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# SUPPLY OF MONEY, NON-NEUTRALITY OF MONEY AND THE COMPARATIVE DYNAMICS

Vijay K. BHASIN*

*Abstract.* A fixed exchange rate model of an open economy is developed by postulating that the labor force and exports grow at exogenously determined rates, but the money supply grows at an endogenously determined rate through the balance of payments. We have shown that money may be neutral or non-neutral in the first-sense. Moreover, money is found to be neutral in the third-sense, i.e., a higher rate of growth of 'active' money would have no effect on the steady-state capital-intensity. Furthermore, the effects of a higher natural rate and a higher saving-income ratio upon the capital-labor ratio, per capita output, consumption, and balance of trade are found to be indeterminate.

## INTRODUCTION

Solow (1956) constructed a neoclassical, non-monetary, growth model for a closed economy. He was interested in examining the behavior of an economy under the assumption of an exogenously determined rate of growth of labor force. In his model, the steady-state equilibrium growth rate is $\dot{K}/K=n=s/v$, where $v$ is the capital-output ratio, $s$ is the saving-income ratio, and $n$ is the rate of growth of labor force.

Twelve years after the publication of Solow's classic article, Khang (1968) constructed a non-monetary, one-sector neoclassical growth model for an open economy by postulating that both labor force and exports grow at exogenous rates. In such a case, unlike Solow (1956) and Swan's (1956) closed model, the system does not automatically attain the asymptotic state of proportional expansion. Even in the absence of technical change the open feature of the model makes it possible for the output per head to increase, or to decrease, or to remain unchanged, depending on whether $n<x$, $n>x$, or $n=x$. In his model, the equilibrium rate of growth of capital stock, for which $\dot{k}/k$ would be constant, is given by $\dot{K}/K=(\alpha\sigma n+\gamma x)/(\alpha\sigma+\gamma)$, where $\sigma$ is the terms of trade elasticity of export demand, $n$ and $x$ are the exogenous rates of growth of labor force and exports respectively, and $\alpha$, $\gamma$ are the elasticities of output with respect to labor and an imported good.

Tobin (1955, 1965) was the first to develop a neoclassical monetary growth model for a closed economy. He too was interested in examining the behavior of

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an economy in which two variables, in this case labor force and the nominal money supply, grow at exogenously determined rates. In his model, the steady-state rate of growth of capital stock is shown to be $\dot{K}/K=s(Y/L)(1-h)/\{1+(1-s)b(k, -\phi)\}$, where $h$ stands for the ratio of the government purchases of goods and services to the domestic output, $\phi$ is the domestic rate of inflation, $(Y/L)$ is the per capita output, and $b$ is the required amount of money per unit of capital.

One-sector, neo-classical, monetary growth models for open economies have been developed by Allen (1972), Harkness (1975), and Bhasin (1981). These models are considered as extensions of a model developed by Tobin (1965) for a closed economy. In the models of Allen and Harkness also, the steady-state properties of an open economy are examined by postulating that both labor force and the nominal money supply grow at exogenously determined rates. Bhasin has examined the steady-state properties of an open economy in which three variables grow at exogenous rates: labor, nominal money supply, and demand for exports. The purpose of this paper is to examine the steady-state properties of an open economy in which labor force and exports grow at exogenous rates, but the rate of growth of nominal money supply becomes an endogenous variable.

While discussing the steady-state properties, the main focus of analysis will be on three kinds of 'non-neutrality' of money. We shall say that money is non-neutral in the first sense whenever the steady-state capital-intensity is lower or higher in a monetary (open) economy than in a non-monetary (open) economy. Money is non-nenutral in the second sense if a once-and-for-all change in the growth-rate of nominal money supply affects the steady-state capital-intensity. Finally, money is non-neutral in the third sense if a once-and-for-all change in the growth rate of 'active' money affects the steady-state capital-intensity. The term 'active' money refers to that part of the money supply which is exogenously determined.

Most of the attempts which have been made to integrate monetary theory with growth theory employ the "active money" method. By the "active money" method we mean to say that the rate of change of the money supply is an exogenous variable. Whether the utilization of a "passive money" method would make any difference as to the results or "predictions" of the analysis is an important question. In a brief note, Olivera (1971) observed that there are significant asymmetries, both in the short-run and long-run, between the "active money" and the "passive money" versions of the monetary growth model. Besides this, Olivera (1971) and Black (1972) have argued that while money and growth models are generally unstable when money is exogenous or "active", they can be stable if the monetary authorities permit money to be "passive", i.e., to be determined some how by the price level. We want to see whether the non-neutrality of money is affected by how the nominal stock of money is created in a monetary growth model of an open economy.

Moreover, we shall inquire whether or not the 'openness' of the one-sector

model does in any way change the traditional conclusions with respect to the comparative dynamic results. In particular, whether a higher saving-income ratio would be associated with higher capital-labor ratio, output per head, per capita consumption; and whether a higher rate of population growth would result in lower capital-labor ratio, output per head, and per capita consumption. We shall also examine the effect of a higher growth rate (natural rate) on the trade balance.

## THE BASIC MODEL

We assume that the domestic economy produces only one composite good $Y$ with the help of three factors of production, capital $K$, labor $L$, and an imported intermediate good $R$. The domestic economy exports a part of $Y$ as payment for the imported intermediate good and the remainder is either used for consumption or to augment the capital stock. All prices are assumed to be flexible except the exchange rate between currencies and the world price level. The terms of trade are endogenously determined because of the assumption that the domestic economy is completely specialized. Since the domestic economy is the sole producer of the domestic good it can affect the terms of trade via changing the price of the domestic output.

The private wealth-owners of the home country keep two assets—money and domestic capital—in their portfolio; and these assets are imperfect portfolio substitutes for each other. The real cash balances are demanded both for transaction and asset purposes. The demand for real money balances is assumed to be proportional to the real capital stock where the proportionality factor depends on the capital-labor ratio, the real yield on capital, and the real yield on real money balances. A part of the real flow of money is attributable to government transfer payments and the other to the balance of trade. Since there are no capital flows and transfers, the balance of payments is the same as the trade balance. Throughout we assume that the product, money, and foreign exchange markets are always in equilibrium.

Money in our model is merely a paper asset; one part of the total money supply is exogenously determined and fully convertible into the world currency (e.g., gold) and the other part is endogenously determined. All money creation is of the 'outside' kind. Also the money supply is endogenous, in the sense that any autonomous change in the exogenous part of the total money supply, by inducing changes in the balance of payments, brings about an opposite change in the endogenous part of the total money supply.

The supply of foreign exchange arises because of the domestic exports, and the demand for foreign exchange is created by domestic imports of intermediate good. If at any exchange rate the supply of foreign exchange equals the demand for foreign exchange then we have an equilibrium in the foreign exchange market. On the other hand, if at any particular exchange rate the value of domestic imports exceeds domestic exports, i.e., there is deficit on the balance of payments or an

excess demand for foreign exchange, then the domestic government sells foreign exchange to the domestic residents in order to maintain the fixed exchange rate and an equilibrium in the foreign exchange market. We assume that the domestic government has sufficient reserves of foreign exchange to meet any contingencies and the government's stock of foreign exchange reserves equals the stock of money attributable to the trade balance. Moreover, there are no transaction costs or any other costs (or benefits) associated with holding stocks of foreign money. Now when the government sells foreign exchange to the domestic residents, residents give in return domestic currency which causes a reduction in the domestic money supply. Thus whenever there is a deficit on the trade balance the second part of the total money supply decreases and whenever there is a surplus on the trade balance the second part of the total money supply increases.

The basic model consists of the following equations:

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|---|---|---|
| $Y=L^{\alpha}K^{\beta}R^{\gamma}\,;\quad \alpha+\beta+\gamma=1\,,$ | Production Function | (1) |
| $L=L_0e^{nt}\,,$ | Labor Growth | (2) |
| $w=\partial Y/\partial L=\alpha(Y/L)\,,$ | Demand price for Labor | (3) |
| $r=\partial Y/\partial K=\beta(Y/K)\,,$ | Demand price for Capital | (4) |
| $Q=Y-X\,,$ | Domestic output for Domestic use | (5) |
| $C=(1-s)N\,,$ | Consumption Function | (6) |
| $N=wL+rK+(M_1/p)\mu_1-\phi(M/p)\,,$ | Disposable Income | (7)[1] |
| $\dot{K}=I-\delta K\,,$ | Net Investment | (8) |
| $I=S=Q-C\,,$ | Gross Investment (Gross Savings) | (9) |
| $\dot{M}/M=(\dot{M}_1/M)+(\dot{M}_2/M)\,,$ or $\mu=j\mu_1+(1-j)\mu_2\,,$ | Rate of Monetary Expansion | (10) |
| $j=M_1/M\,,$ | Ratio of Exogenous Money to Total Money | (11) |
| $M=M_1+M_2\,,$ | Nominal Supply of Money | (12) |
| $\dot{p}/p=\phi\,,$ | Rate of Domestic Inflation | (13) |
| $A=K+(M/p)\,,$ | Real Domestic Wealth | (14) |
| $M/p=b(k, r, -\phi)K\,;\quad b_k>0\,,\quad b_r<0\,,\quad b_{-\phi}>0\,,$ | Demand for Real Money Balances | (15) |

[1] The real disposable income is defined as the earnings from labor services ($wL$) plus the earnings from the capital ($rK$) plus the real value of government transfer payments ($\mu_1 M_1/p$) less the loss in real value of existing cash balances due to the domestic rate of inflation ($\phi M/p$). Moreover, using the Euler's theorem it can be shown that $N=Q+(\dot{M}_2/p)+(\dot{M}_1/p)-\phi(M/p)$.

| | | |
|---|---|---|
| $k=K/L$, | Capital-labor Ratio | (16) |
| $X=X_0e^{xt}(T)^{\sigma}$, | Export Demand | (17)[2] |
| $T=\pi/\xi p$, | Terms of Trade | (18) |
| $T=\partial Y/\partial R=\gamma(Y/R)$, | Demand price for Intermediate Good | (19) |
| $\dot{M}_2/p=J=X-TR$, | Balance of Trade | (20) |
| $\dot{\pi}/\pi=\psi$. | Rate of Foreign Inflation | (21) |

The above equations constitute a complete description of the model and uniquely determines the growth rates of the domestic output ($Y$), the labor force ($L$), the capital stock ($K$), the gross savings ($S$), the capital-labor ratio ($k$), the imported intermediate good ($R$), the consumption good ($C$), the real disposable income ($N$), the gross investment ($I$), the domestic output for domestic use ($Q$), the domestic exports ($X$), the nominal supply of money ($M$), the real domestic wealth ($A$), the nominal money stock which is attributable to trade balance ($M_2$), the rest-of-the-world's terms of trade ($T$), the real wage ($w$), the real rate of return on capital ($r$), the price of imported intermediate good ($\pi$), the ratio of 'active' (exogenous) money (nominal money stock which is attributable to government transfer payments) to total money ($j$), the price of the domestic output ($p$) and the balance of trade ($J$); for given values of the elasticities of output with respect to labor ($\alpha$), capital ($\beta$), an imported intermediate good ($\gamma$), the rate of growth of labor force ($n$), the saving-income ratio ($s$), the rate of capital depreciation ($\delta$), the rate of growth of nominal money stock which is attributable to government transfer payments ($\mu_1$), the fixed exchange rate ($\xi$), the exogenous growth rate of exports ($x$), the rate of foreign inflation ($\psi$) and the terms-of-trade elasticity of export-demand ($\sigma$).

Using the operator '$g$' for logarithmic growth-rate of any variable, i.e., ($gZ=\dot{Z}/Z$), etc., we can show from Eqs. (13), (17), (19) and (20) that

$$gR=[(\sigma-\lambda)/\sigma]gY+(x/\sigma)-[(\mu_2-\phi)/\theta\sigma], \tag{22}$$

where $\lambda$ is the ratio of imports to exports ($TR/X$) and $\theta$ is the ratio of exports to the balance of trade. Now, using Eqs. (1) and (22) we can write

$$gY=[(\alpha\sigma n+\gamma x)/\Delta]+(\beta\sigma/\Delta)gK-[\gamma(\mu_2-\phi)/\theta\Delta], \tag{23}$$

where $\Delta=\alpha\sigma+\beta\sigma+\gamma\lambda$. The growth-rate of the capital stock is exhibited by the following equation:

$$gK=[s(1-\gamma)+\gamma][w/(\alpha k)]-[(X_0/L_0)e^{(x-n)t}(T)^{\sigma}/k]-(1-s)b(j\mu_1-\phi)-\delta. \tag{24}$$

Thus the growth-rate of capital-stock is influenced by the saving-income ratio, the elasticity of domestic output with respect to an imported input, the constant rate

[2] A similar type of export demand function was also suggested by Khang (1968), Bardhan and Lewis (1970), and Banks (1975).

of depreciation, the growth-rate of labor force, the exogenous growth-rate of domestic exports, the terms-of-trade elasticity of export demand, the wage rate, the elasticity of domestic output with respect to the labor force, the capital-labor ratio, the ratio of real stock of money to real stock of capital, the ratio of 'active' money to total money, the domestic rate of inflation, and the rate of growth of nominal money stock which is attributable to government transfer payments. Since the growth-rate of $R$ depends on the growth-rate of $Y$ which in turn depends on the growth-rate of capital-stock, the growth rates of $Y$, $R$, $w$ and $r$ are determined once the growth-path of capital stock is determined. Similarly the growth paths of the other relevant variables can be obtained because they too depend on the growth path of the capital-stock.

The three differential equations of the system are:

$$gk=\dot{k}/k=[s(1-\gamma)+\gamma][w/(\alpha k)]-[(X_0/L_0)e^{(x-n)t}(T)^{\sigma}/k]-(1-s)b(j\mu_1-\phi)-n-\delta\,, \tag{25}$$

$$g\phi=\dot{\phi}/\phi=(1/\varepsilon_{-\phi})[\mu-\phi-(1+\varepsilon_k)gk-[\varepsilon_r\{-\alpha gk-\gamma gT\}/(1-\gamma)]-n]\,, \tag{26}$$

$$gT=\dot{T}/T=\psi-\phi\,, \qquad \text{where} \quad \varepsilon_k=b_k(k/b)\,, \quad \varepsilon_r=b_r(r/b)\,, \quad \text{and} \quad \varepsilon_{-\phi}=b_{-\phi}(\phi/b)\,. \tag{27}$$

These three differential equations can be reduced to two by substituting (27) into (26) and therefore the second differential equation becomes

$$g\phi=\dot{\phi}/\phi=(1/\varepsilon_{-\phi})[\mu-\phi-(1+\varepsilon_k)gk-[\varepsilon_r\{-\alpha gk-\gamma(\psi-\phi)\}/(1-\gamma)]-n]\,. \tag{26'}$$

The steady-state values of $k$ and $\phi$ are determined by the simultaneous solution of the steady-state growth paths of $k$ and $\phi$ which are obtained from Eqs. (25) and (26′) respectively.

Since in steady-state $gk=g\phi=gT=0$ and $x=n$ (if $\sigma<\infty$), Eqs. (26) and (27) imply that

$$\phi=\psi\,, \tag{28}$$

and

$$\mu-\psi=j\mu_1+(1-j)\mu_2-\psi=n\,. \tag{29}$$

Equation (28) indicates that the domestic inflation rate must equal the foreign inflation rate in steady-state. Equations (28) and (29) together imply that in steady-state the domestic money supply as a whole must grow at the sum of the foreign inflation rate (domestic inflation rate) and the domestic 'natural' rate of growth. Thus even though the total supply of money is endogenous, still the difference between the rate of monetary expansion and the domestic rate of inflation (foreign rate of inflation too in this case) must equal to the 'natural' rate of growth. This also implies that in steady-state, regardless of what is happening to $M_1$, the growth rate of $M_2$ will be endogenously adjusted to make the combined

growth rate of $M$ come out right. This does not mean $M_1$ has no role to play, even though the domestic price level is determined by the world price level.

Moreover, the government can manipulate the foreign exchange reserves by changing the rate of growth of the domestically controlled component of the total money supply. For instance, if the domestic government wishes to increase its foreign exchange reserves then the rate of growth of $M_1$ must be reduced; however, we have no explicit equations for stock of foreign exchange reserves. A decrease in the rate of growth of $M_1$ would cause the domestic rate of inflation to fall because in steady-state $\mu-\phi=n$. A lower rate of domestic inflation would cause the ratio of the real money balances to the real stock of capital to increase and as a result both the real disposable income and consumption per unit of capital would rise. Thereby, the capital stock would grow at a lower rate implying that the capital-labor ratio would fall. A lower capital-labor ratio would cause the per capita output as well as the per capita imports to decrease. This would cause a surplus on the trade balance or an excess supply of foreign exchange. Equilibrium in the foreign exchange market requires elimination of this excess supply of foreign exchange, therefore the domestic government buys foreign exchange from the domestic residents and as a result its foreign exchange reserves increase. Furthermore, $M_1$ is required in order to perform the comparative dynamics, i.e., to find whether money is neutral or non-neutral in the third-sense.

Now after substituting (29) into the first differential equation and using the steady-state conditions, we can show that the steady-state capital-intensity is

$$k^*=[\{s(1-\gamma)+\gamma\}(w/\alpha)-(X_0/L_0)(T^*)^\sigma]/\{(1-s)b(k^*, r^*, n-\mu)n+\delta+n\}\,. \quad (30)$$

It should be mentioned that the value of the steady-state capital-intensity obtained in the present model is different from the one obtained by the author in an earlier article mentioned above where all money creation is of the active kind and the exchange rate is flexible. Let $k^*$ be the new steady-state capital-intensity and $k_1^*$ be the steady-state capital-intensity which corresponds to a case where all money creation is of the active kind and the exchange rate is flexible,[3] then it follows that

$$k^*=k_1^*-[\{X-TR)\}/L\{(1-s)nb(k^*, r^*, n-\mu)n+\delta+n\}]\,, \quad (31)$$

which implies $k^*=k_1^*$ if $X=TR$, $k^*<k_1^*$ if $X>TR$, and $k^*>k_1^*$ if $X<TR$. This shows that the steady-state capital-intensity is affected by how the nominal stock of money is created and what assumption is made about the exchange rate. Thus, the new steady-state capital-intensity (which corresponds to a case where both 'active' and 'passive' money exist and the exchange rate is fixed) will be higher, lower, or the same in comparison to that one which corresponds to a case where all

[3] The steady-state capital-intensity has been shown to be

$$k_1^*=[s(1-\gamma)F_1/\{(1-s)nb(k_1^*, r^*, n-\mu)+\delta+n\}]^{\Delta'/(\alpha\sigma+\gamma)}\,, \qquad F_1>0\,, \quad \Delta'=\alpha\sigma+\beta\sigma+\gamma\,,$$

which can be expressed in a form comparable to $k^*$. Therefore, $k_1^*$ can also be expressed as

$$k_1^*=s(1-\gamma)(w/\alpha)/\{(1-s)nb(k_1^*, r^*, n-\mu)+\delta+n\}\,.$$

money creation is of the 'active' kind and the exchange rate is flexible, depending on whether the domestic exports are less than, more than, or equal to the domestic imports.

Now, if we assume that there is no paper asset, i.e., $b=0$, the rate of depreciation is zero, i.e., $\delta=0$, and $X=TR$ at all times then the steady-state capital-intensity shown in Eq. (30) reduces to

$$k_2^*=\{(1-\gamma)s(w/\alpha)\}/n\,, \tag{32}$$

and the steady-state capital-intensity $k_2^*$ is the same as implied in the Khang (1968) model. It can be seen from Eq. (31) that if $X=TR$ then $k^*=k_1^*$; since Bhasin (1981) has already established that $k_1^*<k_2^*$ (the steady-state capital-intensity is lower in a monetary open economy than in a non-monetary open economy), it follows that $k^*<k_2^*$. The steady-state capital-intensity of a monetary open economy (where both 'active' and 'passive' money exist and the exchange rate is fixed) will be lower than that of a non-monetary open economy only if the domestic exports are equal to the domestic imports. Thus money is non-neutral in the first sense if $X=TR$; otherwise for $X\neq TR$ we are not in a position to determine whether $k^*$ will be greater than, less than, or equal to the corresponding steady-state capital-intensity $k_2^*$ of a non-monetary open economy.

## THE LONG-RUN NON-NEUTRALITY OF MONEY

In order to examine the impact of a higher rate of growth of 'active' money on the steady-state capital-intensity we have to differentiate $k^*$ partially with respect to $\mu_1$.[4] We can show from Eq. (30) that

$$\partial k^*/\partial\mu_1=0\,, \tag{33}$$

which implies that money is neutral in the third-sense. An initial increase in $\mu_1$ would cause the domestic rate of inflation to increase because in steady-state $\mu-\phi=n$. A higher rate of domestic inflation would cause the ratio of the real money balances to the real stock of capital to decrease and as a result both the real disposable income and consumption per unit of capital would fall. Thereby, the capital stock would grow at higher rate causing the capital-labor ratio to rise. A higher capital-labor ratio would cause the per capita output and the per capita imports to increase, thus causing deficit on the trade balance or an excess demand for foreign exchange. Since the exchange rate is fixed, this excess demand for foreign exchange must be eliminated and therefore government sells foreign exchange to the domestic residents. When the domestic government sells foreign exchange to the domestic residents the government receives in turn domestic paper currency, thus causing a reduction in $M_2$. As a result of this reduction the above mentioned process of adjustment is reversed and ultimately the real disposable

[4] Since $\mu_1$ is exogenously determined and $\mu_2$ is endogenously, we can not differentiate with respect to $\mu$.

income comes back to its initial level, therefore there is no change in the steady-state capital-labor ratio, i.e., money is neutral in the third-sense.

Very few economists have tried to analyze the impact of an increase in the rate of monetary expansion on the steady-state capital-intensity of open economies. P. Allen (1972) was the first to develop a two-country model[5] in order to examine whether or not an increase in the rate of growth of money supply leads to an increase in the steady-state capital-intensity. She observed that if the rate of growth of money supply is increased in country I which imports a capital good then the long-run labor-capital ratio may fall, remain unchanged, or rise depending on the elasticity of country II's import demand which is greater than, equal to, or less than unity. On the other hand, a rise in the rate of money supply in country II (which imports a consumption good) will raise its long-run capital-intensity, i.e., money is non-neutral in the second sense.

J. Harkness (1975), using the 'small country' assumption, constructed a one-sector monetary growth model for an open economy which trades consumer goods and securities under the flexible exchange rate system. He observed that a rise in the rate of monetary expansion has indeterminate effects on the long-run capital-intensity. He has also shown those conditions under which money may be non-neutral in the second-sense. V. Bhasin (1981) has developed a one-sector, neo-classical, monetary growth model for an open economy which uses an imported intermediate good as an input in domestic production and exports a finished consumer good to the rest of the world under the flexible exchange rate system. The author has shown that a higher rate of monetary expansion would lead to higher steady-state capital-intensity, thus confirming the second kind of non-neutrality of money.

Thus all these authors have analyzed the second kind of non-neutrality of money by considering the 'active' money. In fact, no one has ever tried to analyze the impact of an increase in the rate of growth of money supply on the steady-state capital-intensity of an open economy where trade takes place in consumer and intermediate goods under the assumption of fixed exchange rate and where both 'active' and 'passive' money exist simultaneously. We have shown that in such a model money is neutral in the third-sense, i.e., a higher rate of growth of 'active' money would have no effect on the real variables of the system. In view of this result and the one obtained by the author in another article mentioned above, we can certainly say that the second-kind of non-neutrality of money is affected by how the nominal stock of money is created in a monetary growth model of an open economy.

## COMPARATIVE DYNAMICS

It has been established in the growth literature of one-sector, non-monetary

[5] In her model, one country produces a consumption good and the other country produces a capital good, i.e., there is complete specialization in production.

closed models that a steady-state with a higher saving-rate will have higher capital-labor ratio, output per head, and consumption per head, but a lower output-capital ratio.[6] On the other hand, a faster rate of population growth corresponds to a lower capital-labor ratio, output per head and consumption per head, but a higher steady-state level of output per unit of capital.

Neo-classical growth models have been constructed for open economies which are free to trade goods, services, and securities with the outside world. These models can be grouped into two categories. In the first category, we have models of the Solow-Swan type which are free to trade goods with the rest of the world and which require an imported input for domestic production.[7] In the second category of models, international capital movements are explicitly introduced and their impact on the balance of payments and the rate of growth of the domestic output is generally studied.[8]

It has been established in the first category of models that the open feature of the one-sector model does not in any way change the pre-established conclusions with regard to the comparative-dynamic results. A higher saving-rate will still be associated with higher capital-labor ratio and output per head, and also a higher level of per capita exports; whereas a faster rate of population growth will still correspond to a lower capital-labor ratio and output per head, and also a lower level of per capita exports.[9] However, the value of various elasticities may turn out to be different from those which correspond to a one-sector closed model.

Moreover, it has been established in the second category of models that capital imports do not always raise the steady-state capital-intensity of the indebted country. The steady-state per capita income of the indebted country would rise by virtue of any one of the following parametric variations: increase in the saving-income ratio, decrease in the rate of growth of labor force, fall in the world rate of interest, and a rise in the speed of adjustment of capital flows. In addition, per capita incomes would not be equalized by means of capital inflows if the response speed of capital imports is sluggish. Furthermore, it has been shown that the debt position of the domestic economy is influenced by the world rate of interest, the saving-income ratio, the natural growth rate and the capital-intensity.

So far as the monetary growth models of closed economies are concerned, it has been observed in the literature that a higher saving-rate will be associated with higher capital-labor ratio and output per head, and also a higher level of per capita consumption; whereas a faster rate of population growth will correspond to lower capital-labor ratio and output per head, and also a lower level of per capita consumption.

[6] For example, see Solow (1970), Ch. 2.

[7] For example, see Khang (1968, 1969), Bardhan and Lewis (1970), Black (1970) and Banks (1975).

[8] For example, see Amano (1965), Stein (1965), Donaldson and Neher (1969), Kim (1971), Neher (1970), and Onitsuka (1974).

[9] However, in an open economy, $\partial n = \partial x$ in steady-state, hence the change in $n$ which produces the effects upon capital-labor ratio, output per head, and the level of per capita exports must always be accompanied by an equal change in $x$.

One-sector, neo-classical, monetary growth models have been constructed for open economies which are free to trade goods, services, and securities with the outside world. These models exploit the 'small country' assumption[10] together with fixed exchange rates[11] to make inferences about the effects of growth on the structure of the balance of payments. The traditional Keynesian analysis suggests that economic growth is expected to be associated with a deterioration of the balance of payments.[12] But most of the papers which recognize the monetary nature of the balance of payments reach a conclusion that growth is associated with an over all surplus on the balance of payments.[13] Komiya (1969) has shown that growth is not only associated with an over all surplus on the balance of payments (and trade), but may also create a capital account deficit. Laffer (1971) on the other hand observed that absolute growth in income creates surplus on the over-all balance of payments and the capital account, while the trade balance become a deficit. R. Dornbusch (1971) tried to reconcile these conflicting results and came to the conclusion that growth improves the over-all balance of payments but the effects on the individual trade and capital accounts are ambiguous. Chen (1975) attempted to generalize discussions on the problem of growth and the balance of payments by considering commodity, money, bonds and equities. He concluded that growth normally leads to an improvement in the over-all and current accounts of the balance of payments and a deterioration in the capital account unless the income elasticities of demand for assets are extremely low or the technical progress is highly capital-using.

Models in which the emphasis is on the effects of growth on the structure of the balance of payments suffer from the following limitations. First, such models treat the rate of domestic inflation as constant which may not be a valid assumption in the face of rising rate of world inflation.[14] Secondly, since the real rate of return on capital and the real rate of interest are the same in these models, it means there is perfect substitutability among the various assets. An alternative way is to make the assumption of imperfect substitutability among these assets so as to allow the possibility of differentials in the real yields of various assets. Thirdly, trade is allowed only in securities, thereby completely ignoring the possibility of trade in consumer and intermediate goods. Fourthly, all money is "passive money", thereby not allowing the existence of both types of money: "passive" as well as "active". Finally, the price of the domestic good is assumed to be fixed and exogenously determined which may not be true if the domestic economy is completely specialized and has a monopoly power (for instance, the oil producing

[10] The small country is 'price taker' facing perfectly elastic demand for the supply of assets and goods, hence the terms of trade are given. For more details, see Wilson (1931). As a consequence, world income, and hence world demand for exportables, is exogenous.

[11] The fixed exchange rate implies that money prices are fixed in terms of domestic currency and that changes in the money supply come from the balance of payments and/or domestic credit creation.

[12] For example, see Johnson (1954).

[13] For example, see R. Mundell (1968).

[14] If somehow, the domestic rate of inflation is linked to the world rate of inflation.

countries). In that case, even under the assumption of fixed exchange rates, the terms of trade may not be constant.

Keeping in view these limitations, V. Bhasin (1981) developed a one-sector, neo-classical, monetary, growth model for an open economy and showed that an increase in the saving-income ratio unambiguously raises the capital-intensity and the per capita output; whereas the effects on the per capita consumption and trade level are ambiguous. Contrary to this, a rise in the "natural" rate leads to a fall in the capital-intensity and the output per head. Thus when the monetary growth model of a closed economy is opened so as to include trade in consumer and intermediate goods then the traditional results with respect to higher saving-income ratio and the natural rate of growth upon the capital-labor ratio and the output per head hold true; whereas the effects of higher saving-income ratio and rate of growth of labor force on the consumption per head become indeterminate. On the other hand, when the non-monetary growth model of an open economy is monetized then the effects of higher saving-income ratio and the 'natural' rate upon the per capita level of trade become indeterminate.

Now we can examine whether the existence of both 'active' and 'passive' money does in any way change the pre-established conclusions with regard to the comparative-dynamic results. As we have seen in the last section that $\partial k^*/\partial \mu_1 = 0$ which implies that the effects of a higher $\mu_1$ on the per capita output, consumption, exports, and the balance of trade would be neutral. After differentiating Eq. (30) partially with respect to $n$, we obtain

$$\partial k^*/\partial n = -k^*\{(1-s)b(k^*, r^*, n-\mu)+1\}/\Sigma\,, \tag{34}$$

where

$$\Sigma = (1-s)(1+\varepsilon_k-\varepsilon_r)bn+n+\delta-\{s(1-\gamma)+\gamma\}(w_k/\alpha)+\sigma(\beta/\gamma)(X/K)^*\,.$$

Since the sign of $\Sigma$ is indeterminate, it follows that $\partial k^*/\partial n$ is indeterminate. Thus we are not in a position to determine whether a higher "natural" growth-rate would be associated with a higher, lower, or the same steady-state capital-labor ratio. This result is contrary to the well established result that a higher "natural" growth rate is associated with a lower steady-state capital-labor ratio.

A rise in the "natural" rate implies that the domestic rate of inflation must fall because in steady-state $\mu-\phi=n$. A fall in the domestic rate of inflation raises the real disposable income and thereby the total consumption. A rise in the consumption per unit of capital implies that the rate of growth of capital stock would fall and thus the capital-labor ratio falls. A falling capital-labor ratio would cause the per capita output to decrease and since $(\gamma Y/L)=TR/L$, it follows that per capita imports decrease. This would cause a surplus on the trade balance and therefore an excess supply of foreign exchange. Equilibrium in the foreign exchange market requires elimination of this excess supply of foreign exchange, therefore the domestic government buys foreign exchange from the domestic residents and as a result $M_2$ increases.

At the same time, a fall in the domestic rate of inflation would cause the terms of trade to increase and as a result exports increase and imports decrease. This would cause surplus on the trade balance and again $M_2$ increases. So far as the money market is concerned, a falling capital-labor ratio would cause the real money balances per unit of capital to fall, and a lower rate of domestic inflation would cause the real money balances per unit of capital to rise. These two forces would ultimately cause an excess demand for real money balances and which would be eliminated through an increase in the 'passive' money via balance of payments. As a result of an increase in 'passive' money the above mentioned process of adjustment would be reversed and therefore we do not know what would happen to the steady-state capital-labor ratio. Such a process would be repeated many times until a new steady-state equilibrium is achieved with a higher rate of monetary expansion, a domestic rate of inflation (also the world rate of inflation) lower than the initial steady-state rate of domestic inflation, and all markets are once again in equilibrium.

From Eq. (1) we can write the steady-state level of per capita output as

$$(Y/L)^* = (k^*)^{\beta}(R/L)^{*\gamma}. \tag{35}$$

Now differentiating partially with respect to $n$, we obtain

$$\partial(Y/L)^*/\partial n = \beta(Y/K)^* \qquad (\partial k^*/\partial n). \tag{36}$$

Since $\partial k^*/\partial n$ is indeterminate, it follows that $\partial(Y/L)^*/\partial n$ is also indeterminate implying that we can not determine the effect of a higher "natural" rate of growth upon the steady-state level of per capita output. This result is also contrary to the well established result that a higher "natural" growth rate is associated with a lower steady-state per capita output.

The steady-state level of per capita consumption can be expressed in the following form:

$$(C/L)^* = (1-s)\{(1-\gamma)(w/\alpha) + (j\mu_1 - \psi)b(k^*, r^*, n-\mu)k^*\}. \tag{37}$$

After differentiating (37) partially with respect to $n$ and rearranging some of the terms we get:

$$\partial(C/L)^*/\partial n$$
$$= (1-s)[(1-\gamma)(w_k/\alpha) + b(k^*, r^*, n-\mu)\{n-(1-j)\mu_2\}(1+\varepsilon_k-\varepsilon_r)](\partial k^*/\partial n). \tag{38}$$

Since $\partial k^*/\partial n$ is indeterminate, it follows from (38) that $\partial(C/L)^*/\partial n$ is also indeterminate which implies that the effect of a higher "natural" rate of growth upon the steady-state level of per capita consumption is indeterminate. The present result is in conformity with the result already established by Bhasin (1981) in a model where only 'active' money exists and the exchange rate is flexible.

The steady-state per capita balance of trade can be expressed as:

$$(J/L)^* = (X_0/L_0)(T^*)^{\sigma} - (\gamma/\alpha)w. \tag{39}$$

Now after differentiating (39) partially with respect to $n$ we can show that

$$\partial(J/L)^*/\partial n = -\{(\gamma/\alpha)w_k + (\beta/\gamma)\sigma(X/K)^*\}(\partial k^*/\partial n)\,. \tag{40}$$

Since we know that $\partial k^*/\partial n$ is indeterminate, it follows from Eq. (40) that $\partial(J/L)^*/\partial n$ is also indeterminate. Thus the effect of a higher "natural" rate of growth upon the steady-state per capita balance of trade is indeterminate. This result goes against the traditional conclusion that growth is associated with an over all surplus on the balance of payments. However, it has been observed by Dornbusch (1971) that growth may have indeterminate effects on the trade balance. Though we have arrived at the same conclusion, our model differs from the model of Dornbusch in many respects.

Now we can investigate the sensitivity of steady-state capital-intensity with respect to a change in the saving-income ratio. Differentiating Eq. (30) partially with respect to $s$ and rearranging some of the terms we get

$$\partial k^*/\partial s = \{(1-\gamma)(w/\alpha) + k^* nb(k^*, r^*, n-\mu)\}/\Sigma\,. \tag{41}$$

Since we know that the sign of $\Sigma$ is indeterminate, it follows from (41) that $\partial k^*/\partial s$ is also indeterminate. Thus we are not in a position to determine the effect of a higher saving-income ratio upon the steady-state capital-labor ratio. This result is not in conformity with the traditional result which says that a higher saving-income ratio would be associated with a higher steady-state capital-intensity.

An increase in the saving-income ratio would reduce consumption per head and that in turn would lead to higher gross investment and therefore a higher capital-labor ratio. This would put the money market into disequilibrium and there would be an excess demand for the real money balances. On the other hand, a higher capital-labor ratio would create a deficit on the balance of trade because as $k$ rises the per capita output also increases and since $(\gamma Y/L) = TR/L$, it follows that per capita imports increase. A deficit on the trade balance would create an excess demand for foreign exchange. Equilibrium in the foreign exchange market requires elimination of this excess demand for foreign exchange, therefore the domestic government sells foreign exchange to the domestic residents and as a result $M_2$ is reduced.

A decrease in the rate of growth of endogenous money supply ($\mu_2$) would now cause the domestic rate of inflation to decrease because in steady-state $j\mu_1 + (1-j)\mu_2 - \phi = n$. A lower rate of domestic inflation would cause the ratio of the real money balances to the real stock of capital to increase and as a result both the real disposable income and consumption per unit of capital would decrease. Thereby, the capital stock would grow at a higher rate implying that the capital-labor ratio would again increase. On the other hand, a lower rate of inflation would cause the terms of trade to increases; as a result domestic exports would increase and the domestic imports would be reduced. This would create surplus on the balance of trade and there would be an excess supply of foreign exchange; the domestic government buys foreign exchange from the domestic residents and as a

result $M_2$ increases. This increase in $M_2$ would remove the already existing excess demand for money. Since output and exports per head are increasing at the same time, we are not in a position to determine what would happen to the per capita domestic output for domestic use and therefore the real disposable income, the per capita consumption, and the capital-labor ratio. Also an increase in $M_2$ would now reverse the above mentioned adjustment process. This adjustment process would continue until all the markets are once again in equilibrium. Similarly, it can also be shown that the effects of a higher saving-income ratio on the per capita output, per capita consumption and the per capita balance of trade are indeterminate in a model where both 'active' and 'passive' money exist and the exchange rate is fixed.

Thus we have established that when the monetary growth model is opened to trade in consumer and intermediate goods under the fixed exchange rate system, and both 'active' and 'passive' money exist simultaneously then all the traditional conclusions with regard to the comparative dynamic results become indeterminate. In addition, we have shown that the effect of a higher "natural" rate of growth upon the steady-state level of per capita balance of trade is indeterminate.

## CONCLUSION

We have developed a fixed exchange rate model of an open economy by postulating that the labor force and exports grow at exogenously determined rates, and the total money supply grows at an endogenously determined rate. The aggregate rate of growth of money supply is determined from the value of the ratio of 'active' money to the total stock of money and the rates of growth of 'active' and 'passive' money. We observed that in steady-state the aggregate rate of growth of money supply must equal to the sum of the foreign rate of inflation and the "natural" rate of growth.

We also observed that the steady-state capital-intensity is affected by how the nominal money supply is created. We have found that money is non-neutral in the first-sense if exports equal imports; otherwise if exports are not equal to imports (passive money exists) then we are not in a position to determine whether the steady-state capital-intensity of a monetary open economy would be greater than, less than or equal to the steady-state capital-intensity of a non-monetary open economy. Moreover, it was found that money is neutral in the third sense, i.e., a higher rate of growth of 'active money would have no effect on the steady-state capital-intensity. We have shown that the effects of a higher "natural" rate of growth and a higher saving-income ratio upon the capital-labor ratio, per capita output, per capita consumption, and the per capita balance of trade are indeterminate.

Throughout our analysis we have assumed that the transaction costs are zero, the production and distribution of money cost nothing. It would be interesting to analyze the properties of our model when the transaction costs are not zero.

Moreover, we have allowed trade in consumer and intermediate goods but not in capital goods. One could introduce capital flows and see how sensitive are our results to capital flows. In addition, we have so far assumed that the domestic wealth-owners keep two assets—physical capital and money balances—in their portfolio. But they could keep more than two assets in their portfolio. One could see how present results are affected by the introduction of another asset, say securities.

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