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Monetary policy effects in the short and long run under alternative wealth assumptions

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SHORT AND LONG RUN UNDER
ALTERNATIVE WEALTH ASSUMPTIONS**

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ABSTRACT

In this paper an ad hoc deterministic macroeconomic model, assuming economic agents possess rational expectations, is developed. Emphasis is placed upon the long run nature of the adjustment process, through inclusion of capital stock accumulation and current account balance considerations, arising from an expansion in the monetary growth rate. The significance of wealth for the model's steady state and dynamic properties is emphasised, as well as upon the adjustment process itself.

It is concluded that dynamic stability requires the inclusion of wealth in the output demand equation, and where this is the case a monetary growth expansion produces real effects during the adjustment process as well as in the long run steady state. The additional inclusion of wealth in the money demand equation produces marginal differences in the adjustment of the macroeconomic variables emphasised, during both the adjustment process and in steady state.

INTRODUCTION

This paper is concerned with analysing the macroeconomic adjustment processes arising from an expansion in the monetary growth rate. In doing so a conceptual framework assuming rational expectations is developed, the basis of which can be found in the contributions of Dornbusch (1976) and Buiter and Miller (1980, 1981). Unlike these, however, emphasis is placed upon the long run nature of the adjustment process, which is achieved by the inclusion of capital stock accumulation in the product market, with its resulting effect upon the economy's potential supply of output, and foreign asset stock (bonds) accumulation arising from developments in the current account.

In a model containing rational expectations, the long run steady state will have a major bearing upon the short, as well as long, run adjustment process. Such models are characterised by a stable saddlepath property, requiring that non predetermined, or jump, variables put the economy on to this stable saddlepath instantaneously so that the economy will ultimately converge to long run steady state. Traditionally this role is allocated to asset market variables, and this is maintained here, which thereby contain information on the required adjustment path of the economy over the long, and short, run to steady state.

The importance of wealth, incorporating the capital stock and foreign asset stock, to the model's steady state and dynamic properties, forms the central focus of this paper.

The paper proceeds as follows. In section 1 the conceptual framework is discussed at some length, whilst its dynamic and steady state properties are identified in section 2. Section 3 focuses upon an interpretation of the results derivable from

the model utilising a numerical simulation procedure, for the case of a monetary growth expansion. Finally section 4 presents a summary of the major conclusions from this paper.

1. CONCEPTUAL FRAMEWORK

In this section an ad hoc deterministic macroeconomic model assuming economic agents possess rational expectations, is presented. The latter assumptions imply that this is equivalent to the case of perfect foresight. Emphasis is placed upon the long run nature of the adjustment process, through explicit modelling of capital stock and foreign asset stock accumulation. The former contributes to an increase in potential output supply, whilst the latter requires that in long run equilibrium the current account balance must be zero.

The assumption that economic agents possess rational expectations, implies that the long run nature of the model will have a major bearing upon adjustment in the short run. Long run steady state can only be achieved through an instantaneous adjustment of jump variables onto the new stable saddlepath, which will ultimately converge to this. Adjustment is felt, on impact, in asset markets which remain in equilibrium throughout, indicating that such financial variables contain information on the nature of the required adjustment process over both the short and long run. The neglect of the long run nature of the adjustment process, can lead to the erroneous modelling of developments in the short run (see Harvie (1992)). Asset market developments ultimately impinge upon the slowly adjusting non asset market variables. Such slow adjustment arises from the stickiness of both price and quantity variables, due to the existence of wage/price contracts and costs of adjustment.

Domestic private sector wealth plays a key role in the

model, in terms of its influence upon both its steady state and dynamic properties. It consists of the domestic real currency value of domestically held foreign assets, real money balances, and the real value of the domestic capital stock. The latter consisting of both a physical and market valuation component. Various scenarios whereby wealth affects the demand for output, money, both or neither are identified.

Four assets (financial) are considered in the model domestic money, bonds (inside), foreign bonds and equities. Domestic bonds are assumed for simplicity to be inside bonds, issued by agents in the private sector and held by agents in that sector. Equities represent claims to ownership over the domestic capital stock, the value of which increases as the market valuation to the replacement cost of the capital stock increases. The three non money assets are assumed to be perfect substitutes, the expected real return on each is continuously equalised through arbitrage. In addition domestic money, bonds and equities are assumed to be held only by domestic residents, whilst foreign bonds are accumulated via developments in the current account balance.

Finally, emphasis in the model is also given to both the demand and supply sides of the economy.

The equations of the model[1] in log form, with the exception of the domestic nominal interest rate (r) and the world real interest rate (r*), are now outlined, and in doing so they are categorised under the following broad headings - product market equilibrium, wage-price nexus, asset market equilibrium, external equilibrium and definitions.

Product market equilibrium

(1) $y = \Sigma_1 y + \Sigma_2 w_e + \Sigma_3(Dk + \Sigma_4 k) + \Sigma_5 g + \Sigma_6 T$

(2) $Dk = \eta q$

(3) $s = \lambda_1 k - \lambda_2(w - p)$

Wage/price nexus

(4) $p = \alpha w + (1 - \alpha)e$

(5) $Dw = \phi_1 + \phi_2(y - s) + \phi_3 \pi$

(6) $\pi = Dm$

Equilibrium in asset markets

(7) $m - p = \sigma_1 y - \sigma_2 r + \sigma_3 w^e$

(8) $De = r - r^*$

(9) $R = \varepsilon_1 + \varepsilon_2 y - \varepsilon_3 k$

(10) $Dq = \delta_3^{-1}(q - \delta_1 R + \delta_2(r - \pi))$

(11) $w^e = \gamma_1(f + e - p) + \gamma_2(m - p) + \gamma_3(k + q)$

External equilibrium

(12) $T = \mu_1(e - p) - \mu_2 y + \mu_3 y^*$

(13) $Df = \rho_1 T + \rho_2 r^* f - (1 - \rho_2)(e - p)$

Definitions

(14) $c = e - w$

(15) $l = m - w$

Overall equilibrium in the model requires equilibrium in the product and asset markets, as well as for the external sector. The product market equations are discussed first of all.

Demand (spending) for domestic output (y) is given by equation (1), which is referred to later as the IS equation. This depends upon the level of domestic output itself, domestic private sector real wealth (w^e), domestic gross investment

($Dk + \Sigma_4 k$), government spending (g) and the trade balance (T). Domestic output can either be consumed domestically or exported, and is an imperfect substitute for the overseas produced equivalent.

Domestic private sector wealth depends upon the domestic currency value of domestically held foreign bonds, real money balances, and the real value of the domestic capital stock. The latter depends upon the physical capital stock (k) and the market value of equities, which represent claims to the ownership of the capital stock. It is captured by developments in Tobin's q ratio (q). Changes in the market valuation of equities affect the value of capital in place relative to its replacement cost, creating an incentive, or otherwise, to add to, or reduce, the physical capital stock.

Gross investment in the physical capital stock consists of Dk (net investment), where D is the differential operator, plus replacement investment $\Sigma_4 k$. Where Σ_4 represents the rate of depreciation of the existing physical capital stock. This latter investment is that necessary to maintain the existing capital stock intact.

Factors affecting the trade balance are discussed in more depth below.

Equation 2, the net investment equation, is based upon the capital stock adjustment principle, in which the capital stock adjusts gradually to its new optimal level. Equation (2a) captures this partial adjustment hypothesis:

(2a) $Dk = \eta(k^* - k)$

where k^* represents the desired capital stock and k the actual capital stock. Assuming costs of adjustment, the gap is closed only gradually by η per period. The desired capital stock depends upon its market value as given by (2b)

(2b) $k^* = k + q$

Substituting (2b) into (2a) equation (2) can be obtained. Hence net investment adjusts positively to Tobin's q.

Output supply (s) is endogenously determined within the model, fluctuating in the long, as well as the short, run via the production function given by equation (3). This relates output supply positively to the physical capital stock, and negatively to the real wage (that is the nominal wage (w) deflated by the domestic price level (p)). With the capital stock variable over the long run, capacity output is similarly variable even with a fixed real wage.

The wage/price nexus is given by equations (4) - (6). Emphasis is placed upon the sticky, or slow, adjustment of nominal wages rather than prices.

Equation (4) indicates that the consumer price level (p) is a weighted average of domestic nominal wages (w), and the domestic currency cost of the overseas imported equivalent of the domestic product. The latter is given by the nominal exchange rate (e) times the price of the overseas good $(p^*)^2$.

The adjustment of nominal wages is given by equation (5), an expectations augmented Phillips curve. Nominal wage adjustment arises from three possible sources. These being developments in productivity, wage fixing or bargaining processes (ϕ_1), demand pressure in the labour market as reflected in the demand for output relative to its available supply (y - s) and inflationary expectations (π). The latter is assumed to adjust instantaneously in line with the domestic monetary growth rate (Dm), as indicated by equation (6). Such wage adjustment can therefore be influenced by policy settings regarding the parameters ϕ_1 and ϕ_3,. However, this is not considered further.

Asset market equilibrium is given by equations (7) and (11). The three non-money assets, as previously discussed, are assumed to be perfect substitutes. Arbitrage between them implying the same expected (instantaneous) real rate of return. The common expected rate of return, must in turn be such that economic agents are satisfied with the proportion of money in their portfolios.

Portfolio balance is characterised by a conventional LM equation, equation (7), incorporating domestic real wealth. Demand for real money balances (domestic money stock (m) deflated by the price level (p)) is a function of real income (transactions demand), the domestic nominal interest rate (r) and domestic real wealth (asset demand).

The financial assets contained in the model, require further clarification. Domestic bonds are assumed for simplicity to be inside bonds, that is they are issued by agents in the private sector and held by agents in the same sector. They therefore do not constitute part of the private sector's net wealth. In addition these bonds are assumed to be held only by domestic residents, and are regarded by them as perfect substitutes for foreign bonds. The expected real return on domestic bonds is equivalent to[3]:

$$r - \pi$$

which must be continuously equivalent to the real rate of return on foreign bonds. Since domestic and foreign bonds are regarded as perfect substitutes, and from the perspective of domestic residents there is perfect capital mobility, such capital flows need to take into consideration expected changes in the exchange rate. Expected currency yields must be equalised. This is reflected in the uncovered interest parity condition (equation (8)). Deviations of the domestic nominal interest rate

from the world nominal interest rate result in instantaneous adjustment of the exchange rate, leading to offsetting expectations regarding the future adjustment of the nominal exchange rate. Hence the real return on foreign bonds, in domestic currency terms, is equivalent to $r^* + De - \pi$, which must equate continuously with the return on domestic bonds $(r - \pi)$.

These expected rates of return will be equated instantaneously, through arbitrage, with the expected real return on domestic equities. Domestic equities are assumed to be held only by domestic residents. The expected real return on holding equities is given by:

$$Dq/q + R/q$$

where R is the real profit stream derived from the capital services. Hence the expected return depends upon the expected capital gain/loss from holding equity capital Dq/q, where $Dq = 0$ in steady state, plus the real profits stream derived from the capital service R relative to q. Real profit, as given by equation (9), is assumed to be an increasing function of real income and a decreasing function of the capital stock.

Continual, and instantaneous, arbitrage between domestic bonds, foreign bonds and equity capital implies:

$$Dq/q + (\delta_1 + \delta_2 y - \delta_3 k)/q = r - \pi = r^* + De - \pi$$

Ignoring $r^* + De - \pi$, since this must be equivalent to $r - \pi$, and taking a log linear approximation, we can solve for q:

$$q = \delta_1 R - \delta_2(r - \pi) + \delta_3 Dq$$

or re-arranging, and solving for Dq, we can obtain equation (10)

Real domestic private sector wealth is given by equation (11). It consists of three components, as identified previously. Firstly that arising from domestic holdings of foreign bonds (f), expressed in domestic currency terms (multiplied by the nominal exchange rate) and deflated by the domestic price level. Secondly, holdings of real money balances (m - p). Thirdly the real value of the domestic capital stock, assumed to be entirely owned by agents in the domestic private sector, consisting of a physical quantity (k) multiplied by its market value (q).

The overseas sector consists of the trade balance and the current account. Equation (12) identifies the trade balance, which depends upon the real exchange rate (e - p), the nominal rate deflated by the domestic price level, domestic real income and world real income (y*). The trade balance is an important component of the current account, developments in which are given by:

$$Df + e - p = \rho_1 T + \rho_2(r^*f + e - p)$$

Re-arranging and expressing this in terms of changes in foreign bond holdings, we can obtain equation (13). This indicates that the accumulation of foreign bonds (or asset stocks), as reflected in the current account balance, depends upon the trade balance and real foreign interest income. In long run steady state the current account balance must be zero, or else further wealth effects will arise requiring further macroeconomic adjustment.

Finally equations (14) and (15) define two variables used extensively throughout the paper[4], the real exchange rate (c) (the nominal exchange rate deflated by domestic nominal wages) and real money balances (the nominal money stock deflated by domestic nominal wages) respectively. Such

definitions are useful for expositionary purposes.

2. STEADY STATE AND DYNAMIC PROPERTIES OF THE MODEL[5]

In this section, the steady state and dynamic properties of the model are discussed at some length. Firstly its steady state properties.

Steady state properties

The size and generality of the model under discussion suggests that an algebraic analysis of it is unlikely to provide analytically unambiguous results[6], regarding both its steady state and dynamic properties. These can only be successfully derived through a numerical solution procedure, which is now adopted. However it should also be borne in mind, that the model does possess some analytically unambiguous steady state properties. These being:

$q = 0$

$Dm = Dw = Dp = De = \pi$

$r = Dm + r^*$

$R = r^*$

A numerical solution procedure requires an identification of the numerical values for the model's parameters. Since this paper is not primarily concerned with conducting such a procedure for a particular economy, but rather in deriving results which are of general interest, the parameter values utilised are assumed to possess general plausibility.

The parameter values utilised are contained in Table 1, whilst Table 2 summarises the steady state properties of the model for the key macroeconomic variables of interest arising from an assumed permanent and unanticipated 10 per cent expansion in the monetary growth rate. The results presented in Table 2, categorise these according to the role of the wealth variable (w^e) in the model.

Four possible cases, regarding the role of wealth, are given emphasis, these being:

Case 1. no wealth in the IS equation

$(\Sigma_2 = 0)$,

Case 2. no wealth in the IS and LM equations

$(\Sigma_2 = 0, \sigma_3 = 0)$,

Case 3. wealth in both the IS and LM equations

$(\Sigma_2 > 0, \sigma_3 > 0)$,

Case 4. no wealth in the LM equation

$(\sigma_3 = 0)$.

An interpretation of the steady state properties of the model, for the case of a monetary growth expansion for each of these cases is now conducted. In doing so the results presented in the Appendix and Table 2 are utilised.

Cases 1 and 2 are relatively easy to interpret. In these, since $\Sigma_2 = 0$, there will be no long-run change in real income (y), capital stock (k), trade balance (T), real exchange rate (c) and

nominal foreign assets (f)[7]. However, there would be an effect upon real wealth (w^e), although the precise nature of this would depend upon the numerical values of the parameters of the model. For presumed values of these, see again Table 1, a monetary growth expansion produces a decline in real wealth, arising primarily from a decline in real money balances (the latter result is also derivable from the Buiter-Miller (1980, 1981) model). These are the only real variables affected. Such a conclusion is confirmed from the fact that the key nominal variables in the model, domestic prices (p), exchange rate (e) and wages (w) all increase equi-proportionally, although by less than the proportional increase in the monetary growth rate itself. The nominal interest rate and inflation also increase equi-proportionally, a proportional amount equivalent to the increase in the monetary growth rate, leaving the real interest rate unchanged.

It is noticeable from Table 2 that case 1, in comparison to case 2, produces a larger proportional increase in domestic prices, wages and the exchange rate, as well as for real money balances and real wealth. The reason for this can be most easily derived from the money demand equation. In case 1 wealth affects the demand for money $(\sigma_3 > 0)$, unlike case 2, hence the decline in real wealth which occurs, contributes to a decline in money demand. This occurs in conjunction with the increase in the nominal interest rate, which also reduces money demand. Hence in case 1 money demand falls by more than for case 2, requiring a larger fall in real money supply (m - p), resulting in a larger increase in domestic prices.

The relative change in w^e and l is larger for case 1, where $\sigma_3 > 0$, since Δdet will be smaller, whilst the numerator will be the same for cases 1 and 2 (see appendix).

Cases 3 and 4 are more difficult to interpret since for these the results presented in the appendix are analytically

ambiguous, hence reliance has to be placed upon the results derived from a numerical solution procedure (as presented in Table 2).

Unlike cases 1 and 2 real long run effects, other than that for real money balances and wealth, are also observable for cases 3 and 4. Specifically these relate to real income, the capital stock, the trade balance, the real exchange rate (appreciates)[8], and real wages. In these cases real money balances similarly falls, whilst real wealth now increases.

For the presumed numerical values utilised, the increase in real wealth can be explained as follows. The long run appreciation of the real exchange rate, fall in real money balances and in the capital stock, all contribute to a decline in real wealth (see equation 11). However a sizeable accumulation of foreign assets (bonds), via current account surpluses, more than offsets these effects, resulting in an overall increase in real wealth.

This increase in real wealth in turn increases the demand for output and money. Increased output demand from this source would, however, be offset by developments in other components of output demand. These include a decline in replacement investment, and hence gross investment, arising from an overall decline in the capital stock, and a deterioration in the trade balance. The reason for the latter is discussed below. On the supply side reduced production can be explained again by the smaller capital stock, but also from the higher real wage in the long run.

Additional wealth also generates more demand for real money balances (equation 7), however this is offset by the decline in real income and the rise in the nominal interest rate. In fact the latter two developments dominate in these cases, resulting in an overall decline in demand for real money balances. Such a decline requires a similar reduction in real

money supply, brought about by an increase in domestic prices.

The trade balance deteriorates in long-run equilibrium primarily due to the appreciation of the real exchange rate, although this is offset somewhat by the decline in real income.

The proportional increases in the nominal variables - wages, prices and the exchange rate are different for both cases 3 and 4. Nominal wages increase by more than prices, hence the real wage increases, whilst prices increase by more than the depreciation of the nominal exchange rate, thereby producing the observed appreciation of the real exchange rate.

The proportional changes in these nominal variables, are again less than the proportional change in the monetary growth rate itself. However one nominal variable adjusts by more than that of the monetary growth rate, the foreign asset stock.

It is also noticeable that in case 3, for the parameter values utilised, that the proportional adjustment of both nominal and real variables, with the exception of the nominal interest rate, inflation, real profits and Tobin's q, are all less than that derived for case 4.

Finally the change in the nominal interest rate and inflation are equi-proportional to the change in the monetary growth rate, resulting in an unchanged real interest rate in long run steady state for both cases 3 and 4.

Dynamic properties of the model[9]

The model must exhibit dynamic properties which are consistent with its underlying behavioural assumptions. The dynamic equations of the model cover a set of endogenous control variables, consisting of real money balances (l), the stock of foreign assets (f), the physical capital stock (k), Tobin's q (q) and the real exchange rate (c). The model as described

earlier emphasised that the latter two variables, being determined in asset markets, are non predetermined jump variables, capable of adjusting instantaneously to an exogenous shock. The initial three variables, however, being determined in non asset markets, exhibit stickiness of adjustment and are predetermined non jump variables.

Denoting the endogenous control variables by the vector x, the model generalises to the following approximation of deviations about equilibrium values:

$$Dx = Ax' + Bz$$

where z is a vector of exogenous variables, x' denotes the deviation of x around its equilibrium value, and Dx is its time derivative. A and B are parameter matrices.

The stability of the model depends only upon the properties of the "state" matrix A. The characteristic equation of matrix A can be derived from

$$[A - \theta I]$$

where I is the identity matrix, and the θ's are the characteristic roots, or eigenvalues, of the system. In the system under discussion there will be five θ's corresponding to the 5 state, or control, variables.

An algebraic analysis of model stability based upon the characteristic equation of A, does not produce analytically unambiguous results[10]. However it is possible to derive one necessary condition for stability, in that the determinant of A should be of a particular sign. The model under discussion, a five by five dimensional system, with two presumed jump variables, has to generate a stable saddlepath for these variables to jump on to. There must be two unstable and positive

eigenvalues associated with these, hence the determinant of A, which gives the product of the roots, must be negative. This is so since the other three eigenvalues, associated with the predetermined variables, must all be negative and hence impart stability to the system. If this is not satisfied, the model will, on this basis, be regarded as unstable, with the underlying dynamic adjustment process being inconsistent with the behavioural assumptions of the model.

The exclusion of wealth from the IS equation (case 1 and case 2) produces instability in the dynamic adjustment process of the model, resulting in 2 negative eigenvalues and 3 positive eigenvalues (see Table 3). The latter indicating three jump or non predetermined variables. This is inconsistent with the underlying behavioural assumptions of the model, hence can be regarded as unstable. Inclusion of wealth in the IS equation is therefore crucial for model stability[11].

Table 4 takes the issue of model stability one step further, by identifying the key parameters, and restrictions upon these, necessary for model stability. The key parameters for model stability arise from the product demand equation (Σ_1, Σ_2, Σ_3, Σ_4, Σ_6), output supply equation (λ_1, λ_2), money demand equation (σ_1), real profit equation (ε_2, ε_3), Tobin's q equation (δ_1), wealth equation (γ_1), the trade balance (μ_1, μ_2) and current account equations (ρ_1, ρ_2). In addition model stability requires that the following parameters be greater than zero — Σ_2, ε_3, δ_1, γ_1, μ_1, ρ_1, and ρ_2. The significance of the contribution of the wealth variable, and the parameter Σ_2, is of particular interest.

3. MODEL SIMULATIONS

Whilst Tables 2 - 4 are illuminating in terms of their identification of the steady state and dynamic properties of the model, for various assumptions regarding the role of the

wealth variable, they do not throw much light on the adjustment process itself. This section attempts to provide this missing information.

The discussion in section 2 concluded that the inclusion of the wealth variable in the output demand equation, was essential for the dynamic stability of the model. Hence the numerical simulation procedure conducted in this section, focuses upon the results derivable from cases 3 and 4 only.

The numerical simulation results derived utilised the parameter values given in Table 1. A summary of the adjustment process for key macroeconomic variables is contained in Figures 1[12], which can be used in conjunction with the results contained in Table 2. For brevity only the adjustment of ten macroeconomic variables are identified, these being - real income, capital stock, real wealth, real wages, inflation, price level, nominal interest rate, real exchange rate, trade balance and the foreign asset stock.

Developments in real income are very similar for either case 3 or 4. The initial increase observed arises from, on the demand side, additional investment leading to an accumulation of capital stock, increased real wealth and an improvement in the trade balance. On the supply side increased production is explained by the capital stock accumulation and fall in the real wage.

The initial capital stock accumulation arises from an increase in the q ratio (not shown), largely reflecting an increase in real profits (also not shown). Real wealth increases initially due to the previously mentioned increase in capital stock and the market valuation of it (q ratio), as well as the sizeable accumulation of foreign assets. However real money balances decline (not shown), offsetting somewhat these previous developments.

Real wages decline initially. Whilst both nominal wages

(not shown) and the price level rise, the latter does so by more. However this development is quickly reversed, with nominal wages rising by more than prices, causing real wages to increase.

Inflation increases rapidly initially for both cases 3 and 4, as does the nominal interest rate. In fact the former more than the latter, causing an initial decline in the real interest rate.

The real exchange rate depreciates initially, contributing, despite the increase in real income, to an improvement in the trade performance and resulting accumulation of foreign asset stocks (current account surplus).

After these initial developments, the remainder of the adjustment process is characterised by the following. Real income (demand) declines due to falling investment, in line with the decline in capital stock, and sustained deterioration in the trade balance. After a slight decline in real wealth, after its initial rise, it thereafter recovers, but is not sufficiently strong to offset the previous developments upon real income. On the supply side, falling production, in line with falling demand, is a reflection of a decline in the capital stock and a sustained increase in real wages.

The declining capital stock arises from a similar decline in the q ratio, which itself is a reflection of declining real profits.

Developments in real wealth are a reflection of rising foreign asset stocks, offset by an appreciation of the real exchange rate, which is also offset by a decline in real money balances and the real value of the capital stock. The first effect, in general, being sufficiently strong to offset the latter developments.

The upward trend in real wages is due to a more rapid increase in nominal wages in comparison to that of prices. The rise in the price level itself occurs from the increase in nominal wages, however this is offset somewhat by the

appreciation of the nominal exchange rate. It is this latter development which causes the discrepancy between the adjustment of prices and wages, and hence the development in real wages alluded to.

Inflation declines after its initial increase, achieving steady state relatively quickly. The nominal interest rate likewise achieves steady state relatively quickly, requiring only a slight further increase after its initial sizeable rise.

The real exchange rate appreciates after its initial depreciation, due to both the appreciation of the nominal exchange rate and rise in domestic prices. This development contributes to the deterioration in the trade balance, offsetting the beneficial effects upon this of the decline in real income. Despite the deterioration in the trade balance there are still surpluses on current account, hence accumulation of foreign asset stocks, due to foreign interest income more than offsetting adverse developments in the trade balance.

4. SUMMARY AND CONCLUSIONS

The primary focus of this paper has been to identify the significance of wealth for the steady state, and dynamic, properties of a theoretical macroeconomic model, emphasising the case of an expansion in the monetary growth rate. In terms of its influence upon the steady state properties of the model for such a case, the inclusion of wealth in the output demand equation (cases 3 and 4) affected real variables such as k, c, y, T, s, w^e, l and w - p. The proportional changes in the nominal variables p, w and e diverged, and were less than the change in the monetary growth rate itself. The change in the nominal, and indeed real, variables, is less where wealth is included in both the IS and LM equations (case 3).

Where wealth is only included in the LM equation (case 1)

or not at all in the IS/LM equations (case 2), the only real variables affected were real wealth and real money balances. The nominal variables - p, e and w all move equiproportionally, but by less than the rate of change of the monetary growth rate itself. The proportional changes in the nominal variables, is less where wealth is excluded from both the IS and LM equations (case 2).

Dynamic stability, as defined in section 2, required that the wealth variable be included in the IS equation, but did not require inclusion in the money demand equation (LM). The numerical simulation procedure indicated that the adjustment process itself is a prolonged one, for both nominal and real variables, with the exception of inflation and the nominal interest rate. Case 3 produced marginally smaller adjustments of real wealth, capital stock, foreign asset stock and the price level in both steady state and throughout the adjustment process. Hence for the dynamically stable cases (cases 3 and 4) the inclusion of wealth in the money demand equation produced only minor differences in the adjustment process from the case in which it was excluded.

ENDNOTES

1. For an application of this model to oil/resource shocks, see Harvie and Gower (1993).

2. For simplicity P* has been set equal to one. Taking logs this variable then becomes zero.

3. The expected return on domestic bonds, for simplicity, excludes possible capital gains/losses.

4. See Buiter and Miller (1980, 1981).

5. The steady state and dynamic properties, as well as simulation results, presented in this paper, were derived from a numerical solution procedure known as "Saddlepoint". A description of "Saddlepoint" can be found in Austin and Buiter (1982), and its analytical solution is derived and discussed in Buiter (1982).

6. See appendix.

7. See appendix.

8. As emphasised in this paper, which is (e - w).

9. Useful references for this section include Dixit (1980) and Buiter and Miller (1980).

10. The calculations in fact becoming quite unmanageable.

11. From Table 3 it can be observed that for cases 3 and 4 the system produces 1 negative eigenvalue, 2 complex conjugates with negative real parts (indicating cyclical dynamic stability) and 2 positive eigenvalues (imparting instability to the system).

12. These figures confine analysis of the adjustment process to 50 periods only.

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Steady State Properties of the Model
Monetary Growth Rate Case

$$\frac{dy}{dDm} = \frac{\rho_2 r^* \sigma_2 \varepsilon_3 \gamma_2 \Sigma_2 (1 - \alpha) \lambda_2}{\Delta_{DET}}$$

$$\frac{dk}{dDm} = \frac{\rho_2 r^* \sigma_2 \varepsilon_2 \gamma_2 \Sigma_2 (1 - \alpha) \lambda_2}{\Delta_{DET}}$$

$$\frac{dT}{dDm} = \frac{\rho_2 r^* \sigma_2 \gamma_2 \Sigma_2 (\mu_1 \alpha (\varepsilon_3 - \varepsilon_2 \lambda_1) - \varepsilon_3 \mu_2 (1 - \alpha) \lambda_2)}{\Delta_{DET}}$$

$$\frac{dc}{dDm} = \frac{\rho_2 r^* \sigma_2 \gamma_2 \Sigma_2 (\varepsilon_3 - \varepsilon_2 \lambda_1)}{\Delta_{DET}}$$

$$\frac{df}{dDm} = \frac{\sigma_2 \gamma_2 \Sigma_2 (\alpha (1 - \rho_2 - \mu_1 \rho_1)(\varepsilon_3 - \varepsilon_2 \lambda_1) + \rho_1 \varepsilon_3 \mu_2 (1 - \alpha) \lambda_2)}{\Delta_{DET}}$$

$$\frac{dw^e}{dDm} = \frac{-\rho_2 r^* \sigma_2 \gamma_2 (\Sigma_6 (\mu_1 \alpha (\varepsilon_3 - \varepsilon_2 \lambda_1) - \varepsilon_3 \mu_2 (1 - \alpha) \lambda_2) + (1 - \alpha) \lambda_2 (\varepsilon_2 \Sigma_3 \Sigma_4 - \varepsilon_3 (1 - \Sigma_1)))}{\Delta_{DET}}$$

Where,

$$\Delta_{DET} = \gamma_1 \, \Sigma_2 \, \alpha (1 - \rho_2) \, (\epsilon_3 - \epsilon_2 \, \lambda_1)$$

$$+ \; (\rho_2 \, r^* \, \Sigma_6 (1 - \gamma_2 \, \sigma_3) - \gamma_1 \, \Sigma_2 \, \rho_1) \, (\mu_1 \, \alpha \, (\epsilon_3 - \epsilon_2 \, \lambda_1) - \epsilon_3 \, \mu_2 (1 - a) \, \lambda_2)$$

$$+ \; \rho_2 \, r^* \, \Sigma_2 \, (\gamma_1 \, \alpha \, (\epsilon_3 - \epsilon_2 \, \lambda_1) + \epsilon_2 \, \gamma_3 (1 - \alpha) \lambda_2)$$

$$+ \; \rho_2 \, r^* \, (1 - \alpha) \lambda_2 (\epsilon_2 \, \Sigma_3 \, \Sigma_4 - \epsilon_3 (1 - \Sigma_1)) \, (1 - \gamma_2 \, \sigma_3))$$

$$+ \; \rho_2 \, r^* \, \gamma_2 \, \Sigma_2 \, \epsilon_3 \, \sigma_1 \, (1 - \alpha) \lambda_2$$

Table 1 Parameter values

$\Sigma_1 = 0.5$	ϕ_1 - exogenous	$\delta_2 = 0.5$
$\Sigma_2 = 0.1$	$\phi_2 = 0.7$	$\delta_3 = 0.5$
$\Sigma_3 = 0.5$	$\phi_3 = 1.0$	$\gamma_1 = 1.0$
$\Sigma_4 = 0.2$	$\sigma_1 = 1.0$	$\gamma_2 = 1.0$
$\Sigma_5 = 0.8$	$\sigma_2 = 0.5$	$\gamma_3 = 1.0$
$\Sigma_6 = 1.0$	$\sigma_3 = 0.1$	$\mu_1 = 0.5$
$\eta = 0.7$	ϵ_1 - exogenous	$\mu_2 = 0.5$
$\lambda_1 = 0.5$	$\epsilon_2 = 0.5$	$\mu_3 = 0.5$
$\lambda_2 = 0.5$	$\epsilon_3 = 0.5$	$\rho_1 = 1.0$
$\alpha = 0.7$	$\delta_1 = 0.5$	$\rho_2 = 1.0$

Table 2 Steady state properties of the model — Monetary growth expansion (10%)

Variable	Case 1	Case 2	Case 3	Case 4
l	-5.6%	-5.0%	-6.3%	-6.6%
f	0	0	10.1%	10.5%
k	0	0	-0.75%	-0.78%
q	0	0	0	0
c	0	0	-2.5%	-2.6%
r	10.0%	10.0%	10.0%	10.0%
y	0	0	-0.75%	-0.78%
T	0	0	-0.5%	-0.53%
s	0	0	-0.75%	-0.78%
R	0	0	0	0
we	-5.6%	-5.0%	2.0%	2.1%
p	5.6%	5.0%	5.6%	.8%
e	5.6%	5.0%	3.8%	3.9%
w	5.6%	5.0%	6.3%	6.6%
Dp	10.0%	10.0%	10.0%	10.0%
w - p	0	0	0.75%	0.79%

Case 1 - $\Sigma_2 = 0$, $\sigma_3 > 0$
Case 2 - $\Sigma_2 = 0$, $\sigma_3 = 0$
Case 3 - $\Sigma_2 > 0$, $\sigma_3 > 0$
Case 4 - $\Sigma_2 > 0$, $\sigma_3 = 0$

Numbers show the percentage change from baseline.

Table 3   Eigenvalues under different wealth assumptions

	l	f	k	q	c
Case 1					
No wealth in IS equation	-0.37	-0.02	0.05	0.86	3.50
($\Sigma_2 = 0$, $\sigma_3 > 0$)					
Case 2					
No wealth in the IS/LM	-0.39	-0.02	0.05	0.89	3.20
equations					
($\Sigma_2 = 0$, $\sigma_3 = 0$)					
Case 3					
Wealth in the IS/LM	-0.39	-0.04 ± 0.01		0.82	3.75
equations					
($\Sigma_2 > 0$, $\sigma_3 > 0$)					
Case 4					
No wealth in LM equation	-0.42	-0.04 ± 0.02		0.85	3.47
($\Sigma_2 > 0$, $\sigma_3 = 0$)					

Table 4   Model stability — variation in parameter values

$0 \leq \Sigma_1 \leq 1.23$	$0 \leq \varepsilon_2 \leq 0.7$
$0.01 \leq \Sigma_2$	$0.4 \leq \varepsilon_3$
$0 \leq \Sigma_3 \leq 0.8$	$0.1 \leq \delta_1$
$0 \leq \Sigma_4 \leq 34$	$0.5 \leq \gamma_1$
$0 \leq \Sigma_6 \leq 2.5$	$0.2 \leq \mu_1$
$0 \leq \lambda_1 \leq 0.8$	$0 \leq \mu_2 \leq 2.2$
$0 \leq \lambda_2 \leq 1.3$	$0.5 \leq \rho_1$
$0 \leq \sigma_1 \leq 7.5$	$0.8 \leq \rho_2$

Figure 1   Simulation results

Real income

% deviation from baseline

Time

Capital stock

% deviation from baseline

Time
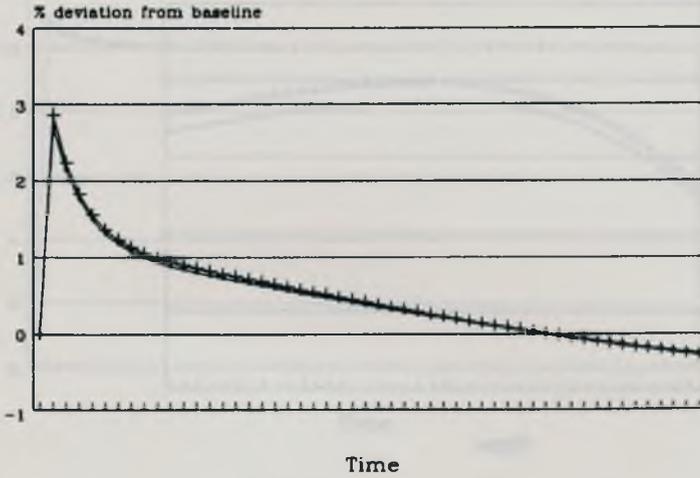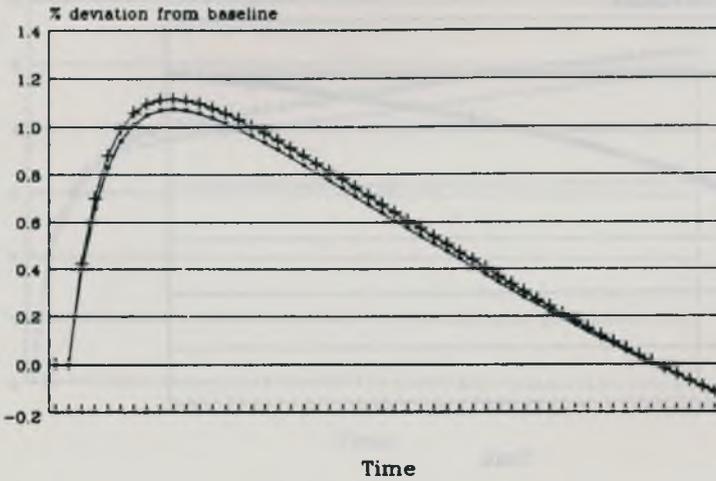
■ Case 3   + Case 4

Figure 1   Simulation results (continued)

Real wealth
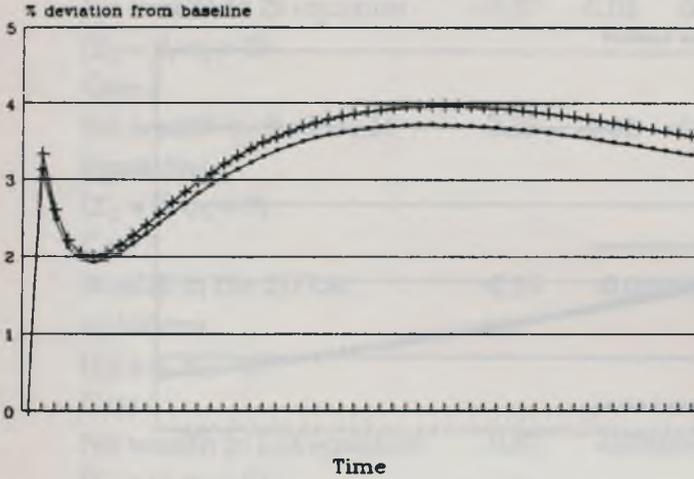
Real wages
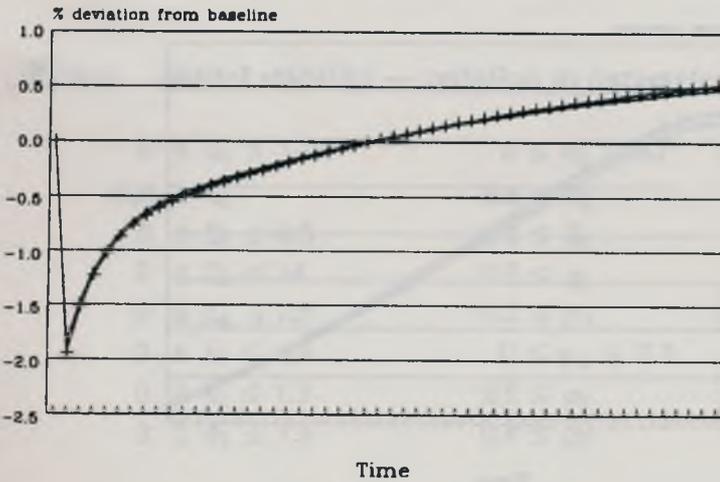
Case 3   Case 4

Figure 1   Simulation results (continued)

Inflation

% deviation from baseline

Time

Price level

% deviation from baseline

Time
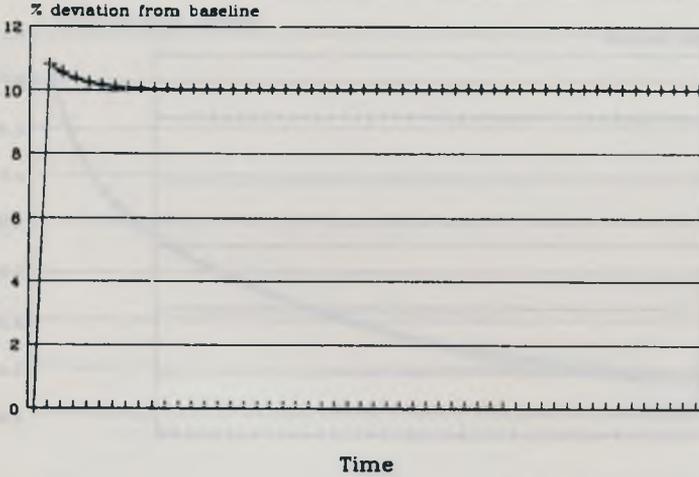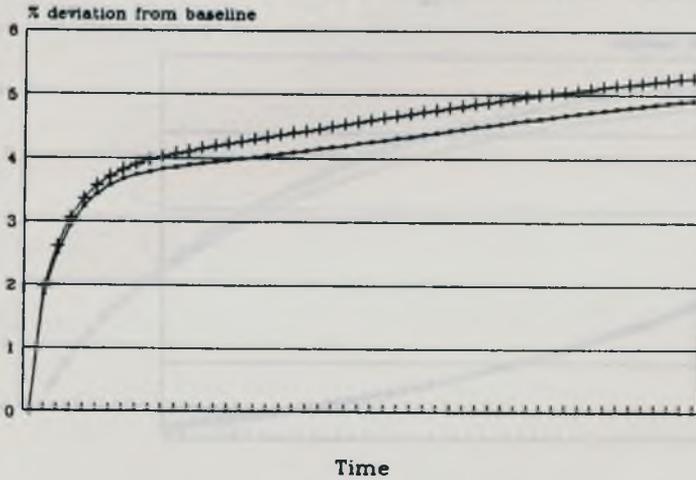
■—Case 3   —+—Case 4

Figure 1   Simulation results (continued)

Nominal interest rate

Time

Real exchange rate

Time

■——Case 3   —+——Case 4
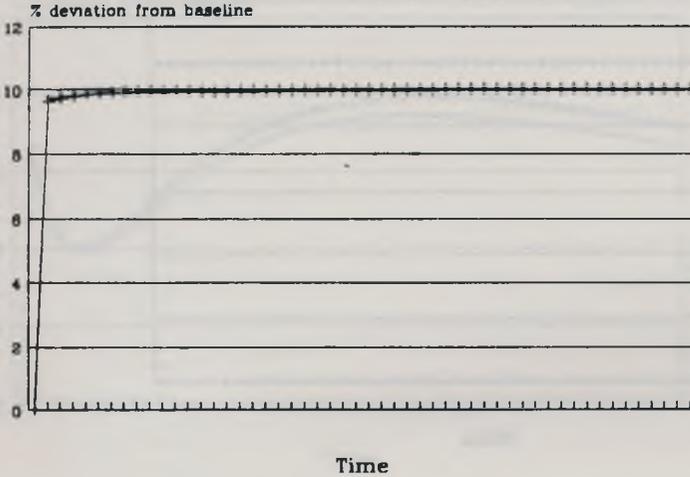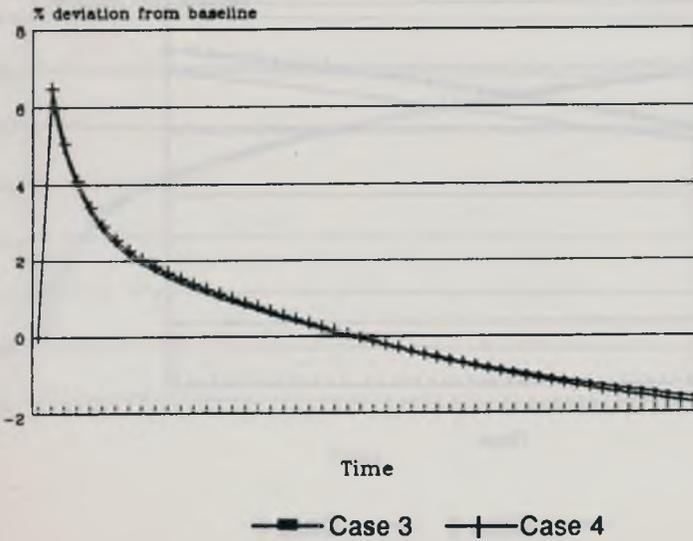
Figure 1   Simulation results (continued)

Trade balance
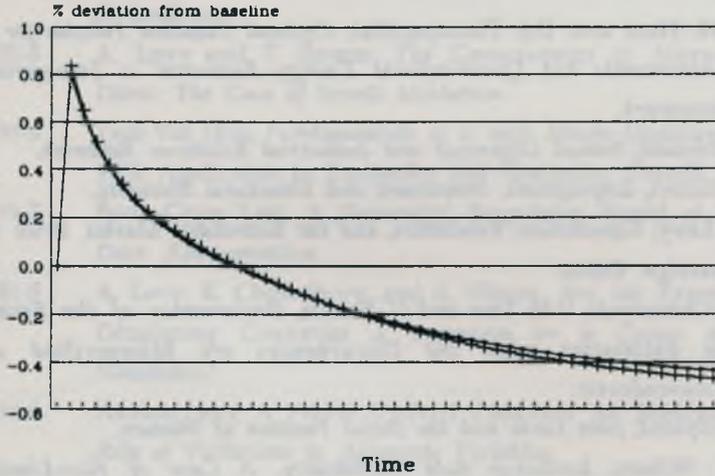
Foreign asset stock

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