FISCAL POLICY IN A DYNAMIC OPEN-ECONOMY NEW-KEYNESIAN MODEL

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ABSTRACT

A two sector open economy model is set up in an uncertain lifetimes framework.One of the sectors is monpolistically competitive. It is shown that the a balanced budget fiscal expansion increases steady state welfare of the representative individual and also along the transition path.

Key words: Fiscal policy, Uncertain Lifetimes, New Keynesian Models, Monopolistic competition

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1 INTRODUCTION

The burgeoning fiscal and trade deficits (the so-called "twin deficits") in the US led to a renewal of interest in the effects of fiscal policy. At the same time in macro economic model-building there was a movement away from the earlier "ad-hoc" models towards optimizing models. So the recent analysis of fiscal policy has been carried out using intertemporal models. There is a strong case for doing so because any model which seeks to look at the twin deficits has to examine the role of saving (private and government) and investment. And saving and investment (and hence the current account of the balance of payments) all need to be modelled in an intertemporal framework.

Most of this body of work (in a closed and an open economy setting) has adopted a competitive market clearing framework. Saving decisions are thus made by price-taking households and investment decisions by price-taking firms. Most models assume an infinitely-lived individual but some look at overlapping generations of finitely-lived individuals.[1] If increasing returns do make an appearance they are external to a firm (as in the endogenous growth models). The emphasis is on predicting the paths of ("mimicing") macroeconomic variables. An increase in government expenditure reduces the level of utility of a representative individual unless such expenditure gives direct utility.

Parallel to the rise of this infinitely-lived price taking economic agent model – the Real Business Cycle model – has been an attempt to recast Keynesian economics into a mould with maximizing agents. The point of departure from the real business cycle models is the absence of competitive markets.[2] These models show how imperfectly competitive markets could lead to Keynesian results.

In this paper I seek to look at fiscal policy in a two sector infinite-horizon model of a small open economy with finitely-lived individuals where one of the sectors in monopolistically competitive. Is it possible that expansionary fiscal policy (a balanced budget increase in government expenditure) makes everyone better off as in the naive text-book Keynesian model and in static new Keynesian models?[3] I show that this is indeed the case. A policy experiment of this kind causes a boom with capital accumulation, rising wages and saving. National income rises but so do prices. It can however be shown that welfare of a representative individual is higher following the shock. The model has a role for the accelerator (a crucial one) and for the multiplier (though this different from the orthodox concept of the multiplier).

The model generates an interesting insight that while both sectors expand in value terms, the output of one sector contracts in physical terms. With both sectors bidding for some common input whose supply is inelastic this is an inescapable result. But profits of both sectors increase together – "strategic complementarity" (see Cooper and John (1988)).

In this paper we are going to discuss the effects of fiscal policy. But it would be immediately obvious to a reader familiar with the new-Keynesian literature that the initial impetus to expenditure could come from "animal spirits" or any taste shock.

The paper is organized as follows. Section 2 sets out the model. Section 3 looks at its dynamic structure, Section 4 then looks at the fiscal experiment. Some concluding comments are offered in Section 5.

2 THE MODEL

Before turning to the detailed specification of the model, I present a brief outline of it. The model has four sectors *viz.* the households, the firms, the government and the rest of the world. At any instant there exist many households born at different times. They consume two goods – a homogeneous good produced under conditions of constant returns to scale and a differentiated good produced under increasing returns to scale.[4] The increasing returns which are internal to the firm arise from the presence of fixed costs. There are three factors of production labour, capital and (say) land. Technology is of the Leontief type. The factor and the homogeneous goods markets are competitive while the market for the differentiated good is monopolistically competitive. The differentiated good is non-traded. The government taxes individuals in a lump-sum fashion and spends on the non-traded good. Its budget is always balanced. The individuals hold two assets in their portfolios – land and a foreign interest-bearing asset. All of the capital stock is foreign owned. There are no costs of adjusting the capital stock. The domestic economy exports the surplus of the differentiated good over domestic consumption. The economy takes all foreign variables (i.e., the interest rate and prices) as given.

The assumption of foreign ownership of the capital stock is made for tractability. In this model domestic ownership of capital makes the accelerator larger and tends to make the model unstable. In any case foreign ownership has long history in the international trade and development literature (see e.g., Eaton (1989)).

The overlapping generations structure of households is familiar from Blanchard (1985), Buiter (1988b), Engel and Kletzer (1990) and Frenkel and Razin (1987). Households are identical in every respect except the time of their births and deaths. They are born without any financial wealth i.e., they are not linked altruistically to any other household alive at the time of their birth. Each household sells one unit of labour in each period of its life. All of them also face an identical, birth-independent probability of death (denoted by π). In the aggregate there is no uncertainty and a proportion π of the population dies each period. The birth rate is also assumed to be π, so that there is no net growth in the population. Each agent buys insurance from competitive insurance firms, who supply these at acturially fair rates, and get a return (make a payment) π on their financial wealth if it is positive (if it is negative). The insurance company inherits the household's financial wealth or liabilities on its death.

The model has two distortions. The first one is associated with monopolistic competition and the second one arises from uncertain lifetimes. The latter assumption means that the rate of return on human wealth (which dies with the individual) and on non-human wealth (for which insurance can be procured) are not the same – the wedge being the probability of death (π). I have used the uncertain lifetime assumption to get a model which has transitional dynamics. Otherwise the only steady state for a small open economy with both the world rate of interest and the discount rate given is to set them equal to each other.

2.1 The Households

A representative household of vintage v (i.e., one which was born on date v) faces a constant probability of death (π), at each instant. It maximizes its lifetime expected utility i.e.,

$$\int_t^\infty \{\log u(\tau, v) \cdot \exp .(-(\beta + \pi)(\tau - t))\} \cdot d\tau \tag{1}$$

subject to

$$\dot{A}(t, v) = (r(t) + \pi).A(t, v) + w(t) - \Pi(t) - P(t).X(t, v) - y(t, v) \tag{2}$$

where

$$u(\tau, v) = X(\tau, v)^\alpha y(\tau, v)^{1-\alpha} \tag{3}$$

and $X(t,v)$ is the (aggregate of) consumption of the differentiated good (P is the associated price index (defined below)), $y(t,v)$ is the consumption of the homogeneous good and $A(t,v)$ is the financial wealth at time t of a person born in period v. β is the rate of time preference and Π the lump-sum tax paid by the household. r the world rate of interest and w the wage rate (both independent of the date of birth).[5]

In addition the household has an initial condition on financial wealth

$$\begin{aligned} A(t,v) &\equiv \bar{A}(t,v) \quad \text{for} \quad t > v \\ &\equiv 0 \qquad\quad\;\; \text{for} \quad t = v \end{aligned} \tag{4}$$

and a transversality condition

$$\lim_{T\to\infty} \exp.\{-[r+\pi]T\} \cdot A(T) \geq 0 \tag{5}$$

This gives rise to the following path for consumption

$$C(t,v) = (\pi+\beta)(A(t,v)+H(t)) \tag{6}$$

$$\text{and} \qquad \dot{C}(t,v) = C(t,v)\{r(t)-\beta\} \tag{7}$$

$$\text{where} \qquad H(t) \equiv \int_t^\infty [w(\tau) - \Pi(\tau))\exp.\{-(r+\pi)\tau\} \cdot d\tau \tag{8}$$

$$\text{and} \qquad C(t,v) \equiv P(t) \cdot X(t,v) + y(t,v) \tag{9}$$

Equation (6) is the consumption function, equation (7) is the Euler equation and equations (8) and (9) the definitions of human wealth and nominal expenditure respectively.

Now given X from (9), the consumer allocates this over the various brands of the differentiated good available at time t i.e., to maximize (suppressing the time indices)

$$X = (\sum_i m_i^b)^{1/b} \qquad\qquad i = 1, \cdots, n$$

where $b \equiv 1 - 1/\sigma \qquad \sigma > 1$

subject to

$$\sum_i p_i m_i = P \cdot X \qquad\qquad i = 1, \cdots, n$$

where

$$P^{(1-\sigma)} \equiv (\sum_i p_i^{1-\sigma}) \qquad\qquad i = 1, \cdots, n$$

where m_i is the amount of the i^{th} brand consumed whose price is p_i. σ is the elasticity of substitution between the various brands of X which below is also the elasticity of demand facing a brand producer (assumed to be greater than one – see equation (15) below). Note that all the brands of the differentiated good are produced domestically.

This gives rise to the following demand functions

$$m_i = C \cdot (p_i^{-\sigma}/P^{1-\sigma}) \qquad i = 1, \cdots, n \tag{10}$$

Since we shall be concerned with a symmetric equilibrium where all domestic brands will be priced equally and the demand for all domestic brands will be the same we shall drop the subscripts.

Finally, financial wealth consists of two assets – foreign assets (F) and land (S) ($z(t)$ being its price). The stock of capital (K) is foreign owned.

$$A(t,v) \equiv F(t,v) + z(t)S(t,v) \tag{11}$$

Aggregating over all the households of different vintages we get

$$C(t) = (\pi + \beta) \cdot \{H(t) + A(t)\} \tag{12}$$

$$\dot{C}(t) = C(t) \cdot \{r(t) - \beta(t)\} - \pi(\pi + \beta) \cdot A(t) \tag{13}$$

where a variable without the vintage index v indicates its aggregate. In (13) we have normalized the size of the population to unity.

The last term on the right-hand side of (13) is by now very familiar from these models. It arises from the fact that the new-born are born without any financial wealth. There are π of them and from (12) they would have consume a proportion $(\pi + \beta)$ of financial wealth if they had any.

2.2 The Firms

There are two goods produced by the economy – the differentiated good, and the homogeneous good. There are two types of costs that a firm has to incur in production in producing the former. The first is the variable cost and the other the fixed cost. We can think of these being produced in different "sectors" – the x-sector producing the variable cost component and the F-sector producing the fixed cost component. The output of a brand is given by x.

It is worth emphasizing a point at this stage that there are no intertemporal decisions involved in production. The firms in question solve a static problem at each moment in time. The fixed cost is like an (recurring) overhead cost and not a sunk cost. Also a discussion on the capital stock is warranted. Below we assume that both the fixed and variable cost component use capital. An interpretation of this would be that the variable cost component uses an imported raw material and the fixed cost consists of importing a blue-print. Since the prices of both of these inputs is fixed we can aggregate them into a foreign-owned "capital stock".

The marginal cost component is produced by a constant returns to scale technology using K, S and l.

$$a_{sx} \cdot q + a_{lx} \cdot w + a_{Kx} \cdot r = e \tag{14}$$

where a_{ij} is the fixed amount of the input i used in the "production" of "sector" $j(i = K, l, s$ and $j = x, F)$, w is the wage rate, r is the rental rate, q is the price of land and e is the marginal cost of production.

This industry is monopolistically competitive and therefore price of a brand is a mark-up on variable costs

$$p = \sigma(\sigma - 1)^{-1} \cdot e \tag{15}$$

We assume that entry drives profits down to zero – the large group case. This implies that $1/\sigma$ of total revenue would go towards covering fixed costs, F (since $(1 - 1/\sigma)$ goes to cover marginal cost)

$$\sigma^{-1}(p \cdot x) = F \tag{16}$$

F is also produced by the two factors by a linear homogeneous technology using K and l only

$$a_{lF} \cdot w + a_{KF} \cdot r = F \tag{17}$$

Note that both for x and F we have assumed that the elasticity of substitutions are zero (i.e., the a_{ij}'s are fixed).

In terms of rates of change the price equations (from (14) to (17) can be written as

$$\theta_{sx} \cdot \hat{q} + \theta_{lx} \cdot \hat{w} + \theta_{Kx} \cdot \hat{r} = \hat{p} \tag{18}$$

$$\theta_{lF} \cdot \hat{w} + \theta_{KF} \cdot \hat{r} = \hat{x} + \hat{p} \tag{19}$$

where θ_{ij} is the share of the i^{th} input in the relevant cost equation.

We are assuming that the economy can borrow or lend in the international market at a rate of interest r (subject to an intertemporal budget constraint). Hence $\hat{r} = 0$. Moreover below (in equation (22)) we shall see that $\hat{q} = 0$.

Then we can solve the two equations (18) and (19) for two variables in terms of the third. In particular $\hat{w}$ and $\hat{p}$ can be solved as functions of $\hat{x}$.

$$\hat{w}/\hat{x} = -1/\Omega < 0 \tag{20}$$

$$\hat{p}/\hat{x} = -\theta_{lx}/\Omega < 0 \tag{21}$$

where $\Omega \equiv \theta_{lx} - \theta_{lF}$ is assumed to be positive.

We have assumed, and it seems reasonable, that variable cost is relatively labour-intensive than the fixed cost component i.e., $a_{lx}/a_{Kx} > a_{lF}/a_{KF}$. But $\theta_{Lx} - \theta_{LF} > 0$ (which turns out to be crucial for most of the results below), in addition, requires that θ_{sx} be small.

The homogeneous good, which is the numeraire, is produced under competitive conditions using land alone.

$$a_{sy} \cdot q = 1$$

where q is the price of input S. We then have

$$\hat{q} = 0 \tag{22}$$

This implies that the price of land z is also unchanging over time (since $r = q/z$ in equilibrium).

2.3 The Government

The government spends an amount $G(t)$ on the non-traded good and finances its expenditure by levying lump-sum taxes on individuals so that its budget is always in balance. We shall look at an experiment where G is constant through time except for a one time permanent increase.

$$G(t) = \Pi(t) \tag{23}$$

2.4 Market Clearing

Equations (24), (25) and (26) give the factor market clearing condition for the three factor markets

$$a_{lx} \cdot nx + a_{lF} \cdot n = 1 \tag{24}$$

$$a_{Kx} \cdot nx + a_{KF} \cdot n = K \tag{25}$$

$$a_{sx} \cdot nx + a_{sy} \cdot Y = \bar{S} \tag{26}$$

Equation (24) is the labour market clearing condition. nx is the output of the differentiated good (we have normalized the total employment to unity). Equation (25) is the market-clearing condition for capital. Equation (26) is the market for land (with $\bar{S}$ being its fixed supply and Y being the output of the homogeneous good).

In rates of change we have from (24) to (26)

$$\delta_{lx} \cdot \hat{x} + \hat{n} = 0 \tag{27}$$

$$\delta_{Kx} \cdot \hat{x} + \hat{n} = \hat{K} \tag{28}$$

$$\delta_{sx} \cdot \hat{x} + \delta_{sx} \cdot \hat{n} + \delta_{sy} \cdot \hat{Y} = 0 \tag{29}$$

where δ_{ij} is the share of the j^{th} sector in the total employment of the i^{th} factor.

We thus have

$$\hat{x}/\hat{K} = -1/\Delta < 0 \tag{30}$$

$$\hat{n}/\hat{K} = \delta_{lx}/\Delta > 0 \tag{31}$$

$$(\hat{n} + \hat{x})/\hat{K} = -\delta_{lF}/\Delta < 0 \tag{32}$$

where $\Delta \equiv (\delta_{lx} - \delta_{Kx}) > 0$.

Note that $(\hat{n} + \hat{x})/\hat{K} < 0$. Equations (30) to (32) are nothing but Rybczinski effects of an exogenous change in the capital stock. An increase in capital increases the number of brands (the capital-intensive "sector") more than proportionately and reduces the output of the other "sector" (again more than proportionately). The interesting point here is that the output of differentiated goods sector as a whole falls when capital increases.

Note however when the capital stock rises the ***value*** of the differentiated goods sectors output rises i.e.

$$(\hat{n} + \hat{p} + \hat{x})/\hat{K} = (\delta_{Lx} + \frac{\theta_{LF}}{\Omega})/\Delta > 0 \tag{33}$$

i.e., the price rise of brands more than offsets the decline in quantity per brand.

How is Y related to K? From equation (32) $\hat{n}x$ is negatively related to K and hence from equation (29) Y must be positively related to K i.e.,

$$\hat{Y}/\hat{K} = -\left(\frac{\delta_{Lx}}{\delta_{Ly}}\right)\left(-\frac{\delta_{LF}}{\Delta}\right) > 0 \tag{34}$$

The intuition behind equation (34) should be clear. An increase in the capital stock lowers the output of the differentiated goods sector (at same time as it causes entry) and hence reduces the demand for land. For full employment to prevail in the market for land Y must increase.

There are two goods markets. In this paper it is assumed that the differentiated good is non-traded.

$$npx = \alpha C + G \tag{35}$$

$$\dot{A} \equiv \dot{F} = rF + w + qS - C \tag{36}$$

Since the differentiated good is non-traded, the excess of production of the homogeneous good over consumption and interest on net foreign assets must provide for the consumption of the homogeneous good and saving. Note that the value of land is constant over time. Hence any new saving must take the form of claims on the rest of the world.

3 DYNAMICS AND STEADY STATE

Equation (12) gives us one of the differential equations governing the dynamics of the economy. It is reproduced as equation (37) below. To obtain the other differential equation we need to substitute (33) and (34) into (36).

$$\dot{C} = (r - \beta)C - \pi(\pi + \beta)F \tag{37}$$

$$\dot{F} = rF + w + qS - C \tag{38}$$

Linearizing this pair of differential equations around the steady state we have (a steady state value is denoted by an overbar)

$$\begin{bmatrix} \dot{C} \\ \dot{F} \end{bmatrix} = \begin{bmatrix} (r-\beta) & -\pi(\pi+\beta) \\ w_K K_C - 1 & r \end{bmatrix} \begin{bmatrix} C - \bar{C} \\ F - \bar{F} \end{bmatrix} + \begin{bmatrix} 0 \\ w_K K_G \end{bmatrix} dG \tag{39}$$

Note that $w_K = w_x x_K$ is positive. For saddle-point stability we require the determinant of the coefficient matrix (call it D) in (39) to be negative. A necessary condition for this is that $w_K K_C - 1$ be negative. We show in the Appendix that this is the case. The behaviour of the system is portrayed in figure 1. Both the $\dot{F} = 0$ and the $\dot{C} = 0$ are upward-sloping but the $\dot{F} = 0$ line is flatter than the $\dot{C} = 0$ line.

By setting $\dot{F} = \dot{C} = 0$ in (37) and (38) we can obtain the steady state values of F and C (given by point E in figure 1). From equation (36) then we get the value of $\bar{Y}$ and from equations (34), (30) and (31) the values of $\bar{K}, \bar{n}$ and $\bar{x}$. Given $\bar{x}$, then equation (20) and (21) give us the values of $\bar{w}$ and $\bar{p}$.

Note that from equation (37) we have $\bar{C} = \pi(\pi + \beta)\bar{A}/(r - \beta)$. If $r > \beta$ then $\bar{A}$ is positive and if $r < \beta$, $\bar{A}$ is negative (see Obstfeld (1989) and Buiter (1988a) for a discussion). We shall assume in this paper$\bar{A}$ is positive, i.e., the economy does not have foreign debt which is greater than the value of land.

4 A BALANCED-BUDGET INCREASE IN GOVERNMENT EXPENDITURE

Suppose now the government increases its expenditure by dG financed by lump-sum tax increases. And let all of the increased government demand by directed towards the non-traded good. Before proceeding a word of caution. Our model does not obey Ricardian equivalence and hence the balanced-budget-increase assumption is not equivalent to a debt-financed increase in government spending. Also remember that the experiment could be reinterpreted as the households increasing their expenditure on the nontraded good.

4.1 The Steady-State Effects

The increase in government expenditure has the following long run effects on C and A.

$$\frac{d\bar{C}}{dG} = -\pi(\pi + \beta)w_K \cdot K_G/D > 0 \tag{40}$$

$$\frac{d\bar{F}}{dG} = \frac{d\bar{A}}{dG} = -(r - \beta)w_K \cdot K_G/D > 0 \tag{41}$$

Since D (the determinant of the coefficient matrix in equation (39)) is negative (for saddle-point stability) the steady state consumption expenditure increases. The effect of the fiscal expansion on the steady state level of wealth depends on the sign of $(r - \beta)$. If this is positive (negative) then the initial level of wealth of this small open economy is positive (negative). Given our assumption $(r - \beta) > 0$ we have $d\bar{A}/dG > 0$.

The effects on the steady state values of other variables can now be calculated. The signs of these are reported below (the exact expressions are to be found in the Appendix.)

$$\frac{d\bar{K}}{dG} > 0 \qquad \frac{d\bar{p}}{dG} > 0 \qquad \frac{d\bar{n}}{dG} > 0 \qquad \frac{d\bar{x}}{dG} > 0$$

$$\frac{d\bar{w}}{dG} > 0 \qquad \frac{d\bar{q}}{dG} = 0 \qquad \frac{d\bar{Y}}{dG} > 0 \qquad \frac{d(\bar{w} - G)}{dG} > 0. \tag{42}$$

An increase in npx causes an inflow of capital. That inflow reduces output per brand and the total physical output of differentiated goods but increases the number of brands available (i.e., increases variety choice). These are pure Rybczinski effects. A fall in output per brand lowers the demand for land and the output of the homogeneous good, Y, has to increase to clear the land market. An increase in capital stock increases the wage rate more than proportionately and the wage rate net of the initial tax increase rises. The human wealth component of wealth rises and therefore so does consumption expenditure. Of course it is possible that the multiplier process is so strong that we have a completely unstable system. The explanation given above is true for a system which is saddle-point stable.

The increased government expenditure, therefore, increases incomes and expenditures and generate a Keynesian boom. The process works through an accelerator mechanism which brings inflows of capital and a multiplier mechanism which in this model is a combination of a Rybczinski effect (a fall in $\bar{x}$) and a Stolper-Samuelson type effect (a fall in $\bar{x}$ causes a rise in $\bar{F}$ and $\bar{w}$).

National income accounts would show an increase investment but this investment is accompanied by an equal increase in imports since all capital is imported (whether we think of K as a stock which undergoes a one time jump as C jumps to put the system on the stable manifold, or in flow terms as raw materials). But this increased capital increases wages and the stock of foreign bonds and hence welfare.

Across steady states, F increases indicating saving during the transition. It is possible that the saving is more than offset by investment i.e., $\dot{F} < \dot{K}$, so that the new net foreign asset position $(F - K)$ is worse than before. The converse case of a current account surplus along the adjustment path cannot be ruled out either.

Finally let us look at the effect on the change in instantaneous utility of a representative individual across steady-states. This can be written as (V is the instantaneous indirect utility function).

$$\hat{\bar{V}} = -\alpha\hat{\bar{P}} + \hat{\bar{C}} = -\alpha\hat{\bar{p}} + \frac{\alpha}{\sigma - 1}\hat{\bar{n}} + \hat{\bar{C}} \tag{43}$$

The last two terms in (43) are positive but the first one is negative since $d\bar{p} > 0$ It is shown in the Appendix that $\hat{\bar{V}} > 0$. Note that $\hat{\bar{V}}$ has the same sign as the change in the usual real income measure (i.e., dV divided by marginal utility of income) in international trade.

4.2 Dynamics

For $r > \beta$ the $\dot{F} = 0$ line shifts up in Figure 2 with no change in the $\dot{C} = 0$ line and the new steady state is to the north-east of the original one. For $r < \beta$ the new equilibrium would be to the north-west and for $r = \beta$ it would be vertically above the old one. In the last case the the new long run equilibrium is attained instantaneously.[6]

Remaining with the $r > \beta$ case, we see that there is an instantaneous increase in C and an instantaneous inflow of physical capital through foreign borrowing. This makes y, x, n, p, w and q behave the same way as they do in the long run. In the short run F is given. We see in the Appendix that welfare rises in the short run (i.e., its behaviour in the short run is similar to the long run behaviour).

Along the adjustment path C and F rise together (for $r > \beta$). Saving and consumption move together. This induces an increase in investment and with attendant increases in y, n, p and w with x falling.

Along the adjustment path we have entry, rising consumption and rising prices of domestically produced brands. The level of welfare of representative individual is higher along this path than at the original equilibrium.

5 CONCLUSIONS

I set up an imperfectly competitive model of the open economy in this paper and examined the effects of a balanced budget increase in government expenditure. This was shown to have the usual properties of an undergraduate textbook Keynesian model. The policy experiment creates a boom which lasts all the way to the new long run equilibrium. The welfare of a representative individual rises instantaneously and stays above the initial level forever. A balanced-budget fiscal policy gives us a path which is Pareto-superior to the initial equilibrium.

All models which seek to explain a rise in output following a fiscal expansion must have some input which is in elastic supply – e.g., in the Real Business Cycles models (and even some new-Keynesian ones) it is labour supply. In our model it is capital which adjusts endogenously. In a better specified model it could be capacity utilization, which adjusts in the short run with a model of the type sketched here explaining the medium to long run dynamics. Note this assumption of a fixed foreign interest rate makes it possible for welfare to rise unambiguously compared to a closed economy (see e.g., Mankiw (1988) but also Matsuyama (1993)).

This paper also highlights two points. First, in two good model all sectors can expand (in value terms) even if all domestic inputs are inelastically supplied. Second, by assuming that the economy is small, foreign input supplies are assumed to be elastic. This could give rise to international spillovers and co-movements in factor prices in a two-country model. It is important not to lose sight of the fact that both of the above could happen in a competitive model. But in such a set-up it could not be welfare improving.

The model of this paper made many strong assumptions to derive the results. Relaxing those assumptions would no doubt modify the results, some amplifying the processes at work here while others working in the opposite direction. An obvious candidate is an improvement in the specification of the investment function – both in relaxing the adjustment pattern and in specifying adjustment costs.

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APPENDIX

A necessary condition for determinant D of the coefficient matrix in equation (39) to be negative is

$$\frac{\partial w}{\partial K}\frac{\partial K}{\partial C} < 1 \qquad (A.1)$$

This inequality can be shown to hold if we first establish that the following two inequalities hold

$$\text{(a)} \quad \delta_{Lx} > \tfrac{\sigma-1}{\sigma} \qquad \text{and (b)} \quad \delta_{LF} > \tfrac{1}{\sigma}$$

Both of these can be easily established by multiplying the right hand side by $\delta_{Lx}+\delta_{LF} = 1$. The inequalities then reduce to $\theta_{Lx} > \theta_{LF}$ which we have assumed to be true in equation (20) and (21).

Turning to (A.1) we have

$$w_K K_C < 1$$

or

$$\frac{1}{\Delta\Omega}\frac{w}{K}\frac{\alpha}{\frac{(\theta_{LF}\delta_{LF}+\theta_{Lx}\delta_{Lx})}{\Delta\Omega}\cdot\frac{npx}{K}} < 1$$

which reduces to

$$\alpha(\frac{\sigma-1}{\sigma}\theta_{lx} + \frac{1}{\sigma}\theta_{LF} < \delta_{Lx}\theta_{Lx} + \delta_{LF}\theta_{LF}).$$

This follows since $\frac{\sigma-1}{\sigma} < \delta_{Lx}, \frac{1}{\sigma} < \delta_{LF}$ and $\alpha < 1$.

We can also show that

$$w_K K_G < 1$$

This is just the preceding inequality without α on the left-hand side.

The long run changes in equation (42) are given below

$$\frac{d\bar{K}}{dG} = \left(1 + \alpha\frac{d\bar{C}}{dG}\right)/\Gamma > 0 \qquad (A.2)$$

$$\frac{d\bar{x}}{dG} = -\frac{1}{\Delta}\cdot\frac{\bar{x}}{\bar{K}}\cdot\frac{d\bar{K}}{dG} < 0 \qquad (A.3)$$

$$\frac{d\bar{n}}{dG} = \frac{\delta_{1-x}}{\Delta}\cdot\frac{\bar{n}}{\bar{K}}\cdot\frac{d\bar{K}}{dG} > 0 \qquad (A.4)$$

$$\frac{d\bar{p}}{dG} = -\frac{\theta_{Lx}}{\Omega}\cdot\frac{\bar{p}}{\bar{x}}\cdot\frac{d\bar{x}}{dG} > 0 \qquad (A.5)$$

$$\frac{d\bar{Y}}{dG} = \frac{\delta_{Lx}}{\delta_{Ly}}\frac{\delta_{LF}}{\Delta} \cdot \frac{\bar{Y}}{\bar{K}} \cdot \frac{d\bar{K}}{dG} > 0 \tag{A.6}$$

$$\frac{d(\bar{F} - \bar{K})}{dG} = [\{-(r-\beta) + \pi(\pi+\beta)\alpha\Gamma^{-1}\}\frac{\partial Y}{\partial K} + 1]/\Gamma \gtrless 0 \tag{A.7}$$

$$\frac{d(\bar{n}\bar{x})}{dG} = -\frac{\delta_{LF}}{\Delta} \cdot \frac{\bar{n}\bar{x}}{\bar{K}} \cdot \frac{d\bar{K}}{dG} < 0 \tag{A.8}$$

$$\frac{d(\bar{n}\bar{p}\bar{x})}{dG} = \Gamma \cdot \frac{d\bar{K}}{dG} > 0 \tag{A.9}$$

$$\frac{d(\bar{w} - G)}{dG} = \frac{w}{CD}\{w_K K_G - 1 + (\theta_{LF}\delta_{LF} + \theta_{Lx}\delta_{Lx})^{-1}\} > 0 \tag{A.10}$$

where

$$\Gamma \equiv \frac{\partial(npx)}{\partial K} = \left(\frac{\delta_{LF}}{\Delta} + \frac{\theta_{LF}}{\Delta\Omega}\right) \cdot \frac{npx}{K} > 0 \tag{A.11}$$

To show that the rise in p (induced by a rise in K can never dominate the effect of increase in expenditure on welfare we note (as in equation (43)).

$$\hat{V} = -\alpha\hat{p} + \frac{\alpha}{\sigma - 1}\hat{n} + \hat{C}$$

A sufficient condition for $\hat{V}$ to be positive (given $\hat{c}$ and $\hat{n}$ are positive) is

$$\begin{array}{lrcl} & \hat{C} & > & \hat{p} \\ \textit{now} & \hat{w} & = & \hat{w}_{\hat{K}} \cdot \hat{K}_{\hat{C}} \cdot \hat{C} \\ & & = & \dfrac{\delta_{LF} + \delta_{Lx}(\sigma - 1)}{\sigma(\delta_{LF}\theta_{LF} + \delta_{Lx}\theta_{Lx})} \cdot \hat{C} \\ & & < & \hat{C} \text{ from conditions (a) and (b) following equation (A.1) above.} \end{array}$$

So if we show $\hat{w} > \hat{p}$ then the proof is complete. But (from equations (20) and (21)) $\hat{p} = \theta_{Lx}\hat{w} < \hat{w}$ and $\theta_{Lx} < 1$.

The above analysis is true both in and out of the steady state.

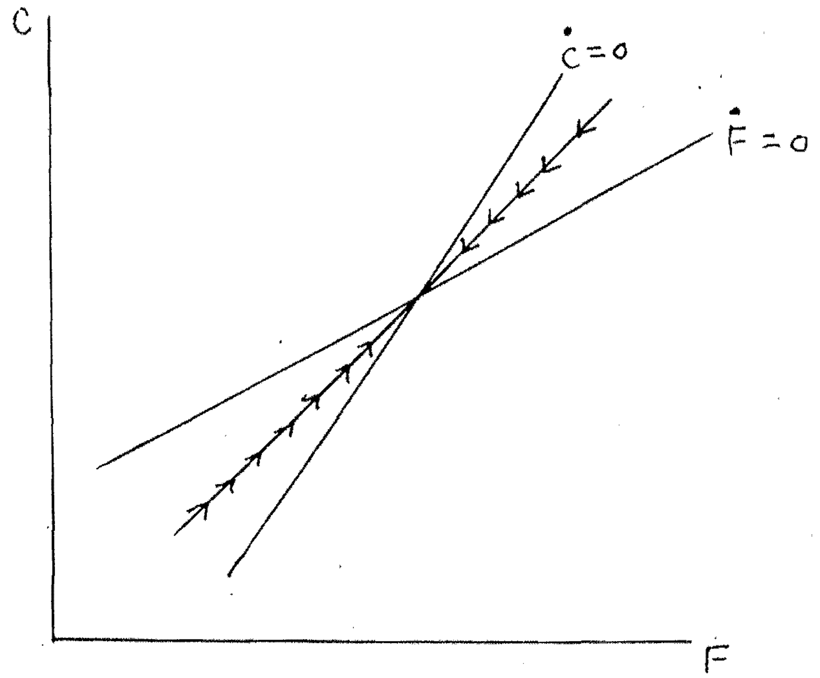

Figure 1

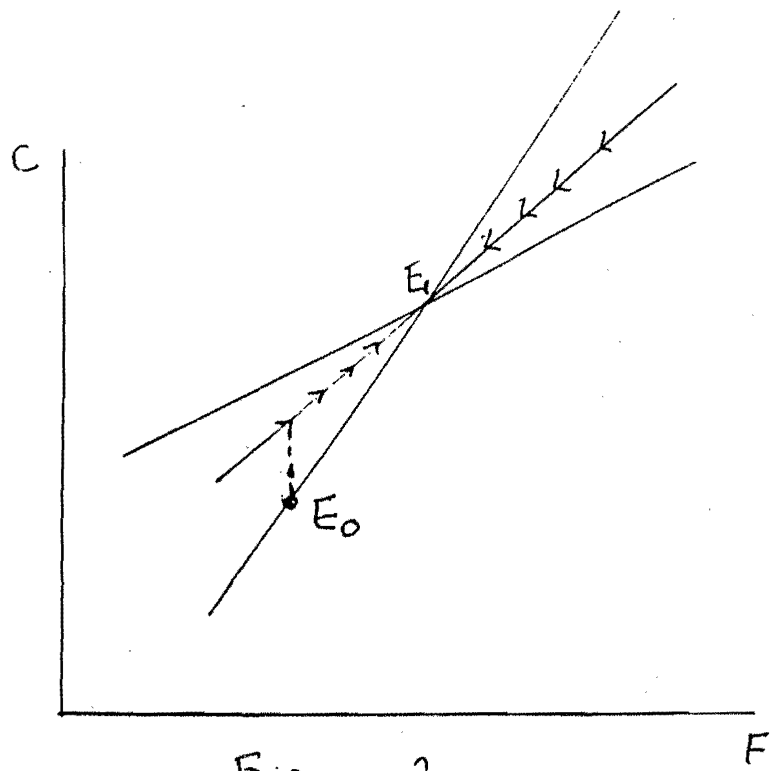

Figure 2

FOOTNOTES

1. See e.g. Baxter and King (1993), Buiter (1988a) and Buiter (1991) and Obstfeld (1989).

2. This is strictly not true because one of the primary focus of new-Keynesian macroeconomics has been on wage and price staggering. The statement in the text refers to issues of capital accumulation and the dynamic effects of deficits. See Mankiw and Romer (1991a and 1991b). The paper by Startz (1990), Woodford (1991), Gali (1994), Chaterji and Cooper (1993) and Rotemberg and Woodford (1993) are especially relevant for the analysis in this paper.

3. E.g., Mankiw (1988) and Matsuyama (1993).

4. We could have followed Ethier (1982) in assuming an intermediate good is subject to increasing returns to scale. Also see Matsuyama (1993) on this.

5. A dot over a variable denotes its time derivative, a subscript denotes a partial derivative and a hat a percentage change.

6. In this case there is no change in the net debtor position of the country. Human capital rises because of the increase in after tax wages. Financial wealth remains unchanged.

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