. Alternatively, $\dot{\theta} = \theta(\dot{A}/A - \dot{R}/R)$ and $\dot{\theta} = 0$ if $\dot{A}/A = \dot{R}/R$, or $\dot{A} = \dot{R} + \dot{D} \simeq \dot{R}$ and $\dot{A}/A \simeq \dot{R}/A \simeq \dot{R}/R$. This restrictive assumption is purposely taken in order to concentrate our analysis on the monetary effect of the balance of payments on economic growth in Chapter IV.

CHAPTER IV

THE SYNTHESIS MODEL OF MONETARY GROWTH THEORY IN A SMALL OPEN ECONOMY

Thus far monetary growth models (whether they are Neoclassical, Keynes-Wicksell, or the Synthesis models) have been formulated and developed in a closed economy context. Consequently, money is created only by the change in domestic monetary assets of the central bank either through government budgetary deficit (outside money creation) or through credit creation of commercial banking system (inside money creation).

Tobin (1965), Mundell (1965), Stein (1966), and Johnson (1967) assumed that the new money is created through government budgetary deficit at zero cost. Later Stein (1970) introduced into his model an inside money creation through open market operations and compared real balance effect on domestic expenditures of different types of inside and outside money creation.[1]

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[1]Stein (1970) argued that people consider inside money as being less private wealth and thus there is a weak real balance effect on expenditures derived from inside money. According to portfolio balance theory [for a good example, see McKinnon (1969)], inside money does not have real balance effect since claims of some people are liabilities of the other people. However, if we apply the same argument to real balance effect with tax illusion for the case of outside money creation through budget deficit, we can justify real balance effect of an inside money with money illusion. There is no theoretical presumption as to the differential degree of real balance effect of inside and outside money.

However, in the model of an open economy with fixed exchange rate system new money is also supplied by a change in foreign reserves held at the monetary authorities, as was shown in the previous chapter. There is an interesting parallel that we can draw between (1) government budget deficits and open market operations and (2) trade balance surplus and external payments flow confined to the capital account. Both affect asset positions in the private sector of the domestic economy in similar ways.

For example, a trade surplus will cause a net increase in the stock of monetary assets of the private sector just as a government deficit financed by monetary expansion will. Both increases in the net private assets may (but need not) take the form of augmenting domestic money supply held by the private sector. They are both outside methods of new money creation. Correspondingly, open market operations such as buying bonds in exchange for money have an economic impact which is similar to the capital inflow when the exchange rate is fixed. The foreign exchange authorities must convert the foreign money into domestic currency on demand. Both these last two are an inside method of new money supply since one monetary asset is merely exchanged for another, leaving the net monetary asset position of the private sector unchanged. The willingness of domestic residents to trade bonds (or securities) for money through external transactions, without at the same time being willing to change their net asset position, is essentially the problem of liquidity preference which can lead to apparent balance of payments

disequilibrium. Monetary liabilities of the central bank will be changed either by a change in domestic monetary assets or by a change in international reserve holdings resulting from balance of payments disequilibrium, unless there is a deliberate domestic monetary policy of a complete sterilization.

Excess demand in the commodity market is not only the result of domestic market disequilibrium but also may be caused by trade imbalances. Even if planned domestic investment happens to be equal to planned savings, the existence of trade imbalance will also bring about excess demand in the commodity market and can affect the domestic price level. Commodity market equilibrium can only be maintained when aggregate demand is equal to aggregate supply. It is not necessary to have planned domestic investment equal to savings to attain commodity market equilibrium in an open economy.

Under the present movement toward international economic integration, domestic capital accumulation may also be realized by international capital movements in addition to domestic savings. Therefore, we have to recognize the role of capital flows in capital formation in an open economy under international capital mobility (even if it is imperfect).

The subject of this chapter is essentially an extension of the existing Synthesized monetary growth model to an open economy. Therefore, we shall continue to retain most of the behavioral assumptions adopted in the closed model of the Synthesized monetary growth theory. For the sake of simplicity, in the following analysis

we shall assume away the government sector but our main conclusions are not vitiated by this simplification.[1]

Recognition of the role of the trade balance in domestic price adjustment and of capital movements in domestic capital accumulation as well as the money supply process through a change in foreign reserves resulting from international payments disequilibrium will enable us to attempt to integrate the balance of payments theory into the Synthesis model of monetary growth theory. The aim of this and the next chapters is to formulate a feedback mechanism through which the balance of payments and economic growth interact with each other.

The suggested process of interaction between the balance of payments and economic growth may be summarized in a simple diagrammatic scheme. The functional relationships with behavioral assumptions and their linkages shall be explained in the following analysis.

Figure 3. A Simple Feedback Model of the Balance of Payments and Economic Growth

$$\begin{tikzcd}
\boxed{\dot{W}/W} \arrow[r] & \boxed{\dot{p}/p} \arrow[r] & \boxed{\dot{K}/N} \arrow[d] \\
\boxed{\dot{R}/R} \arrow[u] & \boxed{\dot{Y}/Y} \arrow[l] & \boxed{(\dot{K}/N)/(K/N)} \arrow[l]
\end{tikzcd}$$

[1]Government expenditures on commodities can easily be included in the private expenditures on goods, and taxes may be included in private savings. Capital movements due to governmental transactions, if any, may be treated as a negligible item.

4.1 The Basic Model

We shall use the same production function as was used in the Neoclassical and Keynes-Wicksell models [neglecting unemployment which can be incorporated into this model by using a utilization coefficient as was shown by Stein and Nagatani (1969)].

Single output, Y, (which is a composite good) is produced with the aid of labor services, N,[1] and the services of the total stock of capital, K; the production function is assumed to be linear homogeneous in both factors with the usual properties.

(4.1) $Y_t = Y(K_t, N_t)$ (neoclassical production function)

(4.1)' $y_t = y(k_t)$; $y'(k) > 0$, $y''(k) < 0$ {for $0 < k < \infty$

$\lim_{k \to 0} y'(k) = \infty$; $\lim_{k \to \infty} y'(k) = 0$}

(4.2) $r = y'(k) = r(k)$

where y_t is output per effective worker, k_t is the capital-labor ratio at a given time t, and $y'(k)$ is the marginal product of capital, that is, rent on unit of capital.

I. Disequilibrium in Commodity Market and Price Dynamics

Excess demand in the commodity market in an open economy is the sum of domestic excess demand (excess of real planned domestic investment over real savings, I* - S*) and foreign excess demand

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[1]In models of economic growth, labor is measured in terms of efficiency unit in order to incorporate Harrod neutral technical progress. From $N_t = N_0$ exp. nt, the rate of growth of "effective" labor, $n(=\dot{N}/N)$ is the sum of the natural rate of growth of population and Harrod neutral technical change. Thus we use the term of "effective" worker rather than population or labor.

(excess of foreign demand for home goods over domestic demand for foreign goods, $(X^* - M^*)/p$]:[1]

$$(I^* - S^*) + (X^* - M^*)/p[=F^*(Y, r + \pi^*, \rho, W/p)] \text{ or}$$

$$(I^* - S^*)/N + (X^* - M^*)/pN[=F(y, r + \pi^*, \rho, W/pN)]$$

Planned domestic investment is assumed to be a function of real output, nominal rate of return on capital, $r + \pi^*$, the rate of return on bonds, i.e., the nominal rate of interest, ρ, and the real monetary assets of the economy, W/p.

(4.3) $$I^* = I^*(Y, r + \pi^*, \rho, W/p);\ I_1^* > 0,\ I_2^* > 0,\ I_3^* < 0,\ I_4^* > 0$$

Following the capital stock adjustment theory of investment in a growing economy, the flow demand for capital depends on the divergence between the actual capital stock, K, and the desired stock, K^d, at the current level of real income, the current rates of return on assets (real capital, bonds, and money), and the real value of monetary wealth, W/p. Again we obtain the above investment function.

$$I^* = \phi^*(K^d - K);\ \phi' > 0$$[2]

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[1]Since we measure planned domestic investment and savings in real terms, we have to deflate the trade balance, which is expressed in money terms, by the domestic price level.

[2]We use here a general equilibrium model of assets demand functions that provides the basis of portfolio balance theory of international payments as shall be shown in the next chapter. For the desired capital stock:
$K^d = K^*(Y, r + \pi^*, \rho, W/p);\ K_1^* > 0,\ K_2^* > 0,\ K_3^* < 0,\ K_4^* > 0$
For the desired money stock:
$M^d/p = L^*(Y, r + \pi^*, \rho, W/p);\ L_1^* > 0,\ L_2^* < 0,\ L_3^* < 0,\ L_4^* > 0$
For the desired bonds stock:
$B^d/p = J^*(Y, r + \pi^*, \rho, W/p);\ J_1^* > 0,\ J_2^* < 0,\ J_3^* > 0,\ J_4^* > 0$

Planned domestic investment per effective worker is expressed:

$$I^*/N(\equiv I) = \phi[k^d(y,\ r + \pi^*,\ \rho,\ \theta v) - k]^1$$

or more generally,

$$(4.3)' \qquad I = I[y(k),\ r(k) + \pi^*,\ \rho,\ \theta v];\ I_1 > 0,\ I_2 > 0,\ I_3 < 0,\ 0 < I_4 < 1$$

As to domestic consumption function, it is assumed that consumption of the private sector depends on real income and the real value of its monetary assets and that consumption function is linear homogeneous in both arguments. We also assume that the marginal propensity to consume out of output is a positive fraction and that consumption is positively related to real monetary wealth (real balance effect).

Therefore, planned domestic savings per effective worker may be expressed in the following way. The conventional result is obtained:

$$(4.4) \qquad S^* = S^*(Y,\ W/p);\ 0 < S_1^* < 1,\ S_2^* < 0$$

$$(4.4)' \qquad S \equiv S^*/N = S[y(k),\ \theta v];\ 0 < S_1 < 1,\ S_2 < 0$$

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[1]In order to show the money supply process through a change in international reserves held at the central bank, we want to express monetary assets of the monetary authorities in terms of foreign reserves in the following way:
$W/pN = \alpha(D + R)/pN = \alpha\{(D + R)/R\}(R/pN) = \alpha\theta v$; where $\theta = (D + R)/R$ is the reciprocal of the foreign reserve ratio to total monetary assets and $v = R/pN$. If we assume that θ is held constant, it implies that domestic monetary assets also change in the same proportion as a change in foreign reserves. A fall in θ may imply a sterilization policy under the case of international payments imbalances or a restrictive domestic monetary policy. θ is therefore regarded as a monetary policy parameter. For the convenience of analysis, we shall assume a constant θ and the money multiplier (α) being equal to one, i.e., $\alpha = 1$.

Very little is lost by assuming that planned domestic savings are inelastic with respect to the rates of return on assets but there is a substantial gain in simplicity.

Exports are assumed to be a function of the domestic expected rate of inflation, π^*, and the exchange rate, e (the domestic price of foreign exchanges). Under a regime of fixed exchange rates, exports function is assumed to be inversely related to the expected rate of inflation only since the current exchange rates are regarded as an exogenous variable and are expected to persist indefinitely.[1]

(4.5) $X^*/p = X^*(\pi^*, e); X_1^* < 0, X_2^* > 0$

(4.5)' $X \equiv X^*/pN = X(\pi^*; e); X_1 < 0$ (under fixed exchange rates)

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[1]In the Keynesian world of price rigidity with unemployment, $X = X(p/p_w; y_w, e)$ where p_w is the given world price level and y_w is real income per effective worker in the outside world. Under the assumption of flexible prices and full employment, $X = X\{(p/p_w)(\pi - \pi_w); y_w, e\}$. $X = X[\pi; (p/p_w), \pi_w, y_w, e]$. Actually, exports are inversely related to the actual rate of inflation rather than the expected rate. As we shall see later, however, the actual rate of inflation is affected by the expected rate and thus we may directly use the expected rate of inflation as an explanatory variable in the exports function. Then $\dot{X} = X_1\dot{\pi} = X_1\dot{\pi}^*$ in the short-run. In the long-run $\dot{X} = X_1\dot{\pi}^* = X_1\beta(\pi - \pi^*) = 0$ since $\pi = \pi^* = \pi_w$ in the long-run equilibrium and $\dot{\pi}^* = \beta(\pi - \pi^*)$ (this $\pi = \pi^*$ and the adaptive price expectations shall be discussed later). In an open (small) economy π^* is directly related to the world rate of inflation, π_w, which is regarded as fixed at the given level in short-run and variable in the long-run; in the long-run π^* tends to converge to π_w.

Imports demand by domestic residents are assumed to be a function of domestic expenditures on consumption and investment ($E^* = C^* + I^*$) and exchange rate. The marginal propensity to import is assumed to be a positive fraction of domestic expenditures.[1]

(4.6) $M^*/p = M^*(E^*, e);\ 0 < M_1^* < 1,\ M_2^* < 0$

(4.6)' $M \equiv M^*/pN = M[E(y, r + \pi^*, \rho, \theta v; e];\ 0 < M_E < 1$ (under a regime of fixed exchange rates)

As to price adjustment function in the commodity market, we shall follow the assumption made by Stein (1970) and Fischer (1972) in their Synthesis model of monetary growth theory in a closed economy: Markets may be organized by specialists[2] who set prices on the basis of both the current state of excess demand and the specialists' expectations on the future state of excess demand.

Therefore, the actual rate of inflation has two components of the expected rate of price change, π^*, and the current excess demand in the commodity market. If we deflate, for the convenience of later manipulations, the real excess demand by effective labor,

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[1]Domestic expenditures on consumption and investment, E^*, is not equal to output, Y, as long as $(X^* - M^*)/p \neq 0$. Therefore, the marginal propensity to import in this model is different from that in the usual Keynesian theory of balance of payments in which imports demand is proportional to real income.

[2]Those specialists are equivalent to the auctioneers in Walrasian tatonnement process.

$$(4.7) \qquad \pi = \pi^* + \lambda[\{I(y, r + \pi^*, \rho, \theta v) + X(\pi^*)\} - \{S(y, \theta v) + M(E(y, r + \pi^*, \rho, \theta v))\}]$$

$$(4.7)' \qquad (\pi - \pi^*)/\lambda = [I(y, r + \pi^*, \rho, \theta v) + X(\pi^*)] - [S(y, \theta v) + M\{E(\cdot)\}] = F\{y(k), r(k) + \pi^*, \rho, \theta v\}$$

("general" IS function)

where $F(\cdot)$ is the excess demand for commodities per effective worker; λ is the speed of adjustment in the commodity market and assumed to be finite and positive ($0 < \lambda < \infty$). The magnitude of λ is dependent on the structure of the competitive market.

II. Capital Accumulation and the Balance of Payments

The balance of payments of the economy is defined as the sum of trade balance and the balance on capital account ($\dot{B}^*$) when we ignore the other items on current account such as service items, and transfer payments as an accommodating item.[1]

$$[(X^* - M^*) + \dot{B}^*]/p \equiv \dot{R}/p \; [= T^*(Y, r + \pi^*, \rho, W/p)]$$

In an open economy domestic capital accumulation (domestic realized investment) may be financed with domestic savings out of output or by incurring international debt (capital inflow).

$$(4.8) \qquad \dot{K} = S^* + \dot{B}^*/p = S^*(\cdot) + \dot{R}/p - (X^* - M^*)/p$$

or

$$(4.8)' \qquad \dot{K}/N = S + \dot{R}/pN - [X(\cdot) - M(\cdot)]$$

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[1]The structure of the balance of payments accounts and their major determinants are to be explained in Chapter V.

If there are no capital movements, then $\dot{K}/N = S$ since $\dot{R}/pN = X - M$. Thus we can avoid the uneasy assumption about the allocation of resources under inflation as was shown in Keynes-Wicksell and Synthesis model in a closed economy: $S^* < \dot{K} < I^*$.

III. Money Market Behavior and Walras' Law

In the supply side of the money market, real money balances per effective worker (θv) can be supplied either by a change in foreign reserve ratio, $1/\theta$, or by a change in real foreign reserve holdings per effective worker, v. A surplus in the balance of payments will affect the money supply under fixed exchange rate system by changing the real value of reserves per worker, v, as long as the monetary authorities remain "idle." The reserve ratio (the reciprocal of θ) shall be affected by domestic monetary policy. In order to minimize the complications related to the money supply process and to concentrate on the effect of balance of payments disequilibrium on monetary growth, we shall assume that θ is kept constant by a deliberate passive domestic monetary policy. Then the supply of new money is created from only a change in international reserves (as a result of international payments imbalances).

(4.9) $\quad (\dot{\theta v}) = \theta\dot{v} = \theta v(\dot{R}/R - \pi - n)$ where $\pi \equiv \dot{p}/p$ and $\dot{\theta} = 0$.[1]

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[1] $(\dot{\theta v}) = \theta v(\dot{\theta}/\theta + \dot{v}/v)$ where $\dot{\theta}/\theta = \dot{A}/A - \dot{R}/R$; $\dot{v}/v = \dot{R}/R - \dot{p}/p - n$; and $A = R + D$. If $\dot{\theta}/\theta = 0$, then $\dot{A}/A = \dot{R}/R$ and $(\dot{\theta v}) = \theta\dot{v} = \theta v(\dot{R}/R - \dot{p}/p - n)$.

As was shown earlier part of this chapter, demand for money increases (see footnote 2, page 52) as real income rises, primarily for transactions purpose. Both transactions and assets demand for real money balances also depends on the opportunity costs of holding wealth in the form of money and the amount of real monetary assets, θv.

An increase in the real value of monetary assets will partly create an increase in demand for commodities and/or for bonds. The remainder of the increment of real monetary assets should be devoted to increasing the demand for money in view of budget constraint and non-inferiority assumption of assets.

One alternative to holding wealth in the form of money is to hold bonds. The nominal rate of interest on bonds is an opportunity cost of holding money. It is assumed that there is no capital gains (or losses) on bonds due to the expected rate of change in bond prices such that the nominal rate of interest is the expected rate of return on bonds. Another alternative foregone by holding money is the expected rate of return on real capital, $r + \pi^*$, which is composed of the expected marginal productivity of capital, $r(k) = y'(k)$, and the expected rate of inflation (or capital gains on real capital), π^*.

(4.10) $$M^d = pL^*(Y, r + \pi^*, \rho, W/p);\ L_1^* > 0,\ L_2^* < 0,\ L_3^* < 0,$$
$$0 < L_4^* < 1$$

or

(4.10)' $$M^d/pN = L[y(k), r(k) + \pi^*, \rho, \theta v]$$

For the sake of simplicity, we shall assume that the bond market is maintained continuously in equilibrium through international capital movements (under capital mobility) or that excess demand (supply) for bonds is instantly eliminated by an infinitely large speed of market adjustment (under capital immobility) so that demand for bonds (B^d) is always identically equal to the supply of bonds (B^s). This is an assumption of convenience rather than necessity.[1]

Invoking Walras' law that the sum of excess demand in all markets must be zero, we obtain

$$(4.11) \qquad [I(\cdot) + X(\cdot)] - [S(\cdot) + M(\cdot)] + [L(\cdot) - \theta v] = B^s - B^d = 0$$

Having recourse to equation (4.7)', equation (4.11) is expressed:

$$(4.11)' \qquad (\pi = \pi^*)/\lambda = \theta v - L\{y(k),\ r(k) + \pi^*,\ \rho,\ \theta v\}$$

(<u>the "general" LM function</u>)

IV. Price Expectations and Dynamic Equation of Growth of Capital Intensity

Price expectations can profoundly affect the stability of the short-run dynamic system. There is a variety of price expectations functions,[2] each of which has a different effect on the stability of the system. Following the Stein-Fischer Synthesis model in a closed economy, we shall use the adaptive expections function:

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[1]Actually all of the monetary growth theorists either assumed away the bond market [Tobin (1965), Stein (1966), and Tsiang (1969), for example] or adopted such a simplifying assumption that bond market is always maintained in equilibrium or that bond is a perfect substitute for money.

[2]For example, $\dot{\pi}^* = f(\pi)$; $f' > 0$, or $\dot{\pi}^* = g[(\dot{\theta v})/\theta v - \pi - n]$; $g' > 0$, $g'' < 0$.

(4.12) $\dot{\pi}^* = \beta(\pi - \pi^*)$ $(0 < \beta < \infty)$

where β is the factor of proportionality and $0 < \beta < \infty$. Price expectations are continuously revised in proportion to the previous forecasting error $(\pi - \pi^*)$.

Finally, there is another important differential equation describing the growth of the capital-labor ratio, k.

(4.13) $\dot{k} = \dot{K}/N - (\dot{N}/N)k = S(y, \theta v) + \dot{R}/pN - [X(\cdot) - M(\cdot)] - nk$

The thirteen equations (4.1) - (4.13) are used to determine the thirteen endogenous variables: y, r, ρ, I, S, X, M, π, π^*, $\dot{K}/N$, v, L, and k in terms of parameters $\dot{R}/R$, θ, and n.

4.2 The Short-Run Model under Capital Immobility

We will now analyze the Synthesis short-run model of monetary growth in an open economy under capital immobility. In the latter part of this chapter we shall introduce another extreme case of perfect capital mobility, and show the importance of the assumption on the capital mobility in our open model of monetary growth theory.

Four equations describe the short-run model: the IS function, the LM function, and the two differential equations representing the proportionate rate of growth of real money balances per effective worker and the adaptive price expectations.

(4.7)' $(\pi - \pi^*)/\lambda = [I(\cdot) + X(\cdot)] - [S(\cdot) + M(\cdot)]$ (<u>the IS function</u>)

(4.11)' $(\pi - \pi^*)/\lambda = \theta v - L(\cdot)$ (<u>the LM function</u>)

(4.9) $(\dot{\theta v}) = \theta v(\dot{R}/R - \pi - n)$

(4.12)' $\dot{\pi}^* = \beta[\pi - \pi^*]$

There are four endogenous variables, $\pi_{(t)}$, $\rho_{(t)}$, $v_{(t)}$, and $\pi^*_{(t)}$ to be determined from the above four equations. We shall disregard the effects of capital accumulation for the short-run analysis and thus eliminate equation (4.13).

I. Short-Run Equilibrium Analysis

By definition, the short-run is a span of time in which the capital intensity and the effective labor force is given, i.e., $k = k_o$ (and $n = 0$). The fixity of k is due to our assumption of instantaneous clearance of labor market (full employment). Given the capital stock, K_o, and labor supply, N_o, full employment implies $N^d = N_o$, where N^d is the demand for labor, and therefore $k_o = K_o/N_o$.[1]

Short-run equilibrium is attained when the price expectations are constant and real money balances per effective worker are also constant. These two conditions for short-run equilibrium require:

From $\dot{\pi}^* = \beta(\pi - \pi^*) = 0, \qquad \pi_s = \pi^*_s$

From $(\dot{\theta v}) = \theta v(\dot{R}/R - \pi - n) = 0, \quad \pi_s = \dot{R}/R - n$

where π_s and π^*_s are short-run equilibrium actual and expected rates of inflation, respectively. Therefore, $\pi_s = \pi^*_s = \dot{R}/R - n$.

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[1]In short-run N^d, which is the actual level of employment or utilized labor, is variable and thus k is also variable. Only in short-run equilibrium would $N^d = N_o$, i.e., only in equilibrium would full employment be possible. From $K_t = K_o \exp. (\dot{K}/K)t$, if the time interval is made sufficiently short (i.e., as $t \to 0$), $\dot{K}$ becomes negligible in relation to capital stock itself ($K_t \to K_o$). Hence, for short-run analysis, the flow of capital stock can be disregarded in relation to the capital stock.

Substituting $\pi_s = \pi_s^* = \dot{R}/R - n$ into the IS and the LM functions, we may obtain a very familiar Metzlerian (1951) macroeconomic model.

$$(4.7)'' \quad I\{y(k_o),\ r(k_o) + (\dot{R}/R - n),\ \rho,\ \theta v\} + X(\dot{R}/R - n)$$
$$= S\{y(k_o),\ \theta v\} + M[E\{y(k_o),\ r(k_o) + (\dot{R}/R - n),\ \rho,\ \theta v\}]$$

$$(4.11)'' \quad L\{y(k_o),\ r(k_o) + (\dot{R}/R - n),\ \rho,\ \theta v\} = \theta v$$

Under capital immobility, solving simultaneously equations (4.7)" (the short-run IS function) and (4.11)" (the short-run LM function) for endogenous variables v and ρ, we obtain the short-run equilibrium values of the two variables, v_s and ρ_s.

Graphically, the slope of the IS schedule is positive. Since an increase (decrease) in real money balances tends to reduce (increase) planned savings per capita, in order to preserve commodity market equilibrium investment must decrease (increase) and this in turn requires a rise (fall) in nominal rate of interest.

$$(d\rho/dv)_{k_o,\dot{R}/R,n,\theta} = -(I_4 - S_2 - M_E E_4)\theta/(I_3 - M_E E_3) > 0 \text{ (the slope of the IS curve)}$$

Along the IS curve, excess demand in the commodity market is zero ($I + X = S + M$) and thus the IS schedule is the locus of combinations of (v, ρ) such that commodity market equilibrium is maintained. Above (below) the IS curve, for any given value of v, actual ρ is higher (lower) than the required ρ to preserve commodity market equilibrium and thus planned domestic investment

would decline (rise) relative to imports. As a result, excess demand would decrease (increase) and domestic price level declines (rises). This in turn increases (decreases) real value of foreign reserves. Horizontal arrows in Figure 4 indicate the direction of movements of v for points off the IS schedule.

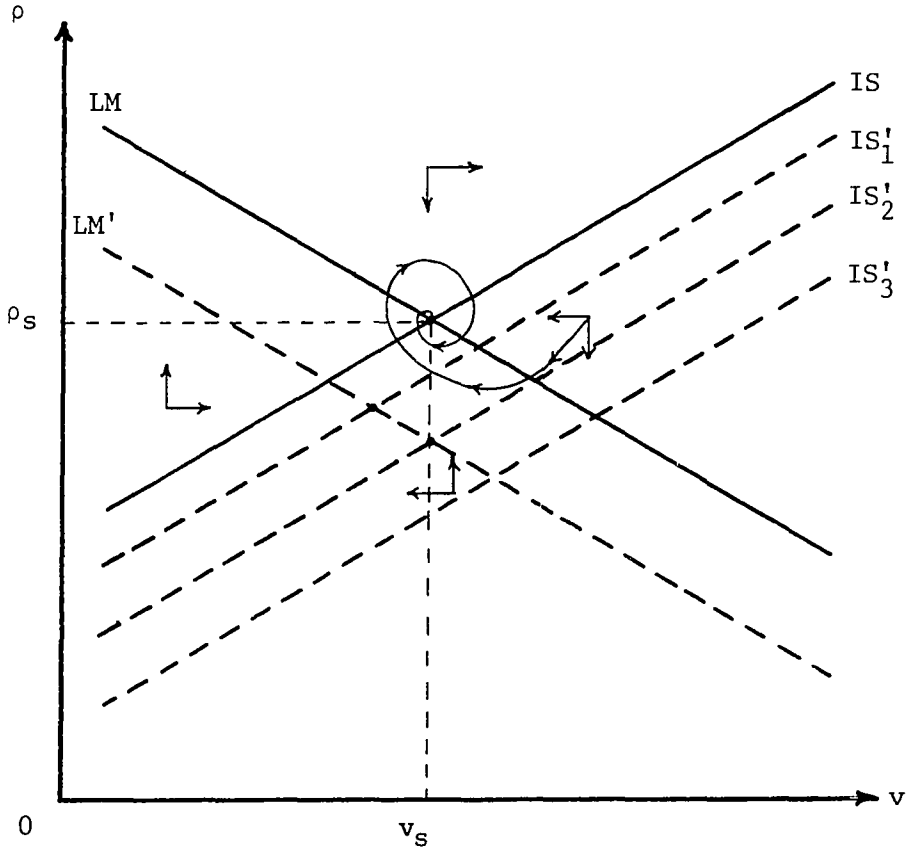
Similarly, the LM schedule is the combinations of (v, ρ) such that money market equilibrium is maintained. The slope of the LM curve is negative. It is because a rise (fall) in v requires a decrease (increase) in ρ to maintain money market equilibrium (since $0 < L_4 < 1$).

$(d\rho/dv)_{k_o,\dot{R}/R,n,\theta} = (1 - L_4)\theta/L_3 < 0$ (the slope of the LM curve)

Above (below) the LM curve, for any given value of v, the actual ρ is higher (lower) than the required level, and there is excess supply of (demand for) real money balances which tends to lower (raise) ρ. Vertical arrows in Figure 4 indicate the direction of movements of ρ for points off the LM schedule. The determination of short-run equilibrium under capital immobility is shown in Figure 4.

Now we can have comparative dynamic exercise about the changes in short-run equilibrium values of v and ρ due to changes in the growth rates of international reserve holdings through persisting balance of payments disequilibrium.

Figure 4. Short-run Equilibrium under Capital Immobility



Short-run Equilibrium under Capital Immobility (Stable Equilibrium) and the Effect of a Rise in $(\dot{R}/R)$ When $I_2 < (M_E E_2 - X_1)$

Since in the short-run equilibrium $\pi_s = \pi_s^* = \dot{R}/R - n$, a rise in $\dot{R}/R$ will raise the short-run equilibrium actual and expected rates of inflation by the same amount $\{[\partial\pi_s/\partial(\dot{R}/R)] = [\partial\pi_s^*/\partial(\dot{R}/R)] = 1\}$, given the other parameters θ and n. An increase in the expected rate of inflation due to a rise in $\dot{R}/R$ will increase planned domestic investment with given ρ and also net imports demand (M - X). Even if the marginal propensity to import (M_E) is less than one, it is ambiguous whether or not there will be excess supply in commodity market. As a result, the IS schedule may shift to the right (left, or remain unchanged) by the size of $[dv / d(\dot{R}/R)]_{IS} = (I_2 + X_1 - M_E E_2)/(S_2 - I_4 + M_E E_4)\theta \overset{(<)}{\underset{>}{=}} 0$,[1] depending on $I_2 \overset{(\geq)}{\underset{<}{=}} M_E E_2 - X_1$.

At the same time, a rise in the expected rate of inflation due to an increase in $\dot{R}/R$ will lower demand for real money balances through the substitution effect and thus the LM curve will shift to the left by the magnitude of $[dv/d(\dot{R}/R)]_{LM} = L_2/(1 - L_4)\theta < 0$.[2]

As a result, equilibrium ρ_s unambiguously decreases if $I_2 < M_E E_2 - X_1$,[3] but we are not certain about the direction of movements of v_s, depending on the relative strength of the effect on the excess demand for commodities and on the excess supply of real money balances.

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[1]This is derived from the IS function. Alternatively, for given value of v, $[d\rho/d(\dot{R}/R)]_{IS} = (I_2 + X_1 - M_E E_2)/(M_E E_3 - I_3) \underset{(>)}{\overset{<}{=}} 0$, depending on $I_2 \underset{(>)}{\overset{<}{=}} M_E E_2 - X_1$.

[2]This result is derived from the LM function. Alternatively, for given value of v, $[d\rho/d(\dot{R}/R)]_{LM} = - L_2/L_3 < 0$.

[3]If $I_2 < M_E E_2 - X_1$, excess supply in both markets requires (by Walras' law) excess demand in the bond market and thus ρ_s tends to fall.

II. Analysis of General Short-Run Model and Dynamic Stability

Here we are not concerned with short-run equilibrium, but we intend to formulate a "general" short-run model in which equilibrium is a special case. Hence we do not assume that the actual rate of price change is equal to the expected rate of inflation.

Since the actual rate of inflation is affected not only by the price expectations of price setting firms but also by some positive proportion to the excess demand per effective worker in the commodity market, the "general" IS schedule slopes negatively in (π, ρ) quadrant given the expected rate of inflation.[1] A decline of the nominal rate of interest raises planned domestic investment and so imports demand. As long as the marginal propensity to import out of expenditures is less than one, the excess demand for commodities per effective worker rises and thereby the actual rate of inflation tends to rise.

$(d\rho/d\pi)_{k_0,v,\pi^*} = 1/\lambda(I_3 - M_E E_3) < 0$ (the slope of the "general" IS curve)

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[1]Mathematically, the "general" IS schedule is defined as the set of (π, ρ) such that the actual rate of price change is the sum of the direct price expectations by price setters and some positive proportion of excess demand for commodities per effective worker, given state variables (k, v, π^*) and parameters ($\dot{R}/R$, n, θ):

(4.7) $\pi = \pi^* + \lambda[\{I(\cdot) + X(\cdot)\} - \{S(\cdot) + M(\cdot)\}] = \pi^* + \lambda F(\cdot)$

Then the slope of the "general" IS curve is directly derived from equation (4.7).

Defining the "general" LM schedule as the set of (π, ρ) such that Walras' law, represented by equation (4.11)', is satisfied with given state variables and parameters under the assumption of continuous maintenance of bond market equilibrium. The slope of the "general" LM function is positive: A rise in the actual rate of inflation with given π^* implies that there exists an increase in excess demand for commodities per effective worker. To finance this increase in expenditures, an increase in the transactions demand for liquidity is required. Under capital immobility this implies a rise in excess bond supply (due to Walras' law).

In order to equilibrate the bond market, ρ must rise instantly. $(d\rho/d\pi)_{k_o,v,\pi^*} = -1/\lambda L_3 > 0$ (the slope of the "general" LM functions) Short-run solutions (but not necessarily the short-run equilibrium) for the nominal rate of interest and the rate of inflation are determined by the intersection of the two schedules.

A. Comparative Static Analysis

(1) The Effect of a Change in Capital Intensity

A rise (fall) in the capital intensity with the other state variables and parameters held constant will raise (lower) per capita income, y(k), but lower (raise) the rent on real capital, r(k). Excess demand for commodities, therefore, will change by the magnitude of $(I_1y' + I_2r') - (S_1y' + M_EE_1y' + M_EE_2r')(\lesseqgtr)0$. If domestic investment increases by less (more) than the sum of savings and imports, then excess demand per effective worker would decrease (increase). There would be a fall (rise) in the actual rate of inflation, π.

The IS schedule will shift downward to the left (upward to the right), i.e., $(d\pi/dk_o)_{IS} = \lambda[(I_1y' + I_2r') - \{(S_1 + M_EE_1)y' + M_EE_2r'\}] \underset{(>)}{\leq} 0.$[1] Ambiguity arises in the direction of the IS curve shift. If we follow the usual Keynesian macroeconomic assumption that a rise in real output tends to raise planned savings relative to investment, i.e., $I_1 < S_1$,[2] then the IS schedule shifts to the left as a result of an increase in capital intensity as long as the marginal propensity to import is less than one.

In the money market, a rise in capital intensity tends to increase excess demand for real money balances per effective worker through the income effect ($L_1y' > 0$) and the substitution effect ($L_2r' > 0$), that is, through both transactions demand and assets demand for real money balances. An increase in real income per capita and a fall in the rent on capital due to capital deepening reinforce each other to raise the demand for liquidity. Given the level of the nominal rate of interest, therefore, Walras' law requires that there be an excess supply of commodities (i.e., $I_1 < S_1$), corresponding to this excess demand for real money balances. Thus the actual rate of inflation tends to decline, i.e., $(d\pi/dk_o)_{LM} = -\lambda(L_1y' + L_2r') < 0$. Alternatively, for given value of

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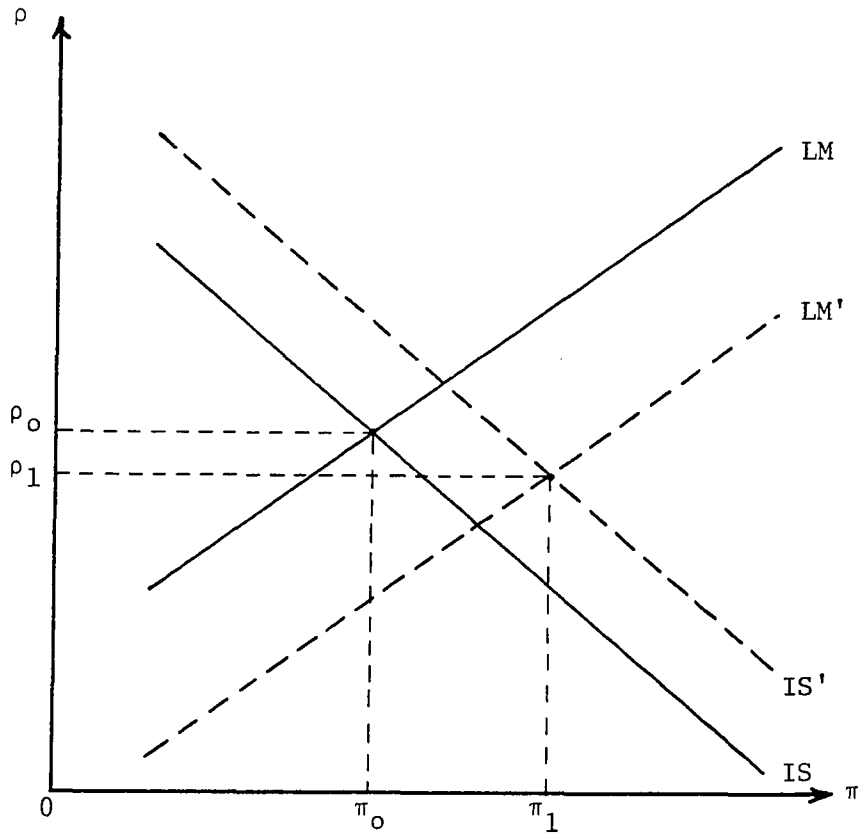
[1]Alternatively, $(d\rho/dk_o)_{IS} = [(I_1y' + I_2r') - \{(S_1 + M_EE_1)y' + M_EE_2r'\}]/(M_EE_3 - I_3) \underset{(>)}{\leq} 0.$

[2]This assumption constitutes the sufficient condition for the dynamic stability in the Hicksian IS-LM model, that is, the negatively sloping IS schedule (commodity market equilibrium requirement curve) in (Y, ρ) quadrant.

Figure 5. The General Solution of

Short-run Model under Capital Immobility



Determination of the Short-run Nominal Rate of Interest and the Rate of Inflation under Capital Immobility, and the Effect of a Rise in Real International Reserve Holdings per Capita (v)

π, excess demand for liquidity will result in a rise in the nominal rate of interest, i.e., $(d\rho/dk_o)_{LM} = -(L_1y' + L_2r')/L_3 > 0$. The LM schedule shifts upward to the left.

The net effect of a rise in the capital-labor ratio, when $I_1 < S_1$, is to lower the actual rate of inflation ($\partial\pi/\partial k_o < 0$) as shall be shown in the mathematical derivation. Leftward shifts of both IS and LM schedules represent an excess supply of commodities and lead to the lower rate of inflation.

Leftward shift of the IS curve tends to lower the nominal rate of interest, whereas leftward shift of the LM schedule is likely to raise it. The net effect, therefore, of a rise in capital intensity hinges on the relative strength of the two counteracting forces, as is obvious in the mathematical solution, even if we comply with the Keynesian assumption of $I_1 < S_1$. The net effect of a rise in the capital-labor ratio on the nominal rate of interest is ambiguous, i.e., $\partial\rho/\partial k_o \lesseqgtr 0$.

(2) The Effect of a Change in Foreign Reserve Holdings per Effective Worker

An increase in foreign reserve holdings per effective worker (v) with other state variables and parameters remaining constant raises the domestic expenditures and imports through real balance effect. If the level of the nominal rate of interest were unchanged, excess demand for commodities per effective worker would rise unless the marginal propensity to import is equal to one, i.e.,

$(d\pi/dv)_{IS} = \lambda(I_4 - S_2 - M_E E_4)\theta > 0$. Alternatively, given the actual rate of inflation, excess demand in the commodity market due to real balance effect would require the nominal rate of interest to rise in order to preserve equilibrium, i.e.,

$(d\rho/dv)_{IS} = (I_4 - S_2 - M_E E_4)\theta / (M_E E_3 - I_3) > 0$. Thus the IS schedule shifts upward to the right.

An increase in net monetary liabilities of the central bank resulting from an increase in international reserve holdings will lead to an excess supply of real money balances (since $0 < L_4 < 1$). For given actual rate of inflation, an increase in v tends to lower the nominal rate of interest to maintain money market equilibrium since $0 < L_4 < 1$, i.e., $(d\rho/dv)_{LM} = (1 - L_4)\theta/L_3 < 0$. Alternatively, for given level of ρ, excess of liquidity will raise the excess demand for commodities and thus leads to a rise in the actual rate of inflation (by Walras' law), i.e., $(d\pi/dv)_{LM} = \lambda(1 - L_4)\theta > 0$. The LM schedule will shift downward to the right.

The net effect of a rise in v is to raise the rate of inflation since rightward shifts in both curves represent an excess demand for commodities. However, the net effect on the level of ρ is ambiguous, depending on the relative strength of the two counteracting forces of liquidity preference effect in the money market and real balance effect in the commodity market. This is because rightward shift of the IS curve through real balance effect tends to raise the nominal rate of interest; whereas rightward shift of the LM schedule through a liquidity preference is at work to lower the nominal rate, ρ.

An once and for all rise in θ (expansionary domestic monetary policy) also has the exactly same effect on the actual rate of inflation and the nominal rate of interest as an increase in v has. Whether a monetary expansion is originated domestically (through a rise in θ) or externally (through a rise in v), it has the same effect on both π and ρ.

(3) The Effect of a Change in the Expected Rate of Inflation

First, the expected rate of inflation has the direct effect on the actual rate of inflation, as was assumed earlier in the price adjustment equation. Second, it also has an indirect effect on both commodity and money markets. Given other state variables and parameters, a rise in the expected rate of inflation will raise planned domestic investment through an increase in nominal rate of return on real capital due to the expectation of capital gains, and also net imports.[1]

There may arise an excess demand for or excess supply of commodities, depending on the relative strength of the effects on investments and on net imports. Arbitrarily assuming that $I_2 \overset{<}{(>)} M_E E_2 - X_1$, excess supply (demand) appears in the commodity market and thus the indirect effect of a rise in π^* is to lower (raise) the actual rate of inflation, i.e., $\lambda[I_2 - (M_E E_2 - X_1)] \overset{<}{(>)} 0$.

---

[1]Since $X = X(\pi^*; e)$ $(X_1 < 0)$ and $M = M[E(\cdot)]$ $(0 < M_E < 1)$, a rise in π^* reduces exports and increases imports. Thus the net imports $(M - X)$ increases.

Total (the sum of both direct and indirect) effect of a rise in π^* on π, for given value of ρ, is ambiguous, depending on the magnitude of I_2 relative to $(M_E E_2 - X_1)$. If $I_2 > M_E E_2 - X_1$, then $(d\pi/d\pi^*)_{IS} = 1 + \lambda[I_2 - (M_E E_2 - X_1)] > 1$; whereas if $I_2 < M_E E_2 - X_1$, then $(d\pi/d\pi^*)_{IS} = 1 + \lambda[I_2 - (M_E E_2 - X_1)] \lesseqgtr 0$, depending on $\lambda \gtreqless 1/[(M_E E_2 - X_1) - I_2]$.

Alternatively, for given value of π, the effect of a rise in π^* on ρ is also ambiguous, depending on the sign of $I_2 - (M_E E_2 - X_1)$. If $I_2 > (M_E E_2 - X_1)$, then $(\partial\rho/\partial\pi^*)_{IS} = [1/\lambda + \{I_2 - (M_E E_2 - X_1)\}] /(M_E E_3 - I_3) > 0$; whereas if $I_2 < M_E E_2 - X_1$, then $(\partial\rho/\partial\pi^*)_{IS} = [1/\lambda + \{I_2 - (M_E E_2 - X_1)\}]/(M_E E_3 - I_3) \gtreqless 0$, depending on $(1/\lambda) + \{I_2 - (M_E E_2 - X_1)\} \gtreqless 0$ [or $\lambda \lesseqgtr 1/\{(M_E E_2 - X_1) - I_2\}$]. The shift of the IS curve due to a rise in π^* critically depends upon the magnitude of I_2 relative to $(M_E E_2 - X_1)$ and on the speed of price adjustment in the goods market, λ, if $I_2 < M_E E_2 - X_1$.

In money market a rise in the expected rate of inflation will cause the liquidity demanded to decrease through a rise in the nominal rate of return on capital, $r + \pi^*$. Invoking Walras' law, excess liquidity, for given level of the nominal rate of interest, must be met by the corresponding excess demand for goods. As a result, the actual rate of price change tends to increase, i.e., $(d\pi/d\pi^*)_{LM} = 1 - \lambda L_2 > 1$. Alternatively, for given actual rate of inflation, excess supply of real money balances necessitates the nominal rate of interest to decline in order to maintain money market equilibrium, i.e., $(d\rho/d\pi^*)_{LM} = (1/\lambda - L_2)/L_3 < 0$. The LM schedule is bound to shift downward to the right.

The net effect of a rise in π^* on π and on ρ is ambiguous, critically depending on the magnitude of I_2 relative to $(M_E E_2 - X_1)$ and λ.[1]

Mathematically, the short-run solution can be derived by simultaneously solving both the "general" IS and LM functions for the actual rate of inflation, π, and the nominal rate of interest, ρ, in terms of state variables k_o, v, and π^*, given parameters of $\dot{R}/R$, θ, and n.

$$\begin{bmatrix} 1/\lambda & -(I_3 - M_E E_3) \\ 1/\lambda & L_3 \end{bmatrix} \begin{bmatrix} d\pi \\ d\rho \end{bmatrix} = \begin{bmatrix} (I_1 - S_1 - M_E E_1)y' + (I_2 - M_E E_2)r' \\ - (L_1 y' + L_2 r') \end{bmatrix} dk_o$$

$$+ \begin{bmatrix} (I_4 - S_2 - M_E E_4) \\ (1 - L_4) \end{bmatrix} (\theta dv + v d\theta)$$

$$+ \begin{bmatrix} (1/\lambda + I_2 + X_1 - M_E E_2) \\ (1/\lambda - L_2) \end{bmatrix} d\pi^*$$

$$\Delta_o = (1/\lambda)\{L_3 + (I_3 - M_E E_3)\} < 0$$

$$d\pi = (1/\Delta_o)[L_3\{(I_1 - S_1 - M_E E_1)y' + (I_2 - M_E E_2)r'\}$$

$$- (I_3 - M_E E_3)(L_1 y' + L_2 r')]\, dk_o + (1/\Delta_o)[L_3(I_4 - S_2 - M_E E_4)$$

$$+ (I_3 - M_E E_3)(1 - L_4)]\, (\theta dv + v d\theta)$$

$$+ (1/\Delta_o)[L_3\{1/\lambda + (I_2 + X_1 - M_E E_2)\} + (I_3 - M_E E_3)(1/\lambda - L_2)]d\pi^*$$

---

[1] $I_2 > M_E E_2 - X_1$ is equivalent to the case in which $I_2 < M_E E_2 - X_1$ with $\lambda < 1/[(M_E E_2 - X_1) - I_2]$, where the net effect of a rise in π^* is to raise π with the ambiguous effect on ρ.

$$d\rho = -(1/\lambda\Delta_o)[\{(I_1 - S_1 - M_E E_1)y' + (I_2 - M_E E_2)r'\} + (L_1 y' + L_2 r')]dk_o$$
$$+ (1/\lambda\Delta_o)[(1 - L_4) - (I_4 - S_2 - M_E E_4)](\theta dv + v d\theta)$$
$$- (1/\lambda\Delta_o)[L_2 + \{I_2 - (M_E E_2 - X_1)\}]d\pi^*$$

Therefore, we obtain general short-run solution of π and ρ in terms of state variables with given parameters.

(4.14) $\pi = \pi(k_o, v, \pi^*; \dot{R}/R, n, \theta)$

(4.15) $\rho = \rho(k_o, v, \pi^*; \dot{R}/R, n, \theta)$

where $\pi_1 \equiv \partial\pi/\partial k_o = (\Delta_1/\Delta_o) \overset{\leq}{(>)} 0$

according as $(I_1 - S_1 - M_E E_1)y' + (I_2 - M_E E_2)r' \overset{\leq}{(>)} 0$, i.e., $I_1 \overset{\leq}{(>)} S_1$.

$\pi_2 \equiv \partial\pi/\theta\partial v = \partial\pi/v\partial\theta = (\Delta_2/\Delta_o) > 0$

$\pi_3 \equiv \partial\pi/\partial\pi^* = (\Delta_3/\Delta_o) > 0$ if $I_2 \geqq M_E E_2 - X_1$

or if $I_2 < M_E E_2 - X_1$ and

$(1/\lambda) + [I_2 - (M_E E_2 - X_1)] \geqq 0$ [i.e., $\lambda \leqq 1/\{(M_E E_2 - X_1) - I_2\}$]

If $I_2 < (M_E E_2 - X_1)$ and $(1/\lambda) + \{I_2 - (M_E E_2 - X_1)\} < 0$ [i.e., $\lambda > 1/\{(M_E E_2 - X_1) - I_2\}$], then $\pi_3 \gtreqless 0$, depending on $\Delta_3 \gtreqless 0$. Even when $(\partial\pi/\partial\pi^*) > 0$, $\pi_3 \leqq 1$ if $L_3\{I_2 - (M_E E_2 - X_1)\} \geqq L_2(I_3 - M_E E_3)$ under the assumption of $I_2 < (M_E E_2 - X_1)$;[1] whereas $\pi_3 > 1$ if $I_2 > M_E E_2 - X_1$.

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[1]This is obvious from $\pi_3 = (\Delta_3/\Delta_o) = 1$

$$+ \underbrace{[L_3\{I_2 - (M_E E_2 - X_1)\}}_{\text{(direct effect)}} - \underbrace{L_2(I_3 - M_E E_3)]}_{\text{(indirect effect)}} / [\{L_3 + (I_3 - M_E E_3)\}/\lambda]$$

If $M_E = 1$, then $0 < \pi_3 < 1$.

$$\rho_1 \equiv \partial\rho/\partial k_o = -(\Delta_4/\Delta_o\lambda) \gtreqless 0 \text{ according as } \Delta_4 \gtreqless 0 \text{ (if } I_1 < S_1,\ \Delta_4 \gtreqless 0)$$

$$\rho_2 \equiv \partial\rho/\theta\partial v = \partial\rho/v\partial\theta = (\Delta_5/\lambda\Delta_o) \lesseqgtr 0 \text{ according as } (1 - L_4) \gtreqless (I_4 - S_2 - M_E E_4)$$

$$\rho_3 \equiv \partial\rho/\partial\pi^* = -(\Delta_6/\Delta_o\lambda) \begin{cases} \gtreqless 0 \text{ according as } L_2 + \{I_2 - (M_E E_2 - X_1)\} \gtreqless 0 \\ \qquad\qquad \text{if } I_2 > (M_E E_2 - X_1) \\ < 0 \text{ if } I_2 \leqq (M_E E_2 - X_1) \end{cases}$$

$$\Delta_1 = L_3\{(I_1 - S_1 - M_E E_1)y' + (I_2 - M_E E_2)r'\} - (I_3 - M_E E_3)(L_1 y' + L_2 r')$$

$$\Delta_2 = [L_3(I_4 - S_2 - M_E E_4) + (I_3 - M_E E_3)(1 - L_4)]$$

$$\Delta_3 = L_3[(1/\lambda) + \{I_2 - (M_E E_2 - X_1)\}] + (1/\lambda - L_2)(I_3 - M_E E_3)$$

$$\Delta_4 = \{(I_1 - S_1 - M_E E_1)y' + (I_2 - M_E E_2)r'\} + (L_1 y' + L_2 r') \gtreqless 0$$

$$\Delta_5 = [-(I_4 - S_2 - M_E E_4) + (1 - L_4)]$$

$$\Delta_6 = [L_2 + \{I_2 - (M_E E_2 - X_1)\}]$$

B. Stability Analysis of Short-Run Model

In the above section, we obtained the endogenous variables $\pi_{(t)}$ and $\rho_{(t)}$ expressed in terms of state variables k, v, and π^*, given parameters $\dot{R}/R$, θ, and n. Unlike the short-run equilibrium analysis in which $(\dot{\theta v}) = 0$ and $\dot{\pi}^* = 0$ so that $\pi_s = \dot{R}/R - n$ and $\pi_s = \pi_s^*$,[1] respectively, we shall assume here that $\pi \neq \dot{R}/R - n$ for the purpose of general short-run dynamic adjustment.

---

[1]The short-run equilibrium value of foreign reserve holdings per effective worker (in real terms), v_s is derived from the equilibrium condition: $\pi_s^* = \pi_s = \dot{R}/R - n$ and $\pi_s = \pi(\dot{R}/R - n,\ v_s)$.

Substituting equations (4,14) and (4.15) into the two differential equations describing the time paths of the two state variables v and π^* (in the short-run capital intensity is fixed at a given level k_o), we have:

$$(\dot{\theta v}) = \theta v[\dot{R}/R - \pi(k_o, v, \pi^*) - n]$$

$$\dot{\pi}^* = \beta[\pi(k_o, v, \pi^*) - \pi^*] \quad (0 < \beta < \infty)$$

These two differential equations constitute the short-run dynamic model in an open economy.

Defining the price expectations schedule (the PP curve) and the real money balance schedule (the RR curve) as the loci of combinations of (π^*, v) such that the expected rate of inflation and international reserve holdings per capita are constant, respectively, we can derive the slopes of both schedules as follows:[1]

$$[dv/d\pi^*]_{\dot{\pi}^*=0} = (1 - \pi_3)/\pi_2 \lesseqgtr 0: \quad \text{the slope of the PP curve}$$

$$[dv/d\pi^*]_{(\theta v)=0} = - \pi_3/\pi_2 < 0: \quad \text{the slope of the RR curve}$$

If $\pi_3 (\geqq, <) 1$, deviations from the PP curve tend to be cumulative (decelerating), that is, price expectations are likely to be self-generating (self-correcting);

$$[d\dot{\pi}^*/dv]_{\theta v=\theta v_o} = \beta(\pi_3 - 1) (\geqq, <) 0$$

Since $\pi_2 > 0$, a rise in real value of foreign reserve holdings per capita resulting from international payments surplus under a regime of

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[1]If $I_2 < M_E E_2 - X_1$, $\lambda > 1/(M_E E_2 - X_1) - I_2$, and $L_3[1/\lambda + \{I_2 - (M_E E_2 - X_1)\}] (\geqq) - (I_3 - M_E E_3)(1/\lambda - L_2)$, then $\pi_3 (\leqq) 0$. Therefore, both curves have positive slope and the PP curve is steeper. See Figure 7 (c).

fixed exchange rates raises domestic price level: $[d\dot{\pi}^*/dv]_{\pi^*=\pi_0^*} = \beta\pi_2 > 0$. If $\pi_3 > 0$ and $\pi_3 (\gtrless) 1$, in order to attain constant price expectations (i.e., $\dot{\pi}^* = 0$), therefore, π^* and v must move in opposite (same) way. This fact gives the negatively (positively) sloping PP schedule.[1] If the current π^* is higher than the required π^*, for given value of v, to maintain constant price expectations, deviations of π^* from the required one tend to be cumulative (decelerating) if $\pi_3 > 1$ $(0 < \pi_3 < 1)$. Horizontal vectors in Figure 6 indicate this destabilizing (stabilizing) force of the deviations of the current π^* from the required π^*. Alternatively, above (below) the PP line, the actual reserve holdings per capita is greater (less) than the required level to maintain constant price expectations for any given value of π^*, this excess (shortage) of liquidity tends to raise (lower) the actual rate of inflation. Therefore, deviations of π^* from the required level tend to generate the spiral of inflation (convergence toward equilibrium π_s^*).

A rise in π^* raises actual rate of inflation if $\pi_3 > 0$. Hence, when there is a rise in the expected rate of inflation, we have to decrease the real value of foreign reserve holdings per effective worker to preserve constant real money balances since $\pi_2 > 0$.[2] This is because the RR schedule slopes downward to the right if $\pi_3 > 0$.[3]

---

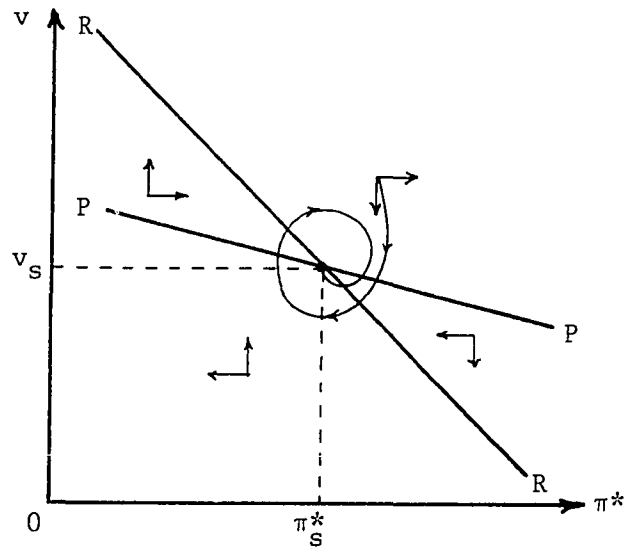
[1]If $\pi_3 = 1$, the PP curve is horizontal, $\pi_3 \leqq 1$ is sufficient to secure the dynamic stability, as shall be shown in the mathematical analysis.

[2]From $(\dot{\theta v}) = [\dot{R}/R - n - \pi(k_o, v, \pi^*)]\theta v = 0$ with given $\dot{R}/R$, θ, and n, and from $\pi = \pi(k_o, v, \pi^*)$; $\pi_2 > 0$ and $\pi_3 > 0$, a rise in π^* requires a decline of v to attain constant real value of money balances.

[3]If $\pi_3 < 0$, then the RR curve slopes upward to the right (positively). For more details, see page 77 footnote 1.

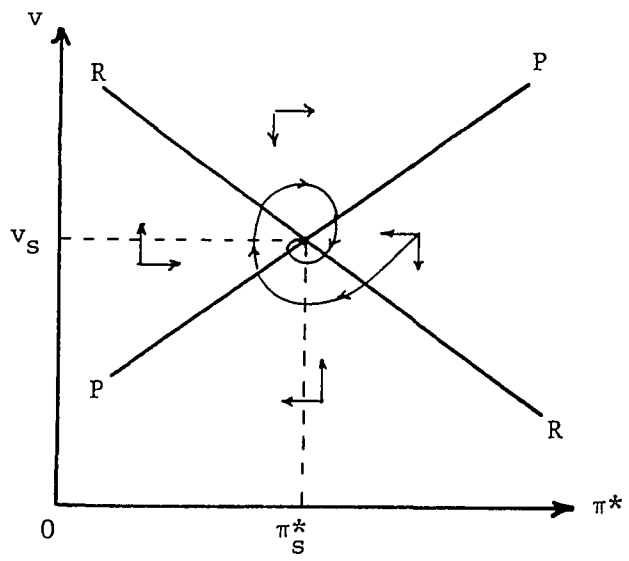
Figure 6. The Stability of

Short-run Dynamic Adjustment



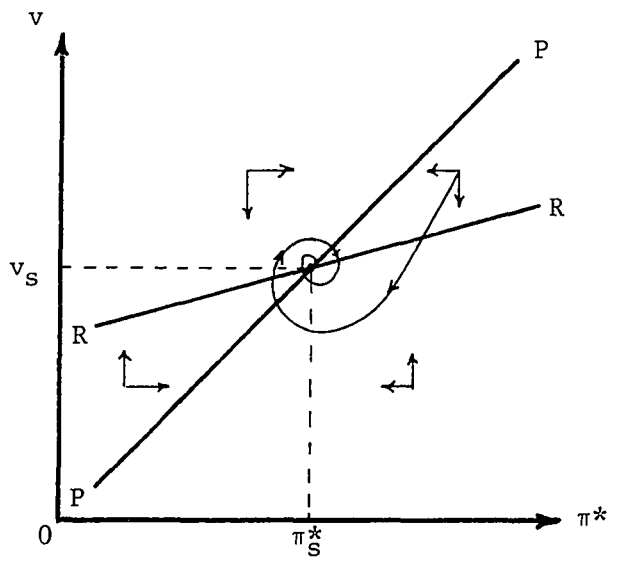
(a) Short-run Dynamic Adjustment When $\pi_3 > 1$

The dynamic stability requires that the slope of the RR curve be steeper than the slope of the PP curve.



(b) Short-run Dynamic Adjustment When $0 < \pi_3 < 1$

The short-run stability is always assured.



(c) Short-run Dynamic Adjustment When $\pi_3 < 0$ Stability is always insured.

Compared with the PP curve, deviations of foreign reserve holdings per capita from the required level to maintain constant real money balances tend to be self-correcting. This constitutes the stabilizing force of the system. If the actual reserve holdings exceeds (falls short of) the amount required, for given value of π^*, to preserve constant real money balances per effective worker, the actual rate of inflation rises (falls). This increase (decrease) in actual inflation lowers (raises) real money balances per capita. Alternatively, if the expected rate of inflation, for any given value of v, is higher (lower) than the required rate to attain constant real money balances, the actual rate of price change rises (falls) and thereby real money balances declines (increases). Such a stabilizing force is described by vertical vectors in Figure 6. Algebraically, the slope of the RR curve is less than the slope of the PP schedule and this fact is consistent with the dynamic stability conditions. Stability of the short-run dynamic adjustment depends on the relative strength of the two forces of price expectations effect $[\beta(\pi_3 - 1) = (\partial\dot{\pi}^*)/(\partial\pi^*)]$ and real balance effect $[-\pi_2 = \{\partial(\dot{\theta v})/\theta v\}/\partial v]$, which shall be summarized and shown in the trace of the coefficient matrix, derived from Taylor linear approximation of the above two basic differential equations, describing short-run dynamic model.

Mathematical analysis of the dynamic stability of short-run model goes as follows: By taking Taylor linear approximation of the above two differential equations around the short-run equilibrium, we obtain the following expression.

$$\begin{bmatrix} -\theta v_s \pi_2 & -\theta v_s \pi_3 \\ \beta \pi_2 & \beta(\pi_3 - 1) \end{bmatrix} \begin{bmatrix} (v - v_s) \\ (\pi^* - \pi_s^*) \end{bmatrix} = \begin{bmatrix} (\dot{\theta v}) \\ \dot{\pi}^* \end{bmatrix}$$

The necessary and sufficient conditions for the local dynamic stability of the short-run model are:

(a) the trace of the coefficient matrix be negative, that is,

$$\beta(\pi_3 - 1) - \theta v_s \pi_2 < 0$$

(b) the determinant be positive, namely, $\beta\theta v_s \pi_2 > 0$.

Looking at these stability conditions, the second condition is always satisfied since $\pi_2 > 0$. In the first inequality condition, two forces of $\beta(\pi_3 - 1)$ and $\theta v_s \pi_2$ are at work.[1]

On the one hand, a rise in π^* may raise or lower the actual rate of inflation by the size of π_3, hinging on the magnitude of $(M_E E_2 - X_1)$ relative to I_2 and the speed of price adjustment, λ, as well as the substitutability of commodities for real money balances $[L_2, L_3$, and $(I_3 - M_E E_3)]$. Inflation due to a rise in π^* tends to be spiral (decelerating), depending on the price expectations effect, $\beta(\pi_3 - 1) \overset{>}{(<)} 0$: $\pi_3 \overset{>}{(<)} 1$ constitutes dynamically destabilizing (stabilizing) force. This is because a rise in π^* raises π by more (less) than π^* and results in a further spiral (deceleration) of inflation through $\beta(\pi_3 - 1) = (\partial\dot{\pi}^*)/(\partial\pi^*) \overset{>}{(<)} 0$.

---

[1]Cross effects $\{(\partial/\partial v)(\dot{\pi}^*) = \beta\pi_2$ and $[\partial/\partial\pi^*][(\dot{\theta v})/(\theta v)] = -\pi_3\}$ are shown as the off-diagonal elements of the coefficient matrix.

The sign and the magnitude of π_3 are critical in the determination of the dynamic stability. Compared with a closed model, the short-run Synthesis model in an open economy is likely to be more stable due to the existence of foreign sector, i.e., $(M_E E_2 - X_1)$ (where $X_1 < 0$). The more the economy is open (i.e., the larger the marginal propensity to import, M_E, and the sensitivity of export to the expected rate of inflation, X_1), the more the system tends to be stable.[1] Therefore, the degree of openness of the economy is crucial to the dynamic stability of the system.

On the other hand, a rise in the actual rate of inflation due to an increase in v lowers real money balances per effective worker. Since domestic spending is positively related to real money balances, a decrease in real balances resulting from a rise in the rate of inflation (due to a rise in v, i.e., $\pi_2 > 0$) will also reduce excess demand for commodities. As a result, this real balance effect $\{\partial[(\dot{\theta v})/(\theta v)]/\partial v = -\pi_2 < 0\}$ will mitigate the inflationary pressure and thus always works as a stabilizing force. Stability can occur if the real balance effect dominates (or reinforces if $\pi_3 < 1$) the price

---

[1]The size of the marginal propensity to import and the sensitivity of export to the expected rate of inflation may be the proxy for the degree of the "openness" of the economy. One could normally expect that small economies would be more open. That is, particularly the marginal propensity to import would be higher for small open economies. Therefore, $(M_E E_2 - X_1)$ is likely to be large.

expectations effect and thereby the trace of the coefficient matrix becomes negative. If the price expectations effect dominates $[\beta(\pi_3 - 1) - \theta v_s \pi_2 > 0]$ due to $\pi_3 > 1$, the trace becomes positive and the system tends to be explosive. For the dynamic stability, small value of the adaptive expectations coefficient, β, which is equivalent to a sufficiently large friction, is also required.

III. Intermediate-Run Model: A Bridge to the Long-Run Model

The intermediate-run model is described by the IS and the LM functions and three differential equations of capital accumulation, price expectations, and the rate of change of real money balances. The intermediate-run behavior of the economy through time is determined by these three differential equations, indicating the time paths of three state variables.

There are two steps to the solution of our intermediate dynamic model. First, to solve the model of the growing economy, represented by three differential equations, the actual rate of price change and the nominal rate of interest (under capital immobility) must be expressed in terms of state variables k, v, and π^*, given parameters $\dot{R}/R$, θ, and n, as was shown by equations (4.14) and (4.15). Second, substituting these intermediate equations of π and ρ into the above three differential equations, the solution of these differential equations in three state variables k, v, and π^* will represent the solution of the intermediate model and thus provide the bridge to the long-run model through the time paths of the growing economy.

Whether the system converges to long-run equilibrium values of k, v, and π^* (i.e., steady state solution values of three state variables) depends, to a large degree, on the properties of intermediate equations (4.14) and (4.15). Given capital intensity, k, foreign reserve holdings per effective worker, v, and the expected rate of inflation, π^*, what will be the actual rate of inflation and the nominal rate of interest under capital immobility? The resulting values of π and ρ will react upon subsequent values of k, v, and π^* in the manner described by three differential equations.

In this way the intermediate system generates a time profile of $\pi_{(t)}$, $\rho_{(t)}$, $k_{(t)}$, $v_{(t)}$, and $\pi^*_{(t)}$. This time paths are designated as the intermediate-run solution and play as a role of the bridge to the steady state. We may trace the time paths of three state variables $k_{(t)}$, $v_{(t)}$, and $\pi^*_{(t)}$, and examine their convergence to the long-run equilibrium values on the basis of three differential equations describing the behavior of the growing economy. Furthermore, we may analyze the effects of variations of parameters ($\dot{R}/R$, θ, and n) on the time paths of state variables.

However, a three dimensional phase diagram in three state variables (k, v, π^*) is difficult to handle and may defeat our purpose of describing the underlying nature of economic processes. Intermediate model is the most important step to the analysis of growing economy in the sense that it provides the bridge between the short-run and long-run models of monetary growth theory. In spite of our recognition of its importance, mathematical manageability of the intermediate model gives impetus for us to sacrifice rigorous analysis of this model.

4.3 The Steady State Solution under Capital Immobility

Long-run equilibrium (the steady state) implies that the ratios of capital per effective worker and real balances per capita are constant $[\dot{k} = (\dot{\theta v}) = 0]$. Consequently:

$$\dot{k} = (\dot{K}/N) - nk = Q(k, v; \dot{R}/R, n, \theta) = 0$$

where $\dot{K}/N = S[y(k), \theta v]$ (under capital immobility)

$$\dot{k} = (\dot{K}/N) - nk = Q(k, v, \pi^*; \dot{R}/R, n, \theta, \rho_w) = 0$$

where $\dot{K}/N = S[y(k), \theta v] + \dot{B}$; $\dot{B} = (\dot{R}/pN) - [X(\cdot) - M(\cdot)]$;

and ρ_w is the nominal rate of interest in the world capital market. (under capital mobility)

Assuming that $\dot{\theta} = 0$,

$$(\dot{\theta v}) = \theta v[(\dot{R}/R) - \pi(k, v, \pi^*) - n] = V(k, v, \pi^*; \dot{R}/R, n, \theta) = 0$$

$$\therefore \quad \pi_e(k_e, v_e, \pi_e^*) = \dot{R}/R - n$$

Moreover, in the steady state the expected rate of price change will be constant $(\dot{\pi}^* = 0)$, but not necessarily $\pi^* = 0$.[1] This implies that: $\dot{\pi}^* = \beta[\pi(k_e, v_e, \pi_e^*) - \pi_e^*] = 0$. Thus in the long-run equilibrium (the steady state) the actual and the expected rates of inflation are identically equal to each other, i.e., $\pi_e = \pi_e^* = (\dot{R}/R) - n(=\pi_w)$.[2]

---

[1]The long-run equilibrium of this system is characterized by the constancy of k, θv, and π^*. The subscript e represents the steady state value of the variable in question.

[2]In the short-run $\dot{R} \neq 0$ may be resulting from $(\pi^* - \pi_w)$ where π_w is the given world rate of inflation. In the long-run equilibrium $(\pi_e^* - \pi_w) = 0$ and π_e^* and π_e converge to π_w, which varies in the long-run.

When $\pi_e = \pi_e^*$, planned aggregate expenditures on commodities are equal to planned aggregate supply of commodities in the IS function. There is no disequilibrium in the commodity market in the steady state of this Synthesized model.

$$\pi_e - \pi_e^* = \lambda[(I + X) - (S + M)] = \lambda F[y(k_e),\ r(k_e) + \pi_e^*,\ \rho_e,\ \theta v_e] = 0$$

Anticipations of price changes lead price setters to mark up prices at a rate $\pi_e^* = \pi_e = \dot{R}/R - n$, without any concomitant excess demand for commodity. Since these expectations are right in the steady state, the price changes are of exactly the "right" amount to preserve equilibrium in the commodity market. From this commodity market equilibrium in the steady state

$F[y(k_e),\ r(k_e) + \pi_e,\ \rho_e,\ \theta v_e] = 0$, we can derive the relationship between the steady state nominal rate of interest and actual rate of inflation (i.e., ρ_e and π_e, respectively). Since in the steady state k_e and θv_e are constant [i.e., $\dot{k} = (\dot{\theta v}) = 0$], commodity market equilibrium is maintained only if $r(k_e) + \pi_e = \rho_e$.

Therefore, $\rho_e = r(k_e) + \pi_e = r(k_e) + (\dot{R}/R - n) = r(k_e) + \pi_w$

From $\dot{k} = 0$, we obtain the first basic equation:

$$\dot{K}/N = nk$$

or

$$S[y(k),\ (\theta v)] = nk: \text{ steady state IS function } (\underline{SIS})$$

In the steady state since commodity market is in equilibrium [i.e., $F(\cdot) = 0$ or $\pi_e = \pi_e^*$], money market should also be in equilibrium [$\theta v = L(\cdot)$ since $(\dot{\theta v}) = 0$] due to Walras' law, under the assumption of continuous equilibrium in the bond market. As a result, we obtain the second basic equation.

$$L[y(k),\ r(k) + (\dot{R}/R) - n,\ \rho_e,\ \theta v] = \theta v:$$

the steady state LM function (<u>SLM</u>)

Two basic equations together with the steady state $\pi_e = \dot{R}/R - n(=\pi_w)$ and $\rho_e = r(k_e) + \pi_e$ enable us to solve for the steady state values of k_e and v_e in terms of $\dot{R}/R$ (or π_w), n, and θ.

I. Solution of the Steady State

Defining the SIS schedule (function) as the locus of the combinations of (k, v) such that the rate of growth of capital is equal to the rate of growth of the effective labor force, that is, $\dot{K}/K = n$ or $\dot{K}/N = nk$[1] where $\dot{K}/N = S[y(k),\ \theta v]$, we can derive the slope of the SIS curve:

---

[1]This is obvious from the equation (4.13)

$$\dot{k} = S[y(k),\ \theta v] - nk$$

Under capital immobility, by setting equation (4.13) equal to zero from the definition of the steady state (long-run equilibrium)

$$\dot{k} = S(\cdot) - nk = 0$$

or

$$\dot{k} = \dot{K}/N - nk = 0,$$

we obtain

$$\dot{K}/N\ \{= S[y(k),\ \theta v]\} = nk$$

or

$$\dot{K}/K = n.$$

$$(dv/dk)_{\dot{R}/R,\ n,\ \theta} = (n - S_1y')/S_2\theta \gtrless 0,$$

depending on

$$(n - S_1y') \lessgtr 0. \qquad \text{(the slope of the SIS curve)}$$

The slope of the steady state commodity market requirement schedule (SIS) depends on the relative magnitude of the income effect of capital accumulation on domestic savings (S_1y') and the growth rate of labor force (n).

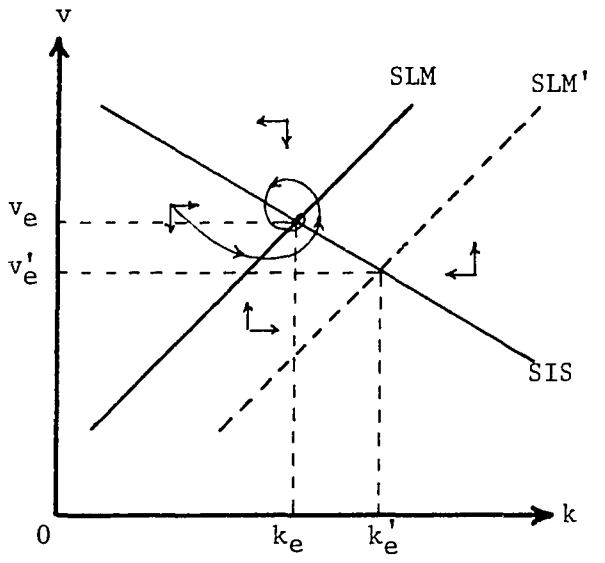
If $S_1y' - n \underset{(>)}{<} 0$, a rise in capital-labor ratio would raise the actual savings less (more) than the required level to preserve the long run commodity market equilibrium ($\dot{k} = 0$). To maintain the constant capital intensity a decrease (an increase) in real money balances is needed to raise (lower) the actual savings. This gives the negatively (positively) sloping SIS curve.

When the SIS curve is negatively sloping, above (below) the curve, for any given value of capital intensity (k), the actual real money balances are greater (smaller) than the required one to maintain steady state. Domestic savings declines (rises) and thus the capital-labor ratio tends to fall (rise). Alternatively, for any given value of real money balances, above (below) the SIS schedule actual capital intensity is higher (lower) than the required level to preserve the steady state ($\dot{k} = 0$). The capital-labor ratio will continue to fall (rise). Horizontal vectors in Figure 7 (a) indicate this phenomenon.

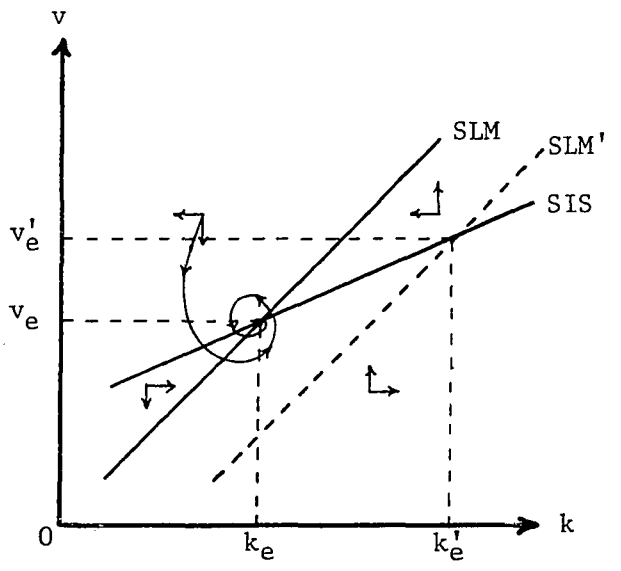
For the case of a positively sloping SIS schedule, when we are off the curve, we can apply the same line of reasoning as

Figure 7. Stable Equilibrium

of the Steady State under Capital Immobility



(a) Stable Equilibrium When $n > S_1y'$ and the Effect of a Change (Rise) in the Growth Rate of Foreign Reserve Holdings



(b) Stable Equilibrium When $n < S_1y'$ and the Effect of a Change (Rise) in the Growth Rate of Foreign Reserve Holdings

the above.[1] In this example deviations from the SIS schedule generate the further deviations as is shown by the horizontal arrows in Figure 7 (b).

Defining the SLM schedule (function) as the locus of points of (k, v) such that demand for and supply of real money balances per effective worker are equal to each other (long-run money market equilibrium),[2] that is, $L[y(k), r(k) + \pi_e, \rho_e, \theta v] = \theta v$.

Taking total differentiation of the SLM function, the slope of the curve is derived:

$$(dv/dk)_{\dot{R}/R,\ \theta,\ n} = (L_1 y' + L_2 r')/(1 - L_4)\theta > 0$$

(the slope of the SLM)

When the capital intensity rises, demand for real money balances tends to increase by the existence of both income and substitution effects

---

[1]Above (below) the SIS curve the actual v, for any given value of k, is greater (less) than the required amount to preserve constant steady state capital-labor ratio and so k decreases (increases) through real balance effect in domestic savings. Alternatively, for any given value of v, above (below) the SIS curve the actual k is less (greater) than the required level to maintain $\dot{k} = 0$. Since $n > S_1 y'$, this causes k to decrease (increase) continuously.

[2]In the steady state since the rate of return on bonds, ρ_e, is identically equal to the nominal rate of yields on capital, $r(k_e) + \pi_e$, bonds may be regarded as a perfect substitute for real capital. Hence we can drop out the bond market equilibrium whereas we initially assumed a continuous equilibrium in that market. We may also omit the steady state money rate of interest, ρ_e, as a separate argument from $r(k_e) + \pi_e$ in the behavioral equations describing the long-run equilibrium since $\rho_e = r(k_e) + \pi_e$.

$(L_1 y' > 0,\ L_2 r' > 0)$. Therefore, to preserve the steady state equilibrium in the money market, real money balances must increase. The SLM curve is unambiguously sloping upward to the right.

Above (below) the curve, for any given value of k, the actual real money balances are greater (less) than the required amount to attain steady state money market. Consequently, the rate of inflation is higher (lower) than the real money balances per effective worker $(\dot{R}/R) - n \overset{>}{(<)} \pi$ from $(\theta\dot{v}) = \theta v(\dot{R}/R - \pi - n) \overset{>}{(<)} 0$. Thus actual real money balances continue to decrease (increase). Alternatively, for any given value of v, above (below) the schedule actual capital intensity is less (greater) than the required level and so the demand for real money balances is less (greater) than the required amount for the steady state. As a result, the rate of inflation rises (declines) and the real money balances will decrease (increase). The vertical arrows in Figures 7 (a) and 7 (b) represent this force at work.

For dynamic (local stability, the slope of the SLM curve is required to be greater than the slope of the SIS schedule.[1] The convergence of the economy to the steady state equilibrium may not be monotonic, depending on the relative strength of the vertical and horizontal vectors.

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[1]We shall see the stability condition of the steady state in the analysis of comparative dynamics.

II. Comparative Dynamics

Now we shall examine the effects on the steady state capital intensity as well as on the financial intensity of a change in the growth rate of international reserves at the monetary authorities, of monetary policy,[1] and of a change in the rate of growth of labor forces due to either Harrod neutral technical change or natural rate of population growth.

Since in the steady state $\pi_e^* = \pi_e = (\dot{R}/R) - n = \pi_w$, a rise (fall) in the growth rate of international reserves will be affected by the rate of inflation in the outside world, i.e., $\partial/\partial\pi_w(\dot{R}/R) = 1$.[2] Referring back to our two basic equations of the SIS and the SLM describing the steady state, we can easily find the effect on the steady state values of k_e and v_e of a rise in the rate of growth of foreign reserves due to a rise in π_w.

A rise in the growth rate of foreign reserves via a rise in $\dot{R}/R$ will result in excess supply of real money balances, for any given value of k, thereby causing the SLM curve to shift downward to the right by the magnitude of

$$[dv/d(\dot{R}/R)]_{SLM} = L_2/(1 - L_4)\theta < 0.$$[3]

---

[1]Strictly speaking, an once and for all change in θ through domestic monetary policy is out of the scope of comparative dynamics. However, for the purpose of convenience, we treat the effect of a change in θ in this section.

[2]In the steady state $\partial(\dot{R}/R)/\partial\pi_w = \partial(\dot{R}/R)/\partial\pi_e = 1$ since $\dot{R}/R = \pi_e + n = \pi_w + n$.

[3]This is derived from the steady state condition for money market as is shown in the SLM function.

Alternatively, a rise in the rate of inflation via an increase in $\dot{R}/R$ raises the yields on capital and bonds (which are equal to each other in the steady state) relative to the yield on real money balances, thereby increasing, for any given value of v, the demand for capital per effective worker. A rise in the demand for real capital will in this turn increase the demand for real money balances via both income and substitution effects. This constitutes a capital deepening force in the path of long-run growth. Thus, if there is a rise in the growth rate of foreign reserves, for any given value of v, the SLM schedule will shift downward to the right without any shift in (effect on) the SIS curve[1] by the magnitude of

$$[dk/d(\dot{R}/R)]_{SLM} = -L_2/(L_1y' + L_2r') > 0.$$

As shall be shown in the graphic analysis and mathematical derivation which summarize the net effect, an increase in $\dot{R}/R$ tends to raise the steady state capital intensity. As the growth rate of foreign reserve holdings (foreign source of monetary base) rises, capital stock increases faster than the given growth rate of effective labor forces and thereby raises the capital intensity. This is caused by the substitution of capital for money due to a rise in the rate of inflation which gives the excess supply in the money market.

The excess supply of real money balances tends to raise price level at a faster rate than before and the real value of money balances held by the private sector declines. Therefore, domestic savings start to increase through real balance effect and also

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[1]Neither of slopes of both curves changes due to a rise in $\dot{R}/R$.

people will substitute capital for money, As a result of an increase in the growth rate of foreign reserves, the steady state capital intensity will rise. This is the conventional result obtained from the standard Neoclassical and the Synthesis model of monetary growth theory in a closed economy.

A change in the foreign reserve ratio to the monetary base (the reciprocal of θ) (through an active monetary policy, for example, open market operations)[1] does shift both the SIS and SLM schedules.[2] For given value of v, a fall in the foreign reserve ratio (an once and for all credit creation or an expansionary domestic monetary policy), given the growth rate of effective labor force and the growth rate of international reserves, will shift the SIS curve by the magnitude of

$$(dk/d\theta)_{SIS} = S_2 v/(n - S_1 y') \overset{<}{(>)} 0, \text{ depending on } (n - S_1 y') \overset{>}{(<)} 0.$$

Alternatively, for given value of k, a change (rise) in θ will shift the SIS curve by the size of

$$(dv/d\theta)_{SIS} = -S_2 v/S_2\theta = -v/\theta < 0.$$

Simultaneously, an expansionary monetary policy (an once and for all increase in domestic monetary assets, D, relative to foreign reserves, R), implied by a rise in θ, gives rise to an excess supply

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[1]For the relationship between domestic monetary policy and θ, see footnote 1 on page 44.

[2]Of course, a change in θ also affects the both slopes of the two curves. However, since these changes in the slopes are relatively unimportant in the determination of the direction of changes in k_e and v_e, we shall ignore them in the following qualitative analysis.

in the money market. In order to attain assets balance (portfolio equilibrium) people will substitute real capital for money (when we continue to assume the maintenance of bond market equilibrium) and the SLM curve will shift, for any given value of v,[1] by the magnitude of

$$(dk/d\theta)_{SLM} = (1 - L_4)v/(L_1y' + L_2r') > 0.$$

Alternatively, for given value of k, a change (rise) in θ will shift the SLM curve by the magnitude of

$$(dv/d\theta)_{SLM} = -(1 - L_4)v/(1 - L_4)\theta = -v/\theta < 0.$$

The net effect shall be shown and summarized in the following graphic analysis and mathematical derivation. In the steady state, an once and for all domestic expansionary monetary policy does not affect the capital intensity, that is, it is neutral on the steady state capital-labor ratio. However, an once and for all increase in θ is

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[1]Because of our restrictive assumption that inflation is caused by an increase in the growth of foreign reserve holdings per effective worker, i.e., $\pi_e = \dot{R}/R - n$, there is no explicit inflation in this model due to a domestic monetary policy. This restrictive nature of the model is brought about by the small country assumption and $\dot{\theta} = 0$, and thus $(\dot{\theta v}) = \theta v(\dot{R}/R - \pi - n)$. We can incorporate the both sources of money creation through a change in θ and/or v over time into the model. However, we sacrifice this general feature of the monetary growth model partly because of convenience purpose and partly because of putting emphasis on the role of foreign reserve positions via persisting balance of payments disequilibrium.

non-neutral on the steady state financial intensity. As shall be shown in both graphic and mathematical analyses, an once and for all expansionary monetary policy unambiguously lowers the steady state real value of foreign reserve holdings of the economy.[1]

A change in the growth rate of effective labor force (either via Harrod neutral technical progress or via a change in the natural rate of population growth) also has non-neutral effect on the steady state capital and financial intensities. For any given value of v, a rise in the growth rate of effective workers will shift the SIS schedule,[2] without affecting the position of the SLM curve, by the magnitude of

$$(dk/dn)_{SIS} = k/(S_1y' - n) \overset{<}{(>)} 0,$$

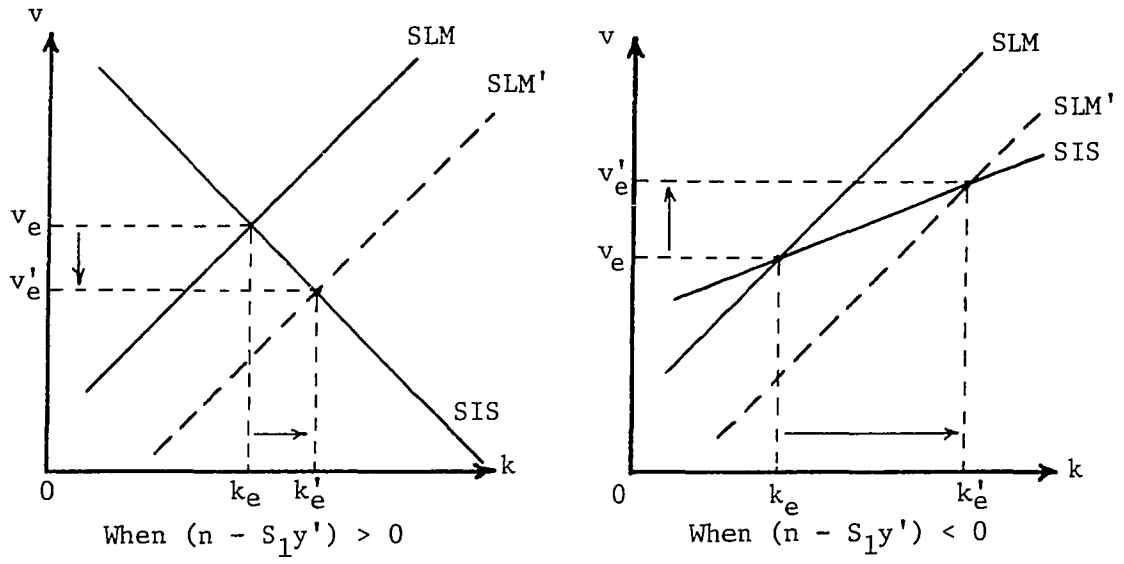
$$\text{depending on } S_1y' - n \overset{<}{(>)} 0.$$

---

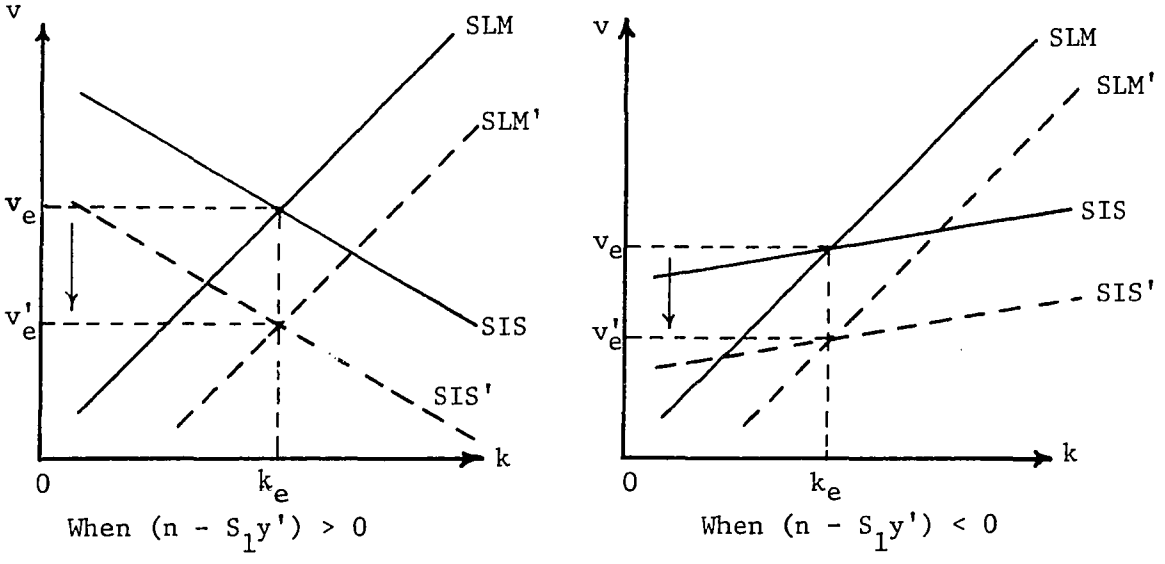
[1]This may be interpreted in the following way of reasoning: In the commodity market, $\partial S/\partial\theta < 0$ and thus k_e decreases $[(dk_e/dS)(\partial S/\partial\theta) < 0$ since $dk_e/dS > 0]$. In the money market, $\partial[\theta v - L(\cdot)]/\partial\theta > 0$ and thus k_e increases $\{\partial k_e/\partial[\theta v - L(\cdot)] \cdot \partial[\theta v - L(\cdot)]/\partial\theta > 0$ since $\partial k_e/\partial[\theta v - L(\cdot)] > 0$, i.e., people will substitute real capital for money to attain portfolio balance if there is an excess supply of real money balances$\}$. Therefore, the net effect of a rise in θ on k_e is zero, i.e., $(dk_e/dS)(\partial S/\partial\theta) + \partial k_e/\partial[\theta v - L(\cdot)] \cdot \partial[\theta v - L(\cdot)]/\partial\theta = 0$. However, if θ rises, then domestic price level rises and $v(\equiv R/pN)$ declines: From $dp/p = (dp/p)^* + \lambda[(I - S) + (X - M)]$ and given $(dp/p)^*$, $dp/d\theta = \lambda[\partial F(\cdot)/\partial\theta] > 0$ since $\partial I/\partial\theta > 0$, $\partial S/\partial\theta < 0$, with $\partial M/\partial\theta > 0$ $(0 < M_E < 1)$.

[2]We shall also ignore the change in the slope of the SIS schedule due to a rise in the growth rate of effective workers on the same ground as noted in the case of a change in θ (see footnote 2 of page 95.

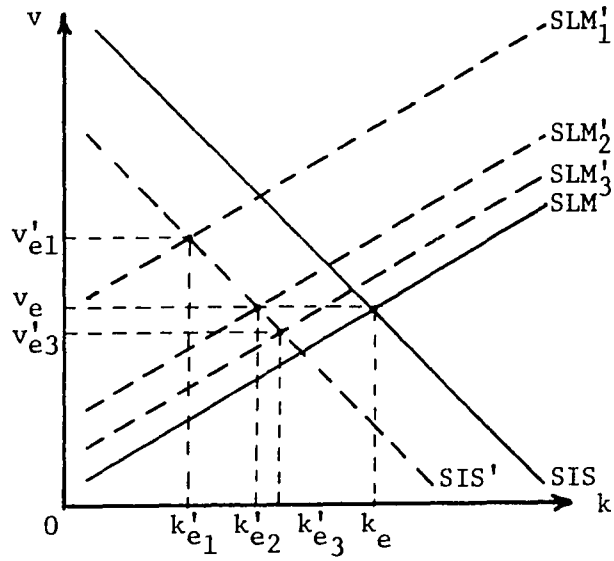
Figure 8. Comparative Dynamics under Capital Immobility: A Graphic Analysis of the Steady State



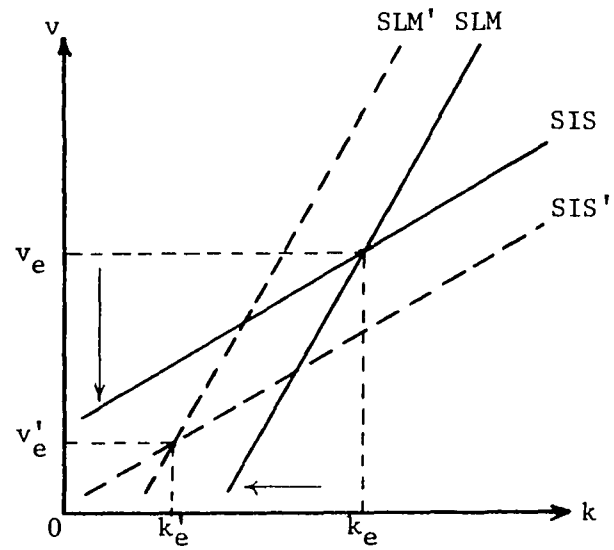
(a) The Effect of a Change (Rise) in $(\dot{R}/R)$



(b) The Effect of a Change (Rise) in θ



When $(n - S_1y') > 0$



When $(n - S_1y') < 0$

(c) The Effect of a Change (Rise) in $n(=\dot{N}/N)$

Alternatively, for any given value of k, a rise in the growth rate of effective workers, n, will shift the SIS schedule by the size of

$$(dv/dn)_{SIS} = k/S_2\theta < 0$$

In the money market, a rise in n, for given value of v, will shift the SLM schedule by the magnitude of

$$(dk/dn)_{SLM} = L_2/(L_1y' + L_2r') < 0$$

Alternatively, for given value of k, a rise in the growth rate of effective labor force will shift the SLM curve by the size of

$$(dv/dn)_{SLM} = - L_2/(1 - L_4)\theta > 0$$

The net effect of a rise in n on the steady state values of capital-labor ratio and financial intensity is shown and summarized in the following graphic and algebraic analyses.

Now we can mathematically derive the effects of the two growth rates, $\dot{R}/R$ and n, and of a domestic monetary policy on the steady state values of capital and financial intensities, by exploiting the above two basic equations describing the steady state of both commodity and money markets (the SIS and the SLM functions, respectively) with the condition of $\pi_e = \pi_e^* = \dot{R}/R - n = \pi_w$.

$$\begin{bmatrix} -(n - S_1y') & S_2\theta \\ (L_1y' + L_2r') & -(1 - L_4)\theta \end{bmatrix} \begin{bmatrix} dk_e \\ dv_e \end{bmatrix} = \begin{bmatrix} 0 \\ -L_2 \end{bmatrix} d(\dot{R}/R)$$

$$+ \begin{bmatrix} k_e \\ L_2 \end{bmatrix} dn + \begin{bmatrix} (-S_2) \\ (1 - L_4) \end{bmatrix} v_e d\theta$$

The necessary and sufficient conditions for the dynamic (local) stability are:[1]

(1) $-(n - S_1y') - (1 - L_4)\theta < 0$. The first condition of the negative trace of the coefficient matrix requires that $-(n - S_1y') < (1 - L_4)\theta$. $-(n - S_1y')$ may be positive or negative since $(1 - L_4)\theta > 0$. [If $-(n - S_1y') < 0$, the local stability is always guaranteed.]

(2) $(n - S_1y')(1 - L_4) - S_2(L_1y' + L_2r') > 0$. The second condition (positiveness of the determinant of the coefficient matrix) requires that the slope of the SIS schedule be smaller than the slope of the SLM curve:

$$(n - S_1y')/S_2\theta < (L_1y' + L_2r')/(1 - L_4)\theta.$$ [2]

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[1]Strictly speaking, we have to take the Taylor linear approximation of the two endogenous variables of k and v in the neighborhood of the steady state (long-run equilibrium) values, as is shown in the following. However, this linear expansion of the two differential equations [$\dot{k} = S(\cdot) - nk$ and $L(\cdot) = \theta v$, which describe the steady state] has the same mathematical characteristics as the above coefficient matrix. Therefore, we can directly use the latter.

$$\begin{bmatrix} -(n - S_1y') & S_2 \\ (L_1y' + L_2r') & -(1 - L_4) \end{bmatrix} \begin{bmatrix} (k - k_e) \\ \theta(v - v_e) \end{bmatrix} = \begin{bmatrix} \dot{k} \\ (\theta\dot{v}) \end{bmatrix}$$

[2]If $n - S_1y' > 0$ and thus $(n - S_1y')/S_2\theta$ (= the slope of the SIS curve) < 0, this condition is always satisfied. If $(n - S_1y') < 0$ and thus $(n - S_1y')/S_2\theta > 0$, the slope of SLM curve must be steeper than the slope of the SIS curve in order to satisfy the stability conditions.

$$dk_e = (1/\Delta)\begin{vmatrix} k_e dn - S_2 v_e d\theta & S_2\theta \\ L_2 dn + (1 - L_4)v_e d\theta - L_2 d(\dot{R}/R) & -(1 - L_4)\theta \end{vmatrix}$$

$$= (1/\Delta)[S_2\theta L_2]d(\dot{R}/R)$$

$$+(1/\Delta)[0]d\theta$$

$$-(1/\Delta)[k_e(1 - L_4)\theta + S_2\theta L_2]dn$$

$$dv_e = (1/\Delta)\begin{vmatrix} -(n - S_1 y') & k_e dn - S_2 v_e d\theta \\ (L_1 y' + L_2 r') & L_2 dn + (1 - L_4)v_e d\theta - L_2 d(\dot{R}/R) \end{vmatrix}$$

$$= (1/\Delta)[L_2(n - S_1 y')]d(\dot{R}/R)$$

$$- (1/\Delta)[(n - S_1 y')L_2 + (L_1 y' + L_2 r')k_e]dn$$

$$- (1/\Delta)[(n - S_1 y')(1 - L_4) - S_2(L_1 y' + L_2 r')]v_e d\theta$$

where $\Delta = (n - S_1 y')(1 - L_4)\theta - S_2\theta(L_1 y' + L_2 r') > 0$ (from the second stability condition.)

Therefore, $\partial k_e/\partial(\dot{R}/R) > 0$; $\partial k_e/\partial n < 0$; $\partial k_e/\partial\theta = 0$.

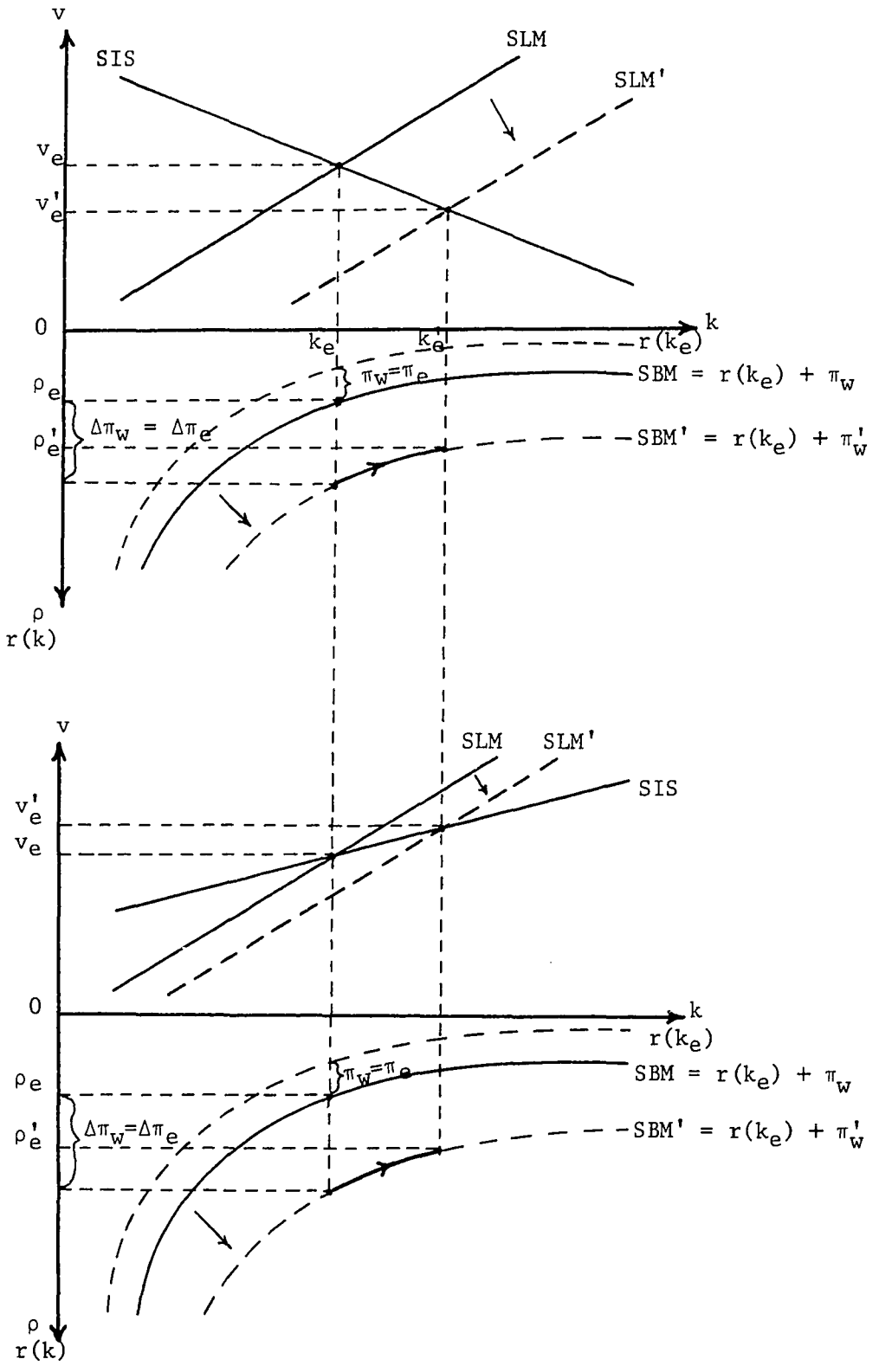
$\partial v_e/\partial(\dot{R}/R) \underset{(<)}{>} 0$ if $(n - S_1 y') \underset{(>)}{<} 0$

$\partial v_e/\partial n \underset{(\gtreqless)}{<} 0$ if $(n - S_1 y') \underset{(>)}{<} 0$, depending on $(n - S_1 y')L_2 + (L_1 y' + L_2 r')k_e \lesseqgtr 0$.

(or relative magnitude of the shift of the SLM curve to the shift of the SIS schedule.)

$\partial v_e/\partial\theta = - v_e/\theta < 0$

Figure 9. The Effect on the Steady State Nominal Interest Rate of a Change (Rise) in the Growth Rate of Foreign Reserve Holdings



Yet we have not considered the effect of a rise in the growth rates of foreign reserves (or a rise in π_w) and effective labor forces on the steady state nominal rate of interest. This can be traced by using Figure 9. In the steady state all the assets are in both stock and flow equilibrium[1] and the rates of return on capital and bonds are equal to each other, i.e., $\rho_e = r(k_e) + \pi_e$. When there is a rise in the world rate of inflation (or an increase in the growth rate of reserves), this tends to raise the steady state nominal rate (direct effect) whereas the rise in capital intensity due to a higher rate of inflation is at work to decrease the marginal product of capital (indirect effect). These two counteracting forces are shown in Figure 9; the former brings the downward shift of the SBM $[=r(k_e) + \pi_w]$ curve and the latter is traced by moving along the new SBM $[r(k_e) + \pi_w']$ curve due to a rise in capital intensity. Theoretically there is no presumption about the behavior of the money rate of interest. The net effect of a rise in the growth rate of foreign reserves (or a rise in π_w) on the money rate of interest depends on the relative strength of the two offsetting effects. Taking into account the fact that the natural rate of interest (or the marginal product of capital) decreases at a decreasing rate $[y''(k) = r'(k) < 0]$, as is shown by the curvature of the SBM curve in Figure 9, we may have a

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[1]This equilibrium may be named as a "full" equilibrium.

presumption that the resulting nominal rate of interest from a rise in the rate of inflation may tend to rise, that is, the direct effect of a rise in the rate of inflation may overbalance (dominate) the indirect effect of a rise in capital intensity due to an increase in $\pi_e (= \pi_w)$.

4.4 The Importance of International Capital Mobility

I. Short-Run Model

We shall now introduce another extreme case of perfect capital mobility. The salient feature of capital mobility assumption lies in the fact that the money rate of interest is no longer endogenous to our small open economy. It is exogenously determined in the international capital market and fixed at the world level of nominal rate of interest, $\overline{\rho}_w$. Bonds market is continuously maintained in equilibrium through instantaneous capital movements between countries. Limiting assumption of perfect capital mobility may imply that there exists a large volume of financial assets that are internationally mobile so that the nominal rate of interest on these assets are the same inside the economy and in the outside world.[1]

In short-run equilibrium model, equilibrium level of international reserve holdings per effective worker is obtained by setting the IS and LM functions equal to each other and solving for the θv. The invariance

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[1]Alternatively, this assumption may be taken to mean that all securities in the system are perfect substitutes. This implies that current exchange rates are expected to persist indefinitely and that spot and forward exchange rates are identical. See Mundell (1968), Chapter 18 (p. 251).

of the nominal rate of interest due to perfect mobility of international capital has a strong resemblance to the Keynesian liquidity trap. In the short-run dynamic analysis, the actual rate of inflation, π, is determined from either the IS function or the LM function. If we use the LM function to obtain this endogenous variable, we have the following equation of the actual rate of inflation in three state variables, given parameters:[1]

$$\pi = \pi(k_o, v, \pi^*; \dot{R}/R, n, \theta, \overline{\rho}_w)$$

where

$$\pi_1 \equiv \partial\pi/\partial k_o = -\lambda(L_1 y' + L_2 r') < 0$$

$$\pi_2 \equiv \partial\pi/\partial v = \lambda(1 - L_4)\theta > 0$$

$$\pi_3 \equiv \partial\pi/\partial\pi^* = 1 - \lambda L_2 > 1 \qquad (0 < \lambda < \infty)$$

$(n = 0$ in the short-run$)$

---

[1] If we use the IS function to derive the relationship between π and k, v, and π^*, we obtain:

$$\pi_1 = \lambda[(I_1 - S_1 - M_E E_1)y' + (I_2 + M_E E_2)r'] \left(\overset{<}{=}\right) 0.$$

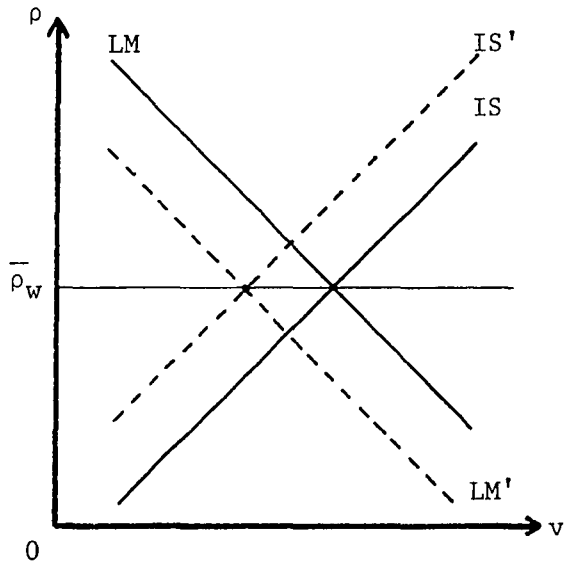
However, the ambiguity on the sign of π_1 will be resolved by the following fact: excess demand for (supply of) commodities is identically equal to excess supply of (demand for) real money balances via Walras' law since bond market equilibrium is always maintained by instant capital movements. Therefore, the sign of π_1 derived from the IS function must be consistent with π_1 derived from the LM function and thus $\pi_1 < 0$. This is also consistent with the stability of the usual Keynesian macroeconomic model: $(I_1 - S_1) < 0$.

$$\pi_2 = \lambda(I_4 - S_2 - M_E E_4)\theta > 0$$

$$\pi_3 = 1 + \lambda[I_2 - (M_E E_2 - X_1)] > 1$$

This is because under capital mobility we lose the "freedom" to change ρ (i.e., $\rho = \overline{\rho}_w$) and thus the excess liquidity due to a rise in π^* must be met by the excess demand for commodities, that is, $I_2 - (M_E E_2 - X_1) > 0$ and $-L_2 = I_2 - (M_E E_2 - X_1)$. Of course, an excess bond supply by domestic residents due to a rise in π^* with fixed exchange rates and $\rho = \overline{\rho}_w$ will result in an instant inflow of capital.

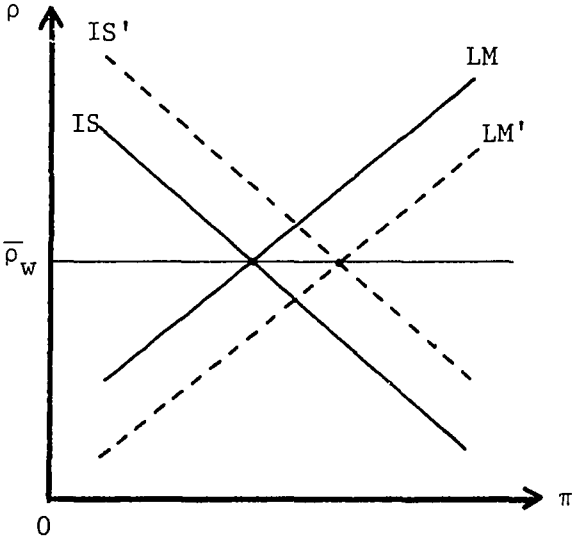
Figure 10. Short-run Equilibrium under Capital Mobility



A rise in the rate of growth of foreign reserves does not change the nominal rate of interest.

Figure 11. The Determination of the Short-run

Rate of Price Change under Capital Mobility



A rise in v or π* only raises the actual rate of inflation.

As is obvious in the above, under capital mobility case, there is no ambiguity about the relationship between the actual rate of price change and the three state variables (k_o, v, π^*).

Under capital mobility the short-run dynamic process and its stability can be analyzed by using two basic differential equations, assuming that in the short-run capital-labor ratio is constant at the given level k_o.

$$(\dot{\theta v}) = \theta v[\dot{R}/R - \pi(k_o, v, \pi^*) - n]$$

$$\dot{\pi}^* = \beta[\pi(k_o, v, \pi^*) - \pi^*]$$

Defining again the RR schedule as the locus of set of (π^*, v) such that $\dot{R}/R = \pi(k_o, v, \pi^*) + n$ (where n = 0), then the slope of the RR curve is derived:

$$(dv/d\pi^*)_{(\dot{\theta v})=0} = -(\pi_3/\pi_2) < 0$$

Defining the PP schedule as the locus of set of (π^*, v) such that $\pi(k_o, v, \pi^*) = \pi^*$, then the slope of the PP curve is:

$$(dv/d\pi^*)_{\dot{\pi}^*=0} = (1 - \pi_3)/\pi_2 < 0$$

The dynamic stability conditions[1] require that the slope of the RR schedule be steeper than the slope of the PP curve, i.e.,

$$|-\pi_3/\pi_2| > |(1 - {}_3)/\pi_2|$$

Compared with the dynamic stability of the short-run model under capital immobility, the adaptive expectations coefficient, β, has an important implication for the capital movements. If β is sufficiently large, the previous forecasting error $(\pi - \pi^*)$ will give a higher price expectations $(\dot{\pi}^*)$ since $\dot{\pi}^* = \beta[\pi(\cdot) - \pi^*]$. This high price

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[1]The dynamic stability conditions are derived by taking Taylor linear approximation of the above two basic differential equations in the neighborhood of the quilibrium values of π_s^* and v_s.

$$\begin{bmatrix} -\theta v_s \pi_2 & -\theta v_s \pi_3 \\ \beta\pi_2 & \beta(\pi_3 - 1) \end{bmatrix} \begin{bmatrix} (v - v_s) \\ (\pi^* - \pi_s^*) \end{bmatrix} = \begin{bmatrix} (\dot{\theta v}) \\ \dot{\pi}^* \end{bmatrix}$$

The first condition (Trace): $\beta(\pi_3 - 1) - \theta v_s \pi_2 < 0$

The second condition (Determinant):

$$\beta\theta v_s[\pi_2\pi_3 - \pi_2(\pi_3 - 1)] = \theta v_s \beta \pi_2 > 0,$$

i.e., $(0>)(1 - \pi_3)/\pi_2$ (=the slope of the PP curve) $> -(\pi_3/\pi_2)$ (=the slope of the RR curve). This is the case of Figure 7 (a). The first condition is met only if β is very small since $\pi_3 = 1 - \lambda L_2 > 1$, or if $\pi_3 = 1$, which implies that the effect of the expected rate of inflation on domestic investment is equal to the effect on the trade balance, i.e., $I_2 + X_1 - M_E E_2 = 0$ (or $L_2 = 0$) or that the value of λ is extremely small. The second condition is always satisfied. Therefore, the degree of openness of the economy, that is, the size of the price expectations effect on the trade balance $(X_1 - M_E E_2)$ is crucial for the short-run dynamic stability.

expectations will in turn raise the actual rate of inflation further through price adjustment process [$\pi = \pi^* + \lambda(I + X - S - M)$] and thus $\pi_3 > 1$ as long as $-L_2 = I_2 + X_1 - M_E E_2 > 0$. Therefore, inflation tends to be cumulative and works as a destabilizing force of the short-run model.[1]

The expected rate of inflation in a small open economy, which is relatively high vis a vis the rest of the world, not only tends to result in an inflation spiral [since $\beta(\pi_3 - 1) > 0$] but also attracts capital inflows under a regime of fixed exchange rates.[2] In short-run a large volume of capital inflow will affect the foreign reserve holdings and the actual rate of inflation. Thus the system will tend to be more unstable since $\pi_3 > 1$.[3]

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[1]This phenomenon gives $\beta(\pi_3 - 1) = \partial\dot{\pi}^*/\partial\pi^*$ (price expectations effect) in the first stability condition the large positive value and indicates the dominance of the price expectations effect (over real balance effect, $\{\partial/\partial v[(\dot{\theta v})/\theta v] = -\pi_2 < 0\}$) which results in dynamically unstable system.

[2]For capital movements under different rates of inflation in different countries, see Frederich A. Lutz (1966), pp. 161-166.

[3]$\pi_3 > 1$, which results from the loss of freedom to change ρ under capital mobility, adversely affects the short-run stability to a significant degree. Of course, real balance effect continues to work as a stabilizing force. However, it is more likely that $[\beta(\pi_3 - 1) - \theta v_s \pi_2]_{\text{capital mobility}} > [\beta(\pi_3 - 1) - \theta v_s \pi_2]_{\text{capital immobility}}$.

Such a high rate of inflation, however, is unlikely to continue for very long, since the economy will soon run into the balance of trade difficulties and thus will be forced to try to step back near the line with the outside world. Furthermore, if the fear spreads that the higher rate of inflation will lead to devaluation of the currency, the tendency to move funds into the small economy will be checked.

If a country has a quite different rate of inflation from the rate in the rest of the world, control of international capital movements by interest rate policy (for example, by establishing interest differentials in view of different rate of interest between countries) is impossible. This provides some grounds for the argument in favor of stable world price and a flexible exchange rate system.

In the long-run the rate of inflation in a small country cannot differ much from the rate in the outside world. Therefore, a small economy is likely to face the limit on its price expectation and the actual rate of inflation.

In all other aspects the analysis of the stability under the case of capital immobility shall be exactly applied and there is no significant difference in the short-run adjustment. Also the comparative dynamic analysis of the effects on the short-run equilibrium model of changes in the growth rates of international reserves and effective labor has the exact analogy to the case of capital immobility on the basis of the same line of reasoning.

Our main concern goes to the steady state model of the monetary growth theory under complete capital mobility.

II. The Long-Run Equilibrium Properties

Recognition of the capital movements gives rise to a significant change in the capital accumulation equation. Now domestic capital formation can be financed not only by domestic savings but by international capital inflows. Thus we have the following differential equation, describing capital accumulation under the environment of international capital mobility, with the same steady state SLM function as under the capital immobility case.

$$\dot{k} = S[y(k),\ \theta v] + v(\dot{R}/R) - X(\dot{R}/R - n)$$
$$+ M\{E[y(k),\ r(k) + (\dot{R}/R - n),\ \rho_w,\ \theta v]\} - nk = 0^{1}$$

(the <u>SIS function</u>)

$$(\dot{\theta v}) = \theta v(\dot{R}/R - \pi_e - n) = 0 \text{ (the } \underline{\text{SLM function}}\text{)}$$

Invoking Walras' law, the second differential equation represents a money market equilibrium, i.e., $L[y(k),\ r(k) + (\dot{R}/R - n),\ \rho_w,\ \theta v] = \theta v$ since commodity market, implied by $\pi_e - \pi_e^* = \lambda[I + X - S - M] = 0$ and the first differential equation, is in equilibrium.

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[1]Recall that $\dot{R}/pN = v(\dot{R}/R) = v(n + \pi_e)$ in the steady state since $\pi_w = \pi_e = \pi_e^* = \dot{R}/R - n$ [from $(\dot{\theta v}) = \theta v(\dot{R}/R - \pi - n) = 0$ and $\dot{\pi}^* = \beta(\pi - \pi^*) = 0$]. Here we use ρ_w instead of $\overline{\rho}_w$ since in the long-run ρ_w is variable even if it is exogenous to a small open economy.

The slopes of the SIS and SLM curves are respectively derived from the above two basic equations describing the steady state.

$$(dv/dk)_{\dot{R}/R,n,\theta} = [n - (S_1 + M_E E_1)y' - M_E E_2 r']$$
$$/[(\dot{R}/R) + (S_2 + M_E E_4)\theta] \gtreqless 0 \text{ (the slope of the SIS curve)}$$

$$(dv/dk)_{\dot{R}/R,n,\theta} = (L_1 y' + L_2 r')/(1 - L_4)\theta > 0 \text{ (the slope of the SLM curve)}$$

Assuming that there exists a stable long-run equilibrium, we can determine the slope of the SIS schedule by referring back to the dynamic (local) stability conditions[1] of the steady state.

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[1]The dynamic stability conditions of the steady state under capital mobility is also analyzed on the basis of the following coefficient matrix obtained by taking the Taylor linear approximation in the neighborhood of the long-run equilibrium.

$$\begin{bmatrix} -\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} & (\dot{R}/R) + (S_2 + M_E E_4)\theta \\ (L_1 y' + L_2 r') & -(1 - L_4)\theta \end{bmatrix}$$

(1) Trace: $-\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} - (1 - L_4)\theta < 0$

(2) Determinant: $\theta(1 - L_4)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\}$
$- (L_1 y' + L_2 r')\{(\dot{R}/R) + (S_2 + M_E E_4)\theta\} > 0$

or $\theta(L_4 - 1)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} + (L_1 y' + L_2 r')$
$\{(\dot{R}/R) + (S_2 + M_E E_4)\theta\} < 0$

From the second condition, if $(\dot{R}/R) + (S_2 + M_E E_4)\theta > 0$, then $\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} > 0$ is required. If $(\dot{R}/R) + (S_2 + M_E E_4)\theta < 0$, then it is required that $(L_1 y' + L_2 r')\{\dot{R}/R + (S_2 + M_E E_4)\theta\} < \theta(L_4 - 1)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\}$ and $n - (S_1 + M_E E_1) - M_E E_2 r' \gtreqless 0$. If $\dot{R}/R + (S_2 + M_E E_4)\theta > 0$ and $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$, local stability is always guaranteed, i.e., it is sufficient for the local stability of the long-run equilibrium. In the determination of the stability, real balance effect on expenditures and the marginal propensity to import (which represents the degree of openness of the economy) play an important role.

A. The Case for a Relatively Weak Real Balance Effect

[The Case I: $(\dot{R}/R) + (S_2 + M_E E_4)\theta > 0$]

If $\dot{R}/R + (S_2 + M_E E_4)\theta > 0$, then the stability requires (from the second stability condition) that $n - \{(S_1 + M_E E_1)y' + M_E E_2 r'\} > 0$ and $\theta(L_4 - 1)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} < -(L_1 y' + L_2 r')\{(\dot{R}/R) + (S_2 + M_E E_4)\theta\}$ or $\theta(1 - L_4)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} > (L_1 y' + L_2 r')\{(\dot{R}/R) + (S_2 + M_E E_4)\theta\}$. Consequently, the slope of the SIS curve is greater than the slope of the SLM schedule, i.e., $\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\}/[(\dot{R}/R) + (S_2 + M_E E_4)\theta] > (L_1 y' + L_2 r')/(1 - L_4)\theta > 0$ where the SIS curve has a positive slope.

When there is an increase in k, actual capital accumulation is less than the required level to maintain constant capital intensity since $n - \{(S_1 + M_E E_1)y' + M_E E_2 r'\} > 0$. If we decrease v to increase domestic savings, given $\dot{R}/R$, there is a concomitant decrease in imports. The net effect is a further decrease in capital accumulation since $(\dot{R}/R) + (S_2 + M_E E_4)\theta > 0$.

Only when we increase v, there is an increase in capital accumulation which can offset the effect of a rise in k. This gives the SIS curve a positive slope.

Above (below) the SIS schedule, for any given value of v, the actual k is less (greater) than the required level to preserve $\dot{k} = 0$. The capital intensity tends to rise (decline) since $n > (S_1 + M_E E_1)y' + M_E E_2 r'$. Alternatively, for given value of k, above (below) the SIS curve the actual v is higher (lower) than the required amount and the capital intensity tends to rise (fall) through real balance effect. Horizontal arrows in Figure 12 (a) indicate this phenomenon.

B. The Case for a Relatively Strong Real Balance Effect

$[(\dot{R}/R) + (S_2 + M_E E_4)\theta < 0]$

If $\dot{R}/R + (S_2 + M_E E_4)\theta < 0$, then local dynamic stability requires (from the second stability condition) that

$$-(L_1 y' + L_2 r')\{\dot{R}/R + (S_2 + M_E E_4)\theta\} > (L_4 - 1)\theta$$
$$\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\},$$

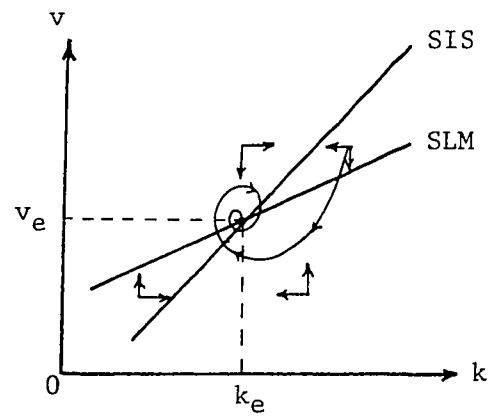
i.e., the slope of the SLM curve is greater than the slope of the SIS curve $[(L_1 y' + L_2 r')/(1 - L_4)\theta > \{n - (S_1 + M_E E_1)y' - M_E E_2 r'\}$ $/\{(\dot{R}/R) + (S_2 + M_E E_4)\theta\}]$ and $n - (S_1 + M_E E_1)y' - M_E E_2 r' \gtreqless 0$.

(1) Case II: If $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$ with $(\dot{R}/R) + (S_2 + M_E E_4)\theta < 0$, then the slope of the SIS curve is negative and the stability conditions are always satisfied. As k rises, the actual capital accumulation falls short of the required level to preserve constant capital-labor ratio. We have to decrease v in order to increase domestic savings (and thereby to raise capital accumulation) since there is a relatively strong real balance effect in savings function, i.e., $(\dot{R}/R) + (S_2 + M_E E_4)\theta < 0$. This gives the negatively sloping SIS curve.

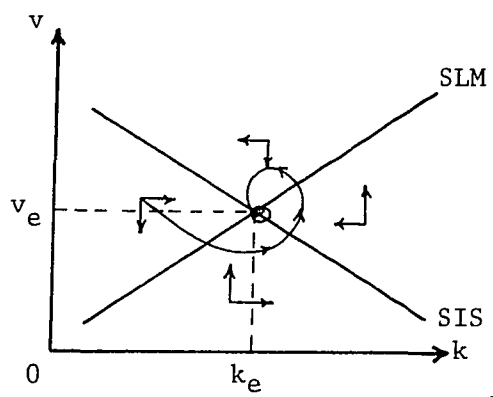
Above (below) the SIS schedule, for given value of v, the actual k is greater (less) than the required level to preserve constant capital intensity and capital-labor ratio tends to decline (rise) since $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$.

Alternatively, for given value of k, above (below) the SIS curve the actual v is greater (less) than the required amount to preserve $\dot{k} = 0$. As a result, domestic savings will decrease (increase) and

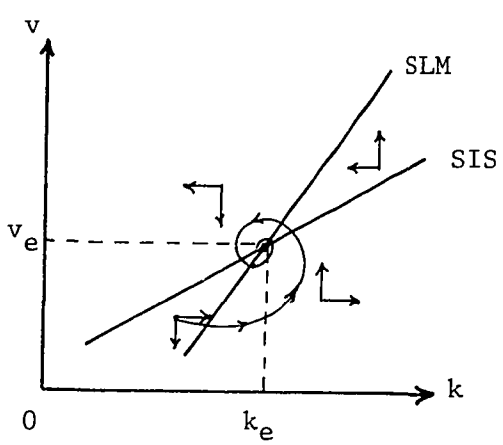
Figure 12. Stable Long-run Equilibrium under Capital Mobility



(a) Case I: Clockwise Adjustment When $[\dot{R}/R + (S_2 + M_E E_4)\theta] > 0$ and $n - \{(S_1 + M_E E_1)y' + M_E E_2 r'\} > 0$



(b) Case II: Counterclockwise Adjustment When $[\dot{R}/R + (S_2+M_E E_4)\theta] < 0$ and $n - \{(S_1 + M_E E_1)y' + M_E E_2 r'\} > 0$



(c) Case III: Counterclockwise Adjustment When $[\dot{R}/R+(S_2+M_E E_4)\theta] < 0$ and $n - \{(S_1 + M_E E_1)y' + M_E E_2 r'\} < 0$

thus capital intensity tends to fall (rise) since there is a relatively strong real balance effect, $(\dot{R}/R) + (S_2 + M_E E_4)\theta < 0$. Horizontal vectors in Figure 12 (b) represents this force at work.

(2) Case III: If $n - (S_1 + M_E E_1)y' - M_E E_2 r' < 0$ with $\dot{R}/R + (S_2 + M_E E_4)\theta < 0$, then the slope of the SIS curve is positive but flatter than the SLM schedule due to the stability requirements

$$(L_4 - 1)\theta\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} < - (L_1 y' + L_2 r') \{\dot{R}/R + (S_2 + M_E E_4)\theta\}$$

or

$$0 < \{n - (S_1 + M_E E_1)y' - M_E E_2 r'\}/(\dot{R}/R) + (S_2 + M_E E_4)\theta < (L_1 y' + L_2 r')/(1 - L_4)\theta.$$

Since an increase in k results in the higher actual capital accumulation than the required level to preserve constant capital-labor ratio, i.e., $n < (S_1 + M_E E_1)y' + M_E E_2 r'$, v must increase when there is a relatively strong real balance effect in domestic savings. This is why the SIS curve has a positive slope.

Above (below) the SIS curve, for given value of v, the actual k is less (greater) than the required level to maintain $\dot{k} = 0$, k tends to decrease (increase) since $n - (S_1 + M_E E_1)y' - M_E E_2 r' < 0$. Alternatively, for any given value of k, above (below) the SIS schedule actual v is greater (less) than the required amount to maintain constant capital intensity and thus k tends to decrease (increase) through a relatively strong real balance effect. Horizontal arrows in Figure 12 (c) indicate this phenomenon.

However, the slope of the SLM curve is always positive since a rise in k requires an increase in v through both income and substitution effects ($L_1y' > 0$ and $L_2r' > 0$, respectively) to preserve money market equilibrium as long as $0 < L_4 < 1$.

III. Comparative Dynamic Analysis

Using the above two SIS and SLM functions, comparative dynamic analysis can analogously be conducted on the same basis of economic reasoning as in the case of capital immobility: the effects on the steady state capital and financial intensities of changes in the growth rates of foreign reserves and the effective labor force as well as the effect of an once and for all monetary policy.

A. The Effect of a Change (Rise) in the Growth Rate of Foreign Reserves ($\dot{R}/R$)

In the commodity market, a rise in $\dot{R}/R$, for given value of v, will shift the SIS curve [1] by the magnitude of

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[1]Of course, a rise in $\dot{R}/R$ will also change the slope of the SIS curve by the magnitude of $\{d/d(\dot{R}/R)\}(dv/dk_e)_{SIS} = -\{n - (S_1 + M_EE_1)y' - M_EE_2r'\}/\{(S_2 + M_EE_2)\theta + \dot{R}/R\}^2 = [-1/\{(S_2 + M_EE_4)\theta + \dot{R}/R\}]$ $(dv_e/dk_e)_{SIS} \gtreqless 0$, depending on $\dot{R}/R + (S_2 + M_EE_4)\theta \lesseqgtr 0$. However, since this change in the slope of the SIS curve is relatively unimportant in the qualitative determination of the direction of changes in the steady state k_e and v_e, we shall ignore it in this comparative dynamic analysis. The same logic shall be applied to the cases of changes in the slopes of the two curves due to changes in n ($=\dot{N}/N$) and θ.

$$[dk/d(\dot{R}/R)]_{SIS} = [v_e + M_E E_2 - X_1]/[n - (S_1 + M_E E_1)y' - M_E E_2 r']$$
$$\{\gtrless\}0, \text{ depending on } n - (S_1 + M_E E_1)y' - M_E E_2 r' \{\gtrless\} 0.$$

Alternatively, for given value of k, a rise in $\dot{R}/R$ will shift the SIS schedule by the magnitude of

$$[dv/d(\dot{R}/R)]_{SIS} = [v_e - X_1 + M_E E_2]/-\{\dot{R}/R + (S_2 M_E E_4)\theta\}\{\gtrless\}0,$$
$$\text{depending on } \dot{R}/R + (S_2 + M_E E_4)\theta \{\lessgtr\} 0.$$

Simultaneously, in the money market, a rise in $\dot{R}/R$, for given value of v, will shift the SLM curve (without any change in the slope) by the size of

$$[dk/d(\dot{R}/R)]_{SLM} = - L_2/(L_1 y' + L_2 r') > 0.$$

Alternatively, for given value of k, a rise in $(\dot{R}/R)$ will shift the SLM curve by the magnitude of

$$[dv/d(\dot{R}/R)]_{SLM} = L_2/(1 - L_4)\theta < 0.$$

The net effect of such a rise in $(\dot{R}/R)$ on the steady state capital and financial intensities are shown in the following graphic and algebraic analyses.

B. The Effect of a Change (Rise) in the Rate of Growth of Effective Workers (n)

In the commodity market, a rise in n, for any given value of v (or k), will shift the SIS curve by the magnitude of

$$(dk/dn)_{SIS} = [X_1 - M_E E_2 - k_e]/[n - (S_1 + M_E E_1)y' - M_E E_2 r']$$
$$\{\lessgtr\}0, \text{ depending on } n - (S_1 + M_E E_1)y' - M_E E_2 r' \{\gtrless\} 0.$$

or

$$(dv/dn)_{SIS} = [k_e + M_E E_2 - X_1]/[(S_2 + M_E E_4)\theta + \dot{R}/R]\{\gtrless\}0,$$
$$\text{depending on } (S_2 + M_E E_4)\theta + \dot{R}/R \{\gtrless\} 0.$$

Simultaneously, in the money market, a rise in n, for any given value of v_e(or k_e), will shift the SLM schedule by the size of

$$(dk/dn)_{SLM} = L_2/(L_1y' + L_2r') < 0$$

or

$$(dv/dn)_{SLM} = - L_2/(1 - L_4)\theta > 0.$$

The net effect of a rise in n on the steady state values of capital and financial intensities are summarized in the following graphic and mathematical analyses.

C. The Effect of an Expansionary Monetary Policy

In the commodity market, an once and for all rise in θ, for any given value of v (or k), will shift the SIS schedule by the magnitude of

$$(dk/d\theta)_{SIS} = (S_2 + M_EE_4)v_e/[n - (S_1 + M_EE_1)y' - M_EE_2r'] \begin{bmatrix} > \\ (<) \\ < \\ (>) \end{bmatrix} 0$$

if

$$S_2 + M_EE_4 \quad 0 \text{ and } n - (S_1 + M_EE_1)y' - M_EE_2r' \quad 0$$

or

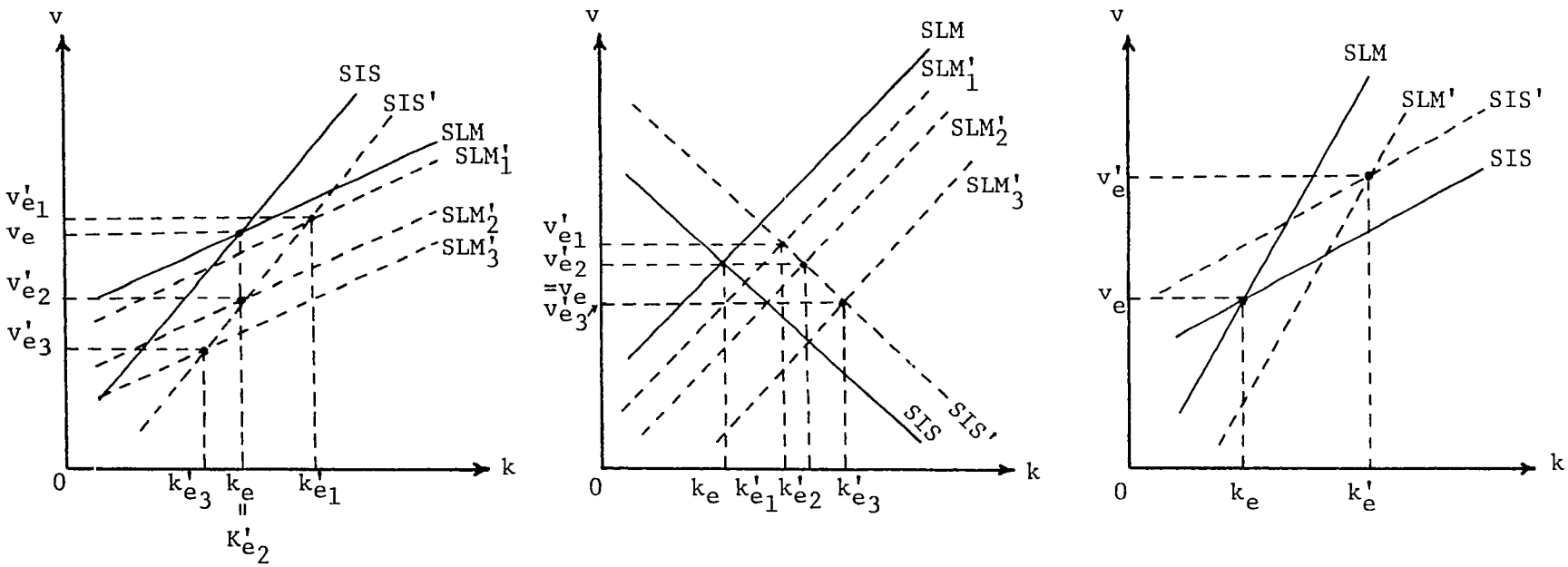
$$(dv/d\theta)_{SIS} = - (S_2 + M_EE_4)v_e/[(S_2 + M_EE_4)\theta + \dot{R}/R] \begin{bmatrix} > \\ (<) \\ < \\ (>) \end{bmatrix} 0$$

$$\text{if } (S_2 + M_EE_4) \overset{<}{>} 0 \text{ and } (S_2 + M_EE_4)\theta + \dot{R}/R \overset{>}{(<)} 0$$

In the money market, a rise in θ, for any given value of v (or k), will also shift the SLM curve by the size of

$$(dk/d\theta)_{SLM} = (1 - L_4)v_e/(L_1y' + L_2r') > 0$$

Figure 13. Comparative Dynamics under Capital Mobility: A Graphic Analysis of the Steady State

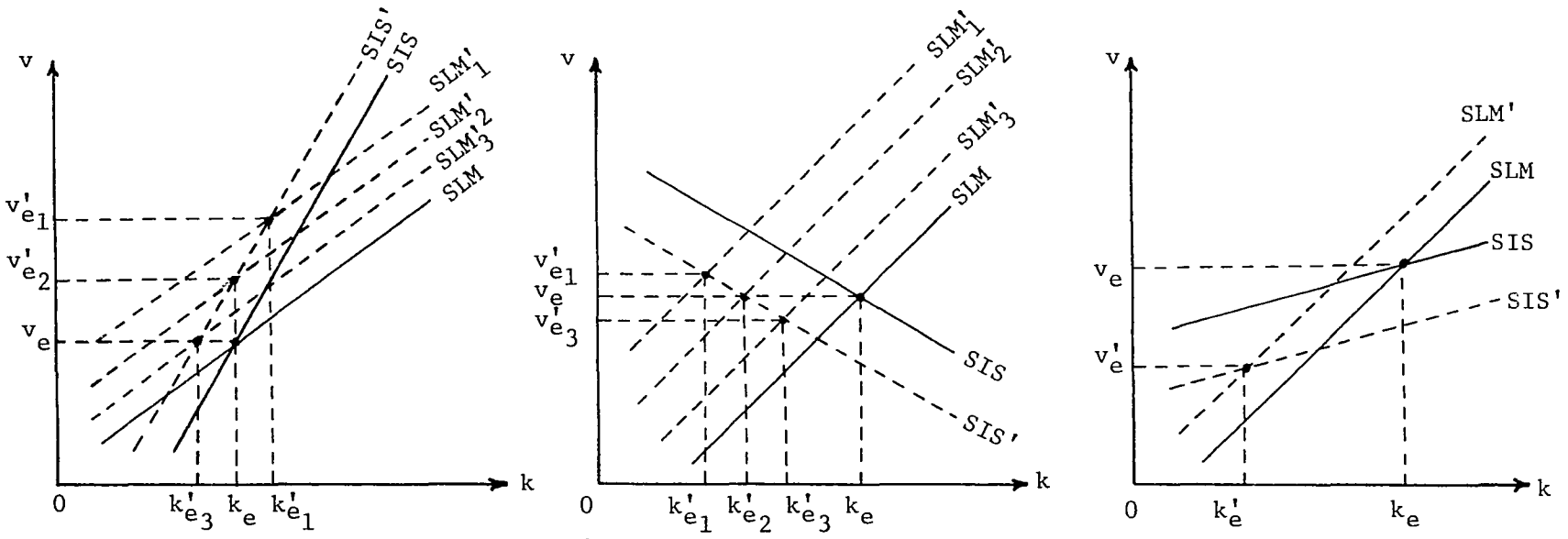


$[\dot{R}/R + (S_2 + M_E E_4)\theta] > 0$ and $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$

$[\dot{R}/R + (S_2 + M_E E_4)\theta] < 0$ and $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$

$[\dot{R}/R + (S_2 + M_E E_4)\theta] < 0$ and $n - (S_1 + M_E E_1)y' - M_E E_2 r' < 0$

(a) Effect of a Change (Rise) in $(\dot{R}/R)$

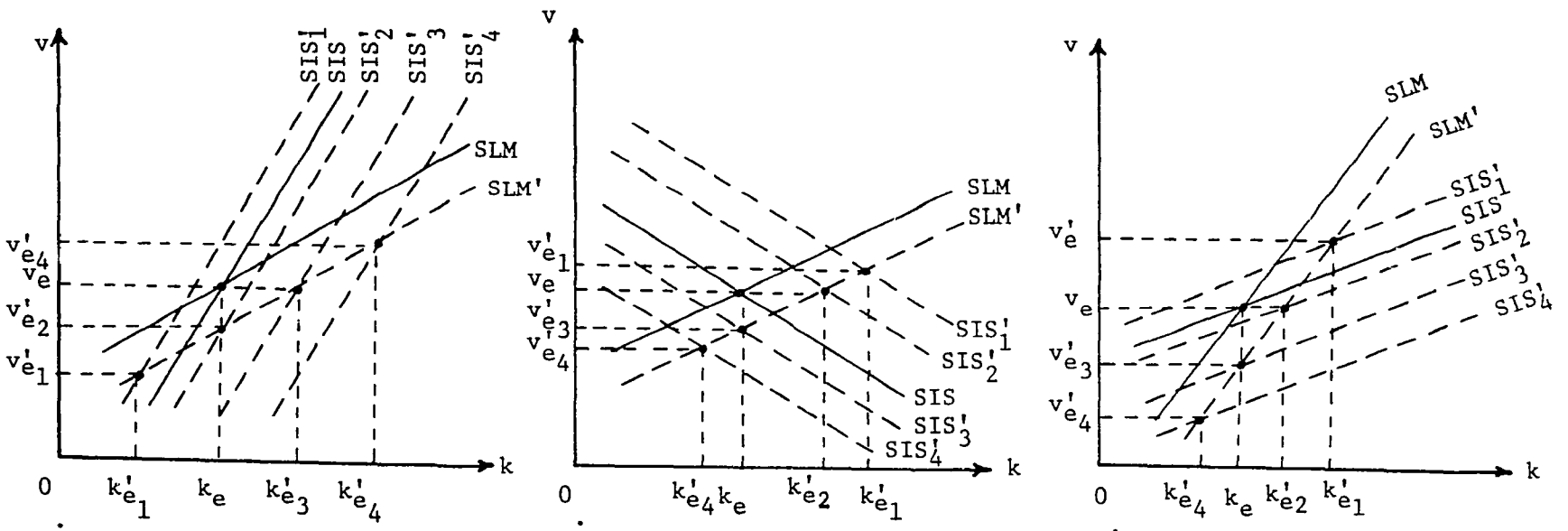


$[\dot{R}/R + (S_2 + M_E E_4)\theta] > 0$ and
$n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$

$[\dot{R}/R + (S_2 + M_E E_4)\theta] < 0$ and
$n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$

$[\dot{R}/R + (S_2 + M_E E_4)\theta] < 0$ and
$n - (S_1 + M_E E_1)y' - M_E E_2 r' < 0$

(b) Effect of a Change (Rise) in n



$[\dot{R}/R + (S_2 + M_E E_4)\theta] > 0$ and
$n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$

$[\dot{R}/R + (S_2 + N_E E_4)\theta] < 0$ and
$n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$

$[\dot{R}/R + (S_2 + M_E E_4)\theta] < 0$ and
$n - (S_1 + M_E E_1)y' - M_E E_2 r' < 0$

(c) Effect of an Once-and-for-all Change (Rise) in θ

or

$$(dv/d\theta)_{SLM} = (L_4 - 1)v_e/(1 - L_4)\theta = - v_e/\theta < 0.$$

The net effect of an once and for all expansionary monetary policy on the steady state values of the capital-labor ratio and the financial intensity is shown and summarized in the following graphic and algebraic derivations.

By using the above basic functions (SIS and SLM functions), we are able to derive mathematically the same results obtained in the graphic analysis.

$$\begin{bmatrix} \{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} & -\{(S_2 + M_E E_4)\theta + \dot{R}/R\} \\ (L_1 y' + L_2 r') & (L_4 - 1)\theta \end{bmatrix}$$

$$\begin{bmatrix} dk_e \\ dv_e \end{bmatrix}$$

$$= \begin{bmatrix} (S_2 + M_E E_4) \\ (1 - L_4) \end{bmatrix} v_e d\theta + \begin{bmatrix} (v_e + M_E E_2 - X_1) \\ (-L_2) \end{bmatrix} d(\dot{R}/R)$$

$$+ \begin{bmatrix} (X_1 - M_E E_2 - k_e) \\ L_2 \end{bmatrix} dn$$

$$\Delta_M \equiv \theta(L_4 - 1)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\}$$
$$+ (L_1 y' + L_2 r')\{(S_2 + M_E E_4)\theta + \dot{R}/R\} < 0$$

from the Stability Condition.

$$dk_e = (1/\Delta_M) \begin{vmatrix} [(S_2 + M_E E_4)v_e d\theta + (v_e - X_1 + M_E E_2)d(\dot{R}/R) & -\{(S_2 + M_E E_4)\theta + \dot{R}/R\} \\ [(1 - L_4)v_e d\theta - L_2 d(\dot{R}/R) + (X_1 - M_E E_2 - k_e)dn] & (L_4 - 1)\theta \\ + L_2 dn] & \end{vmatrix}$$

$$= [(1 - L_4)(\dot{R}/R)v_e]d\theta/\Delta_M$$

$$- [(1 - L_4)\theta(v_e - X_1 + M_E E_2) + L_2\{(S_2 + M_E E_4)\theta + \dot{R}/R\}]d(\dot{R}/R)/\Delta_M$$

$$+ (1/\Delta_M)[L_2\{(S_2 + M_E E_4)\theta + \dot{R}/R\} - (1 - L_4)\theta(X_1 - M_E E_2 - k_e)]dn$$

$$dv_e = (1/\Delta_M)\begin{vmatrix} \{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} & [(S_2 + M_E E_4)v_e d\theta + (v_e - X_1 + M_E E_2)d(\dot{R}/R) + (X_1 - M_E E_2 - k_e)dn] \\ (L_1 y' + L_2 r') & [(1 - L_4)v_e d\theta - L_2 d(\dot{R}/R) + L_2 dn] \end{vmatrix}$$

$$= (1/\Delta_M)[(1 - L_4)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} - (L_1 y' + L_2 r')(S_2 + M_E E_4)]v_e d\theta$$

$$- (1/\Delta_M)[L_2\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} + (L_1 y' + L_2 r')(v_e - X_1 + M_E E_2)]d(\dot{R}/R)$$

$$+ (1/\Delta_M)[L_2\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} - (L_1 y' + L_2 r')(X_1 - M_E E_2 - k_e)]dn$$

If $\dot{R}/R \gtreqqless 0$, then $\partial k_e/\partial\theta \lesseqqgtr 0$.

If $(S_2 + M_E E_4)\theta + \dot{R}/R \leqq 0$, then $\partial k_e/\partial(\dot{R}/R) > 0$.

If $(S_2 + M_E E_4)\theta + \dot{R}/R > 0$, then $\partial k_e/\partial(\dot{R}/R) \gtreqqless 0$, depending on $(1 - L_4)\theta(v_e - X_1 + M_E E_2) + L_2\{(S_2 + M_E E_4)\theta + \dot{R}/R\} \gtreqqless 0$.

If $(S_2 + M_E E_4)\theta + \dot{R}/R \leqq 0$, then $\partial k_e/\partial n < 0$.

If $(S_2 + M_E E_4)\theta + \dot{R}/R > 0$, then $\partial k_e/\partial n \lesseqqgtr 0$, depending on $L_2\{(S_2 + M_E E_4)\theta + \dot{R}/R\} - (1 - L_4)\theta(X_1 - M_E E_2 - k_e) \gtreqqless 0$.

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$ and $(S_2 + M_E E_4) > 0$, then $\partial v_e/\partial\theta \lesseqgtr 0$, depending on

$$(1 - L_4)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} - (L_1 y' + L_2 r')(S_2 + M_E E_4) \gtreqless 0.$$

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$ and $(S_2 + M_E E_4) \leqq 0$, then $\partial v_e/\partial\theta < 0$.

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' < 0$ and $(S_2 + M_E E_4) \geqq 0$, then $\partial v_e/\partial\theta > 0$.

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' < 0$ and $(S_2 + M_E E_4) < 0$, then $\partial v_e/\partial\theta \lesseqgtr 0$, depending on

$$(1 - L_4)\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} - (L_1 y' + L_2 r')(S_2 + M_E E_4) \gtreqless 0.$$

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' \leqq 0$, then $\partial v_e/\partial(\dot{R}/R) > 0$.

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$, then $\partial v_e/\partial(\dot{R}/R) \gtreqless 0$, depending on

$$L_2\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} + (L_1 y' + L_2 r')(v_e - X_1 + M_E E_2) \gtreqless 0.$$

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' \leqq 0$, then $\partial v_e/\partial n < 0$.

If $n - (S_1 + M_E E_1)y' - M_E E_2 r' > 0$, then $\partial v_e/\partial n \lesseqgtr 0$, depending on

$$L_2\{n - (S_1 + M_E E_1)y' - M_E E_2 r'\} - (L_1 y' + L_2 r')(X_1 - M_E E_2 - k_e) \gtreqless 0.$$

Under international capital mobility, ambiguity exists on the effect of a rise in the growth rate of international reserves on the steady state capital and financial intensities. The marginal

propensity to import affects the direction of the movement in both capital and financial intensities to a significant degree when there are changes in $(\dot{R}/R)$, n, and θ.

Compared with the capital immobility case, the steady state capital and financial intensities due to a change in the growth rate of foreign reserves are ambiguous. In an open economy the capital mobility is crucial to the determination of the effect of a change in the growth rate of foreign reserves and/or monetary policy. Under capital mobility, monetary policy is no longer neutral to the steady state capital intensity. These ambiguous results are comparable to those obtained from the Neoclassical and Keynes-Wicksell models in a closed economy. Under international capital mobility, the nominal rate of interest is exogenously determined and so the time path of the nominal rate is also exogenous to the system. It is not affected by a change in the growth rate of reserve holdings of a small open economy.

4.5 Summary and Conclusion

Some of the salient features of our open model of monetary growth theory under a regime of fixed exchange rates may be summarized as follows:

(1) New money is created through a change in foreign monetary assets held at the central bank due to a persisting disequilibrium in the balance of payments. Here we put aside the problem of the optimality in the composition of monetary assets between foreign and domestic assets and also the optimality problem of money supply process. Particularly, in a small open economy that has a relatively

large foreign sector, it is believed that a significant portion of money supply comes from the change in international reserve holdings and it may have an important effect on the economic growth through the channel we showed thus far.

(2) In an open economy domestic capital accumulation may be financed not only through domestic savings but also through capital inflow into the economy. However, under the assumption of capital immobility there is virtually no difference between the open and closed model even though the actual rate of inflation is affected by the foreign sector.

(3) Dynamic local stability of short-run equilibrium of the open model is strengthened by the introduction of the import function, assuming that import demand depends on the amount of domestic expenditures on which price expectation has influence, and the export function. The degree of openness of the economy, in other words the marginal propensity to import out of expenditures (as well as the sensitivity of the exports to the anticipated rate of inflation), is crucial for the enhancement of the both short-run and long-run dynamic (local) stability, and it is also important in the determination of the effect of a change in the growth rate of foreign reserves and of monetary policy on the steady state capital and financial intensities.

(4) In the Stein-Fischer Synthesis model of monetary growth theory in a closed economy in which money is created either through government budgetary deficit (outside money creation) or through domestic credit creation by the banking sector (inside money creation),

or through both, a rise in the rate of monetary expansion unambiguously raises the steady state capital-labor ratio and lowers real money balances per effective worker. That is, the Tobinesque Neoclassical results are obtained.

However, the present open model of Synthesized monetary growth theory under capital mobility shows ambiguity about the effects on the steady state capital and financial intensities of an increase in the rate of growth of foreign reserve holdings at the monetary authorities. The degree of international capital mobility plays a crucial role in the determination of the effects on the steady state capital-labor ratio and real money balances of an increase in the rate of growth of foreign monetary assets held at the central bank as well as in the determination of dynamic stability of the long-run equilibrium.

The balance of payments affects the growth of international reserve holdings of a small open economy under fixed exchange rate system and thereby has a significant implication for the growth policy in the context of monetary growth theory.

CHAPTER V

ECONOMIC GROWTH AND THE BALANCE OF PAYMENTS

In the previous chapter we developed a model of monetary growth in a small open economy in which new money is created through continuous imbalance in international payments under a regime of fixed exchange rates. Now we are in a position to analyze the remaining half of a feedback mechanism of monetary growth and the balance of payments.

A wide-spread theme of post-World War II writings on international payments adjustments theory is that a high rate of economic growth tends, ceteris paribus, to deteriorate the balance of payments.[1] When an economy grows at a relatively rapid rate, its imports, given constant prices of world commodities, will increase and the balance of payments (ignoring international capital movements) necessarily deteriorates. This holds for any exogenously determined time path of exports if the same income elasticity of import demand exists in all the countries.

Thus the balance of payments is regarded as a constraining factor on economic growth. This argument, however, provides a conflict with the facts observed in our real world. Recent experience of the balance of payments in a few rapidly growing economies, such as West Germany, Italy, and France, recorded an improving tendency; whereas several relatively slowly growing countries, such as the United

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[1]For example, see Johnson (1966), p. 146.

States, the United Kingdom, and Belgium, have had prolonged difficulties in international payments.[1]

Analytical results obtained from the traditional Keynesian model[2] [for example, Johnson (1958)] of the balance of payments (ignoring international flow of capital) and economic growth miss the important

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[1]Mundell (1968), Chapter 9, argued in his highly original contribution to the problem that the Japanese balance of payments deficits for the 1950's during which it recorded a very high rate of economic growth was the consequence of its deliberate "monetization" policy. If the central bank monetizes all the assets the private sector wants to commit to additional money holding, when there exists an increase in demand for money due to economic growth, then it can prevent a payments surplus from being realized. If, for example, the central bank in a rapidly growing economy progressively lowers the reserve ratio, it can generate a balance of payments deficit by creation of domestic credit (the purchase of domestic assets) in excess of money hoarding (desired increase in money balances), or whatever balance of payments deficit or surplus it wishes. The effect of monetization on the balance of payments accounts in the course of economic growth shall be analyzed in the later part of this chapter.

[2]$\dot{R}_{(t)} = X^*_{(t)} - M^*_{(t)}$; $M^*_{(t)} = c + \mu Y_{(t)}$ where c is a constant and μ is the marginal propensity to import out of income. Therefore, $\dot{R}_{(t)} = X^*_{(t)} - c - \mu Y_{(t)}$. Here price is assumed to be constant *à la* Keynes and hence it does not matter whether variables are expressed in real or money terms.

connection between demand for commodities and liquidity requirements. In other words, post-war Keynesian models of international payments adjustments are not formulated on the basis of general equilibrium theory and are not appropriate to deal with the relationship between growth and the balance of payments.

In this chapter we shall examine this relationship by using an alternative approach to this important problem, based on a general equilibrium model of the balance of payments, which is similar to those developed by Mundell (1968),[1] Komiya (1969), and Dornbusch (1971).

5.1 The Structure of the Balance of Payments and the Method of Analysis

A country's overall balance of payments is composed of the balances on the current account and the capital account. In the framework of a general equilibrium model with three categories of assets, which are assumed to be "gross" substitutes for one another, the overall balance of payments as well as each account is the reflection of flow adjustments in portfolio balances by the private sector.[2]

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[1]Mundell ignored international movements of capital. Our model owes much to McKinnon and Oates (1966), Oates (1966), and McKinnon (1969) in the sense that the balance on the international payments accounts are essentially considered as a reflection of the assets portfolio adjustment process by the private sector of the economy.

[2]For the sake of simplicity, we shall again assume that only the private sector adjusts its portfolio balance. We assume away government expenditures and taxes which can easily be included in investment and savings of the private sector, respectively.

In order to demonstrate the relation between economic growth and the behavior of the balance of payments accounts in the simplest possible way, we shall ignore the items on current account other than the trade balance, like transportation. We shall also neglect the transfer payments since they can be regarded as a balancing item when there is disequilibrium in the trade and/or the capital accounts.

The real balance per capita on the trade account, which is identical to the real balance per capita on the current account due to our simplifying assumption, is captured by the flow equilibrium condition in the commodity market. That is, the real balance of trade per effective worker is the difference between real output and domestic expenditures on consumption and investment (or domestic absorption) or the excess supply of output over domestic expenditures.

$$(5.1) \qquad B_1/pN\ [\equiv (X^* - M^*)/pN] = y(k) - C[y(k), \theta v] - I[y(k), r(k) + \pi^*, \rho, \theta v]$$
$$= y(k) - E[y(k), r(k) + \pi^*, \rho, \theta v]$$

where B_1 is the balance of trade in terms of domestic currency.

Similarly, the real balance per capita on the capital account is identified as the result of flow adjustments in the domestic bond market to preserve the stock equilibrium there. The stock supply of and demand for bonds by domestic residents (in real and per capita terms) are respectively assumed to be functions of real income, $y(k)$, the nominal rate of return on physical capital, $r(k) + \pi^*$, the bond

rate of interest, ρ, and the stock of real money balances, θv, of the economy:

(5.2) $B^{s*}/pN = H[y(k), r(k) + \pi^*, \rho, \theta v]; H_1 > 0, H_2 > 0, H_3 < 0, H_4 < 0$

(5.3) $B^{d*}/pN = J[y(k), r(k) + \pi^*, \rho, \theta v]; J_1 > 0, J_2 < 0, J_3 > 0, 1 > J_4 > 0$

In the stock supply side of bonds, an increase in real income is assumed to increase the amount of bonds supplied in real terms; for as real output rises, the greater volume of production tends to increase the firm's requirements for loan capital with which to finance their investment in plant, equipments, and inventories.

A rise in the nominal rate of return on real capital will induce firms to increase their investment so that they are willing to supply more bonds; whereas an increase in the nominal rate of interest (or a decrease in the price of bonds) will increase the costs to firms in their investment financing. As the volume of monetary assets of the economy increases, firms are likely to decrease their debt outstanding to households or commercial banks.

On the stock demand side of bonds, demand for bonds (in real terms) by domestic residents is assumed to be an increasing function of real income and the real value of domestic monetary assets and again homogeneous of degree one in real income and real money balances. This is because an increase in household savings resulting from an increase in real income or a rise in liquidity of the private sector is likely to increase demand for bonds. We assumed earlier that none

of the assets are inferior goods. Demand for bonds will unequivocally be affected by the rate of return on real capital and bonds through the substitution effect and the opportunity cost considerations.

When there is a stock disequilibrium in the bonds market due to exogenous shifts in the state variables or parameters, we can adjust bonds market to those exogenous changes and maintain the stock equilibrium through flow adjustments in this market. Under the case of perfect capital mobility, therefore, the balance of the capital account is the result of flow adjustments, responding to any stock disequilibrium in domestic bond market. Thus the capital account balance is identical to the excess flow supply of (demand for) bonds by domestic residents:

$$(5.4) \qquad B_2/pN\ [\equiv(\dot{B}^{s*} - \dot{B}^{d*})/pN] = B[y(k),\ r(k) + \pi^*,\ \rho,\ \theta v]$$
$$= \tau[H\{y(k),\ r(k) + \pi^*,\ \rho,\ \theta v\} - J\{y(k),\ r(k) + \pi^*,\ \rho,\ \theta v\}]$$

where B_2 is the capital account balance in terms of domestic currency and τ is the positive proportionality coefficient of stock transformation into a flow function (the reciprocal of the length of the period in question).

By definition, the real value of the overall balance of payments per capita, B_3/pN, is the sum of the real balances per effective workers on the above two accounts. Invoking Walras' law, the overall balance is identical to the private sector's excess flow demand for real money balances; that is, the result of flow adjustments in the money market in order to maintain stock equilibrium.

(5.5) $B_3/pN[\equiv(B_1 + B_2)/pN] = \tau[L\{y(k), r(k) + \pi^*, \rho, \theta v\} - \theta v]$

where B_3 is the overall balance of payments in terms of domestic currency.[1]

In the following analysis, for the sake of convenience, it is assumed that a small open economy is initially in equilibrium. Furthermore, we are mainly concerned with the "impact effect"[2] of economic growth on the balance of payments rather than the steady state effect.

By taking total differentiation of equations describing individual accounts of the balance of payments with respect to time, we obtain the following differential equations of general solution:

(5.6) $$(\dot{B_3}/pN) = \tau[(L_1y' + L_2r')\dot{k} + L_2\dot{\pi}^* + L_3\dot{\rho} + (L_4 - 1)(\theta\dot{v} + v\dot{\theta})]$$
$$=(B_3/pN)(\dot{B}_3/B_3 - \pi - n)$$

(5.7) $$(\dot{B_1}/pN) = [y'(k) - E_1y' - I_2r']\,\dot{k} - I_2\dot{\pi}^* - I_3\dot{\rho}$$
$$- E_4(\theta\dot{v} + v\dot{\theta}) = (B_1/pN)(\dot{B}_1/B_1 - \pi - n)$$

(5.8) $$(\dot{B_2}/pN) = \tau[\{(H_1 - J_1)y' + (H_2 - J_2)r'\}\dot{k} + (H_2 - J_2)\dot{\pi}^*$$
$$+ (H_3 - J_3)\,\dot{\rho} + (H_4 - J_4)(\theta\dot{v} + v\dot{\theta})] = (B_2/pN)$$
$$(\dot{B}_2/B_2 - \pi - n)$$

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[1]Therefore, B_3 is identical to $\dot{R}$ in our previous notation.

[2]This terminology is borrowed from Kemp (1964).

5.2 Economic Growth and the Balance of Payments

In the development of the Synthesized monetary growth model, we expressed economic growth in terms of the capital deepening process of the economy. As capital intensity rises over time, real output of the economy increases with a given production function since $y'(k) > 0$. Thus in the following analysis we will first examine the effect on the international payments accounts of economic growth represented as an increase in capital intensity over time under the two extreme environments of international capital mobility. Next we will consider the effect of an exogenous change in the central bank's monetary liabilities, that is, monetization (domestic credit creation) through a change in the reserve ratio (the reciprocal of θ).

Suppose that, due to a rise in capital intensity over time, the real output of the economy has increased; suppose also that there is no autonomous increase in the supply of or demand for money. The price level is given at any instant, that is, inherited from the past, and the anticipated rate of price change is predetermined by the price setting firms. The country may be producing any number of different kinds of commodities (Y is a composite good) and may be perfectly or imperfectly specialized.

I. The Case of Complete Capital Mobility

As was shown in the previous chapter, under the case of international capital mobility, the nominal rate of interest is exogenously determined in the world capital market. Accordingly, the

effect on each account of international payments of economic growth resulting from capital deepening over time is summarized as follows:

(5.6)' $(\dot{B}_3/pN)/\dot{k} = \tau(L_1 y' + L_2 r') > 0$

(5.7)' $(\dot{B}_1/pN)/\dot{k} = y'(k) - E_1 y'(k) - I_2 r'(k) > 0$

(5.8)' $(\dot{B}_2/pN)/\dot{k} = \tau[(H_1 - J_1)y'(k) + (H_2 - J_2)r'(k)] \underset{(>)}{\leq} 0$

An increase in the capital intensity over time will raise the demand for real money balance through both the transaction (income) and substitution effects. The additional money desired by the public due to an increase in income and substitution should be supplied by the central bank by purchasing international reserves for domestic assets when the reserve ratio is held constant, otherwise be met by a fall in domestic price level. Thus, given the stock of domestic monetary assets and the rate of price change, the growth of the capital intensity and thereby the growth of output is a factor improving the overall balance of payments.

In the commodity market, the growth of output resulting from the capital deepening process will increase domestic expenditures on consumption and investment $[0 < E_1 = (C_1 + I_1) < 1]$. On the other hand, a fall in the real rate of return on capital (the marginal product of capital) is likely to induce people to invest less. The former (expenditure effect) constitutes a deteriorating factor and the latter (the substitution effect) works as an improving force on the trade account. However, since the marginal propensity to spend is less than one, the net effect of economic growth is unambiguously to improve the trade balance.

In the capital account, income effect $[(H_1 - J_1)y']$ of economic growth on excess flow supply of bonds by domestic residents is ambiguous since $(H_1 - J_1) \lesseqgtr 0$;[1] whereas the substitution effect $[(H_2 - J_2)r']$ unambiguously tends to decrease (increase) flow excess supply of (demand for) bonds by domestic residents since $(H_2 - J_2) > 0$ and $r'(k) < 0$, and thus this substitution effect works to deteriorate the capital account. Therefore, the net effect is ambiguous, depending on $\tau[(H_1 - J_1)y' + (H_2 - J_2)r'] \lesseqgtr 0$. Taking into consideration an unequivocal effect on the overall and the trade balances does not resolve the ambiguity surrounding the effect on the capital account of growth. If $(H_1 - J_1) \leqq 0$, then the capital account always tends to deteriorate as the economy grows.

Only if we presume that the net income effect, $(H_1 - J_1)y'$, is positive and dominates over the substitution effect of economic growth on the excess flow supply of bonds by domestic residents, i.e., $\tau[(H_1 - J_1)y' + (H_2 - J_2)r'] > 0$, will the capital account improve.

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[1]According to Johnson (1966), an increase in income may have the following three conflicting effects on the capital account: (1) worsening the capital account through direct or indirect foreign investment due to an increase in private savings; (2) improving the capital account via diversion of domestic and foreign savings toward domestic investment resulting from "improved profit prospects;" (3) again improving the capital account through "increased prospects of capital gains on equity and real-estate investment." Johnson argued that in principle, (2) and (3) might be strong enough to outweigh (1), i.e., $(H_1 - J_1)y' > 0$. Furthermore, he concluded that "it seems most reasonable and empirically justifiable to assume that the net effect" of income expansion "will be a worsening of the overall balance of payments." This conclusion may be attributable to his strong assertion that "expansion of income...will increase the demand for imports and possibly divert exports from foreign to domestic markets, thereby worsening the current account."

In order for the overall balance of payments to improve as a result of growth, it is necessary that the trade-balance-improving effect must dominate the capital-account-worsening effect if the capital account deteriorates, i.e., if $\tau[(H_1 - J_1)y' + (H_2 - J_2)r'] < 0$.

II. The Case of Capital Immobility

Under this polar case of perfect capital immobility, the balance on the trade account is identical to the overall balance of payments. The nominal rate of interest becomes an endogenous variable, determined by the interactions between commodity market and money market.[1]

An increase in capital intensity through time raises real output with lowering of the rent of physical capital, and thereby improves the overall balance of payments via an increase in flow excess demand for real money balances resulting from the income effect ($L_1y' > 0$) and the substitution effect ($L_2r' > 0$).

In the absence of international capital mobility, Walras' law requires that there exist an excess supply of commodities, corresponding to this excess flow demand for real money balances. Given the expected rate of price change and the stock of monetary assets, an excess flow demand for liquidity tends to raise the nominal rate of interest and thus lowers domestic expenditures in

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[1]As was shown in the last chapter, on the assumption that the speed of adjustment in bonds market is large enough to maintain continuous equilibrium, the implied relationship between the (short-run) nominal rate of interest and the three state variables (k, v, and π^*) was derived.

$$\rho_{(t)} = \rho\{k_{(t)}, v_{(t)}, \pi^*_{(t)}; \dot{R}/R, n, \theta\}; \rho_1 \gtreqless 0, \rho_2 \gtreqless 0, \rho_3 \gtreqless 0.$$

commodity market. As a result, the trade balance, which is identical to the overall balance of payments, improves more than under the case of perfect capital mobility.

Referring back to the preceding analysis under capital mobility, we may find that this result is also highly plausible. Under perfect capital mobility, economic growth tends to deteriorate the balance on the capital account except for the case in which the positive net income effect dominates the substitution effect. The capital-account-worsening effect of economic growth under capital mobility, which constitutes a deteriorating force in the overall balance of payments by reducing the trade-balance-improving effect, no longer works under international capital immobility. Therefore, economic growth resulting from capital deepening tends to improve the balance of payments even more than under the case of capital mobility unless there is strong positive income effect on the bond supply function.

To sum up: As a small open economy grows through a rise in the capital intensity over time with given stock of monetary assets, people want to increase their real money holdings due to both the income and the substitution effects of capital deepening. Flow adjustments in the money market can be accomplished by an increase in the balance of payments surplus at given expectations on the rate of price change. An increase in real output tends to raise the excess flow demands in all assets markets. It raises, however, domestic expenditures on goods and services by less than the

increment of income, i.e., $0 < E_1 < 1$. Together with the investment-reducing effect ($I_2 r'$) of capital deepening, this tends to improve the trade balance.

An increase in the excess flow demand for bonds by domestic residents (due to capital deepening), except for the case in which there is a strong positive income effect in the bonds supply function, is conducive to capital outflow when capital is freely mobile between countries; whereas under capital immobility such a flow adjustment through capital movements cannot occur. Instead domestic adjustment in the assets markets tends to change (raise) the nominal rate of interest and thus the trade balance tends to improve even more through a decrease in the domestic expenditures in commodity market.

The balance of payments turns out to improve in any case as the economy continues to grow.[1] This is the only way in which an increase in money supply is effectuated when there is no autonomous (or deliberate policy-induced) increase in money supply.

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[1]Our analysis of the effect of economic growth on international payments accounts is similar to Komiya (1969) in which growth is defined as an exogenous increase in productivity parameter, "α." However, he did not specify the type and the source of a shift in productivity. He implicitly assumed the following static production function: $Y = Y(K, N; \alpha)$. His analysis, therefore, is essentially comparative statics, like Johnson (1966). In the context of growth theory, we incorporated α into N, which is measured in terms of efficiency units. We measure the productivity of inputs in terms of factor intensity. Our assets demand functions are different from his.

5.3 Allowance for Deliberate Domestic Monetary Policy (Domestic Credit Creation or Monetization)

In the course of economic growth, not only does capital deepening occur but also many other aspects of the economy may change. Therefore, the observed effect of economic growth on the balance of payments accounts should rather be considered as the composite result of interactions through simultaneous changes in many other exogenous economic and/or non-economic factors.[1]

Within the framework of our analysis, one of the important exogenous factors is an autonomous increase in the ratio of foreign reserves to total monetary liabilities of the central bank (the reciprocal of θ). If θ is equal to one, it implies that domestic base money and international reserves are equivalent to each other. Given the amount of foreign reserves at the monetary authority, a change in θ may represent a change in domestic credit creation (or open market operations): an increase in θ implies an expansionary monetary policy, and vice versa.[2]

The effect of domestic credit creation on the balance of payments can easily be derived from the above general solution.

(5.6)" $\quad d(B_3/pN)/d\theta = \tau[(L_4 - 1)v] < 0 \qquad (0 < L_4 < 1)$

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[1]For the role of non-economic factors, see Lamfalussy (1966).

[2]Lowering of θ as a result of a balance of payments surplus signifies the pursuance of the sterilization policy by monetary or government budgetary policy.

(5.7)" $d(B_1/pN)/d\theta = -(C_2 + I_4)v = - E_4 v < 0$

(5.8)" $d(B_2/pN)/d\theta = \tau[(H_4 - J_4)v] < 0$

An increase in money stock by domestic credit creation (deliberate expansionary monetary policy) will increase domestic expenditures on goods and services, and decrease the flow excess demand for liquidity and the flow excess bonds supply by domestic residents through the real balance effect. Both the trade and the capital accounts deteriorate and thus the overall balance of payments will turn into deficit. As is obvious in the above equations, an increase in θ adversely affects all the accounts by raising the liquidity of the economy.

On the same line of reasoning, the effect of a parametric shift in the initial foreign reserve holdings with a constant θ will also raise the total money stock of the economy. Thus all the international payments accounts will tend to deteriorate.

When there is a rise in the expected rate of price change, other things remaining constant, it will increase the expenditures on commodities as well as the excess flow supply of bonds by domestic residents whereas it will lower the demand for liquidity. Therefore, the balance on the capital account improves with the deterioration of the trade balance. Deterioration of the overall balance due to a decrease in demand for liquidity implies that the trade-balance-worsening effect dominates the capital-account-improving effect (capital inflow).

In the above analysis, we found that economic growth resulting from capital deepening process over time unambiguously improves the overall balance of payments. The assumption on the degree of capital mobility is not crucial in the sense that it does not affect the directions of the effects on individual payments accounts but only affects the strength of them. Our findings confirm the works on this important problem done by Mundell and Komiya.

The portfolio adjustment model of international payments theory, based on general equilibrium analysis, provides the unmistakably "correct" reflection of flow adjustments in the assets markets. The balances on the international payments accounts are essentially the reflection of flow adjustments in the assets markets to attain portfolio equilibrium. So far, the analysis is short-run (including intermediate-run).

In the steady state all the real variables are growing at the same rate of effective labor growth, $n = \dot{N}/N$, if there is no change in the price level. Consequently, the steady state growth rate of a balance of payments surplus or deficit is also equal to n if there is no change in the price level. If there is a constant rate of inflation, as was shown in the last chapter, the steady state growth rate of a surplus or deficit on the balance of payments accounts is equal to the sum of the growth rate of effective labor force and the rate of inflation (which is identical to the world rate of inflation):

(5.9) $$(\dot{B}_i/pN) = (B_i/pN)[(\dot{B}_i/B_i) - \pi - n] = 0$$

or

(5.9)' $$(\dot{B}_i/B_i) = \pi_e + n = \pi_w + n. \quad (i = 1, 2, 3)$$

CHAPTER VI

CONCLUSIONS, QUALIFICATIONS, AND COMMENTS

This completes our analysis of feedback mechanism of the balance of payments and economic growth. We asserted originally that the current monetary growth theory analyzes the effect of monetary growth on the economic growth path and thereby attempts to integrate monetary and growth theories in the context of a closed economy.

Money is created through only domestic monetary policy, that is, changes in domestic monetary assets of the central bank. Therefore, these models were applicable to a large and relatively closed economy. They neglect new money creation through balance of payments disequilibria which are important for a small open economy with a relatively large foreign sector. This qualification was likely to be especially important for the analysis of an open model with international capital movements.

In order to examine the role of money in growth of a small open economy, it was necessary to construct a model incorporating money creation explicitly through growth of foreign reserve holdings of the economy. This is essentially an extension of monetary growth theory to encompass a small economy open to international trade and capital movements. Moreover, it was asserted that there is a feedback between growth and the balance of payments.

In this framework it was found that international capital movements are important in short-run and long-run adjustments and dynamic stabilities of such adjustments as well as in the determination of the effect of monetary growth (through persisting balance of payments disequilibrium under a regime of fixed exchange rates) on the steady state values of capital-labor ratio and financial intensity.

Several basic conclusions emerge from this analysis. First, in a relatively (small) open economy the supply of the monetary base is substantially beyond the direct control of the monetary authorities, even if the money multiplier is highly stable and predictable. Compared to the domestic monetary base, changes in international reserves resulting from the movements in the nation's balance of payments tend to be larger than in a relatively (large) closed economy. Changes in foreign reserves are likely to be the major source of new money supply of the economy.

Second, a rise in the rate of growth of foreign reserves under capital immobility raises both the actual and the expected rates of inflation, but its effect on the short-run equilibrium values of real reserve holdings and the nominal rate of interest is generally ambiguous. The direction of movements in the short-run equilibrium values of these two endogenous variables depends on the relative strength of the effect on the excess demand in the commodity market and on the excess supply of liquidity.

Third, a rise in the rate of growth of foreign reserve holdings under capital immobility unambiguously raises the steady state value of the capital intensity of the economy (but the effect on the steady state value of real reserve holdings depends on the relative strength of the income effect in domestic savings function of a rise in the capital intensity to the growth rate of effective workers, $S_1y' - n \gtrless 0$). Under capital mobility, a rise in the rate of growth of international reserves has an ambiguous effect on the steady state capital intensity, depending crucially upon the relative strength of the real balance effect in domestic expenditures and the marginal propensity to import (the degree of openness of the economy) to the growth rate of foreign reserves, $\dot{R}/R + (S_2 + M_E E_4)\theta \gtrless 0$.

Fourth, an once and for all expansionary domestic monetary policy is neutral to the steady state capital intensity under capital immobility. However, it has a non-neutral effect on the steady state capital-labor ratio under capital mobility. It may raise or lower the steady state capital intensity, depending on the rate of growth of international reserves.

Fifth, a rise in the rate of growth of effective workers tends to lower the long-run equilibrium capital intensity under capital immobility; whereas it has an ambiguous effect on the steady state capital-labor ratio under capital mobility, depending upon the relative strength of real balance effect in domestic expenditures and

the marginal propensity to import relative to the growth rate of international reserve holdings.

Finally, economic growth as a result of a capital deepening process tends to improve the overall balance of payments but leads to a deterioration of the capital account and an improvement in the trade balance. Essentially, these are the short-run effects of growth on the balance of payments accounts. In the steady state the balance of payments must grow at the rate of growth of effective workers, plus the steady state rate of inflation.[1]

The model used to arrive at these conclusions employs a number of restrictive assumptions. Many of these have been mentioned previously. We neglected the role of money as a producer's good. Since most discussions of money begin with its role in facilitating exchange, it would appear that any monetary theory which neglects this role is seriously deficient.[2] We did not distinguish disposable real income from real output in the savings function even when there is an expected rate of inflation; instead, we used a real balance effect in the savings function. The specification of the rest of the world sector was incomplete. The

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[1]The steady state actual (and expected) rate of inflation converges to the world rate of inflation in a small open economy that has a relatively large foreign sector.

[2]However, in such an economy in which financial structure is well developed, any further increase in real money balances would not be likely to squeeze a significant amount of resources from the process of exchange, then in evaluating the effects of marginal changes in the stock of real balances, ignoring this effect would be justified.

differences between foreign and domestic real growth rates were not considered, and also foreign assets were not included in the domestic private sector's portfolios and domestic assets were excluded from foreign wealth portfolios. By exploiting the small country assumption, all economic conditions in the outside world were assumed to be unaffected by actions in the domestic economy. In particular, the prices of foreign goods and bonds were treated exogenously, that is, we assumed that this country is so small that it cannot affect the international terms of trade. Domestic monetary assets in the monetary base were assumed to be negligible and we also ignored government sector in money supply process as well as in aggregate expenditures of the economy. Relaxation of these assumptions, while complicating the model considerably, should not affect qualitatively the conclusions stated above.

A more serious stricture is placed on the applicability of our basic conclusions by the use of the long-run steady state comparative dynamics. We did not consider the social cost of new money creation through a persisting international payments imbalances. The cost of inflow of foreign reserves is a loss of goods and services in real terms. In financial terms the primary influence of the inflow of foreign exchanges is on the money supply process. One way to eliminate the continuing inflow of international reserves is to develop a more flexible exchange rate system. The other alternative is to maintain the present regime of fixed exchange

rates and have the monetary authorities neutralize the impact of changes in foreign reserves on money supply process. In the long-run the use of monetary and fiscal policy actions to offset domestic inflationary pressure arising from an inflow of foreign exchanges means that a small open economy experiencing continuous balance of payments surplus trades investment and consumption goods for foreign exchanges. Hence, in real terms this results in a welfare loss for the economy.

The social or welfare costs of money creation resulting from international payments imbalance may have important consequences for economic policies and our model should therefore take them into consideration. A persisting balance of payments disequilibrium is costly in the context of economic growth. Throughout, the analysis has forcused on the growth paths resulting from variations in the growth rate of foreign reserve holdings of the economy without consideration of its optimality problem and continuous adjustments in the domestic monetary assets. The adjustment to disequilibrium in international payments has been ignored.

We did not take care of aspects of optimal growth theory, that is, the Golden-rule criterion for maximum consumption problem was ignored. We never considered the debt servicing problem when there are international capital movements with which real disposable income would no longer be identical to product. Income would be earned from the holdings of foreign capital, and this income could

be used to supplement domestic consumption sources. Similarly, a capital inflow would require that part of the national product be diverted to foreigners. The domestic expected rate of inflation would not be independent of the world rate of inflation in the long-run.

We detoured an important class of problems involved in intermediate-run adjustments and growth paths of the state variables which bridge the short-run to the long-run steady state equilibrium. In short, the world economy is never actually at a position of long-run steady state equilibrium, but rather in a continuous process of adjustments toward such a state. In order to take account of this factor, the model developed here could be modified by specifying explicitly the dynamics of disequilibrium behavior.

The use of simulation techniques might then be employed to analyze the effects on the economic growth of the rate of growth of foreign reserve holdings and the domestic monetary policy as well as the effect of economic growth on the balance of payments in the important intermediate-run. The methodology of economic theory often involves the examination of polar cases. Considerations of such cases allows simplifying assumptions which, though abstracting in significant respects from reality, point to variables and produce theorems that illuminate the complex intermediate cases of the real world.[1]

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[1]The assumptions of perfectly mobile and immobile capital, for example, have been justified on these grounds by Mundell (1968), Chapter 18.

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