International Finance Discussion Papers

Number 225

June 1983

THE IMPACT OF SUPPLY SIDE POLICY RULES ON EXCHANGE RATES, INTEREST RATES AND THE TERMS OF TRADE: AN EXPLORATION UNDER ALTERNATIVE PRICE RULES

by

Colin Lawrence*

I. Introduction

In the 1970s all major industrialized nations experienced a universal but nonuniform decline in productivity.[1] There were also a number of perplexing violations of purchasing power parity accompanied by significant shifts in the terms of trade between major trading partners.[2] Policy decision making shifted from the traditional fiscal-monetary mix towards supply side policies oriented towards revitalizing industrial sectors.

This paper explores how exogenous shifts in the rate of disembodied technical progress and exogenous supply side policies affect the exchange rate, the terms of trade, the nominal interest rate and the anticipated real rate of return. In particular the analysis focuses on the uncertainty as to whether agents perceive the supply shock to be permanent or not. I consider the role of sudden credible policies designed to improve productivity. The type of pricing rule adopted by agents in an uncertain environment is shown to play a central role in determining how domestic and international markets respond to supply shocks. For example if all prices are fully flexible, more credible supply side policy rules will induce less volatility in both nominal and real interest rates than less credible policy regimes. Also, credible policy rules will make both the exchange rate and nominal interest rate relatively more volatile under price contracts than under full price flexibility.

A further purpose is to investigate how supply side shocks influence the dynamic paths of the exchange rate and the terms of trade under different pricing rules. Earlier Keynesian models pioneered by Meade (1951) synthesized Joan Robinson's partial equilibrium elasticity approach to foreign exchange markets with the closed economy Keynesian paradigm.[3] This framework has recently been adopted by a growing literature concerned with the effects of imported price disturbances (such as oil) on output, the exchange rate and inflation [for example, Findlay and Rodriguez (1977), Buiter (1978) and Katseli (1980)]. These Keynesian models postulate that elasticity conditions underlying the demands and supplies of international goods play an important role in describing how imported intermediate good prices affect the exchange rate. This result contrasts sharply with the monetary approach to the exchange rate [for example, Mundell (1968)] which views the exchange rate as the relative price of national monies.[4] These models postulate that positive supply shocks would appreciate the exchange rate irrespective of elasticity conditions.[5] The above Keynesian and monetary results are derived from a particular set of restrictive assumptions. The Keynesian models generally assume short run price rigidities and ad hoc expectations, whereas the monetary models abstract from imperfect substitution in consumption.

In the light of this controversy, I readdress the question as to whether or not the Marshall Lerner (M-L) elasticity condition is at all relevant in explaining the dynamics of exchange rate behavior in response to nonuniform (across countries) supply shocks. This is explored under different information structures and pricing rules adopted by rational agents facing uncertainty. Ironically if the supply shock is regarded as transient and if domestic (nominal) prices are set by contracts, the M-L elasticity condition is irrelevant in determining the exchange rate path.[6] However, this case is an exception. If the shock is regarded as permanent, elasticity conditions would again play a role under a regime of price contracts. Moreover, if prices were flexible, then regardless of the perceived persistence of the shock and imperfections in current information, the M-L elasticity condition would again be central in explaining the equilibrium paths of the exchange rate and domestic interest rate.[7] In fact, the M-L condition is <u>sufficient</u> to guarantee that positive (negative) supply shocks will appreciate (depreciate) the exchange rate regardless of the underlying information structure, the pricing rule and the perceived permanence of the shock.

A further issue addressed here is the covariation between the exchange rate, the terms of trade and deviations from purchasing power parity.[8] Under flexible prices and full current information, I show that the M-L elasticity condition is a necessary and sufficient condition to guarantee that a slowdown (increase) in productivity would simultaneously <u>depreciate</u> (appreciate) the exchange rate and <u>improve</u> the domestic terms of trade. This suggests that the exchange rate cannot be expected to play a role in accommodating terms of trade shifts in response to supply shocks. Thus, under flexible prices, supply shocks will induce more short run volatility in the domestic price level than the exchange rate if the M-L elasticity condition holds.

The structure of this paper is as follows. Section II develops the model of a quasi small open economy under fully flexible prices. Section III reexamines the basic postulates developed in I under anticipatory pricing in the form of one period ahead nominal price contracts. Section IV introduces imperfect information and endogenous output behavior. The conclusion summarizes the main findings of the paper.

II. A Classical Model

a. Structural Equations

A quasi small open economy is fully specialized in the production of good x. Domestic agents consume x, an imported good, y and are net exporters of x. While the economy has a large share of the world x market, it is small in the imported good, $\bar{y}$ market. Agents hold their existing wealth in the form of domestic real balances, domestic bonds and foreign bonds. The home country is also small in the world capital market and in terms of risk default, domestic and foreign bonds are perfectly substitutable.

The supply of output x is exogenous to the model and its stochastic deviation from trend growth is a result of a supply side policy rule adopted by the fiscal authorities as well as random disturbances such as disembodied technical growth.[1] I adopt a version of Muth's (1960) statistical model, as presented in Sargent (1979), to represent this output process. The output model is as follows:

2.1 $$\tilde{x}_t = \tilde{x}_{t-1} + v_t$$

2.2 $$x_t^s = \tilde{x}_t + \varepsilon_t$$

$$Ev_t = E\varepsilon_t = 0$$

$$Ev_t v_s = E\varepsilon_t\varepsilon_s = Ev_t\varepsilon_s = 0 \qquad \text{for all } s,\ t \quad s \neq t.$$

$$Ev_t v_t = \sigma_v^2;\ E\varepsilon_t\varepsilon_t = \sigma_\varepsilon^2$$

x_t^s is measured output, $\tilde{x}_t$ is permanent output, while ε_t is transient output. Both ε_t and v_t are each stationary, serially uncorrelated random processes with mean 0 and variances σ_v^2 and σ_ε^2 respectively. The two processes are orthogonal at all lags. v_t is a persistent disturbance as described by the random walk in equation (2.1), while ε_t is a temporary disturbance. Agents cannot directly observe $\tilde{x}_t$, v_t or ε_t. The only output information available to them is the current and past levels of measured output as well as policy announcements by the fiscal authorities. According to Wold's theorem there exists a random variable u_t which obeys

2.3 $$u_t - \rho u_{t-1} = \varepsilon_t - \varepsilon_{t-1} + v_t, \qquad 0 \leqq \rho \leqq 1,$$

where u_t us a stationary serially uncorrelated random process with mean zero and variance, σ_u^2. ρ is defined as follows,[2]

$$\rho = 1 + \tfrac{1}{2}\left(\frac{\sigma_v^2}{\sigma_\varepsilon^2}\right) - \sqrt{\frac{\sigma_v^2}{\sigma_\varepsilon^2}\left(1 + \tfrac{1}{4}\,\frac{\sigma_v^2}{\sigma_\varepsilon^2}\right)}\ .$$

By substitution of (2.3) into (2.1) and (2.2) and by extensive manipulation, output x can be described as,

2.4 $$x_t^s = x_{t-1}^s - \rho u_{t-1} + u_t .$$

By differentiation of ρ with respect to $\sigma_v^2/\sigma_\varepsilon^2$ the following can be shown:

$$\frac{\partial\rho}{\partial\frac{\sigma_v^2}{\sigma_\varepsilon^2}} < 0, \qquad \lim_{\frac{\sigma_v^2}{\sigma_\varepsilon^2}\to 0} \rho = 1 \quad \text{and} \quad \lim_{\frac{\sigma_v^2}{\sigma_\varepsilon^2}\to \infty} \rho = 0.$$

ρ represents the fraction of the disturbance u_t that agents regard as transitory and $(1 - \rho)$ is the fraction of u_t agents regard as permanent. ρ can thus be interpreted as agents' evaluation of a supply side policy rule.[3] The process described in (2.4) reflects a sudden supply side policy regime in which the government announces that it will permanently stimulate economic growth by means of various fiscal measures and agents are uncertain as to the ability of the government to sustain such a policy. A policy rule designed to stimulate output permanently is credible if agents attach a value close to zero for ρ. Alternatively, (2.4) can represent disembodied technical shifts in productivity and agents' uncertainty regarding the permanence of the shock. An important part of the analysis will be to focus on how the credibility of policy as measured by ρ affects the impact of sudden supply side policy shocks on the exchange rate, the terms of trade and financial markets.

Real income, I_t is the value of domestic product less the value of servicing the net external debt. For simplicity I assume that the share of debt service relative to output is very small so that it can be ignored. I_t is then approximated as

2.5 $$I_t \simeq x_t^s + P_{xt} - P_t ,$$

where P_{xt} is the nominal price of x and P_t is the price deflator, defined as a weighted average of the nominal prices of x and the imported good, y. The weights are the shares of consumption out of total domestic absorption, B_t. P_t is defined as,

2.6 $$P_t = \theta P_{xt} + (1 - \theta)P_{yt} \qquad 0 \leqq \theta \leqq 1,$$

where P_{yt} is the nominal price of the imported product y. Substitution of (2.6) into (2.5) yields,

2.7 $$I_t = x_t^s - (1 - \theta)\lambda_t$$

where $\lambda_t \equiv P_{yt} - P_{xt}$ is the terms of trade -- the price of foreign goods in terms of home goods. Aggregate domestic absorption depends negatively on the anticipated real rate of return (to be defined below) and positively on real income, I_t:

2.8 $$B_t = - \delta_1 r_t + \delta_2 I_t \qquad \delta_1, \delta_2 > 0.$$

If the real rate of return rises (ceteris paribus) future consumption will become cheaper and agents will substitute out of domestic consumption into future consumption. δ_2 is the elasticity of absorption with respect to current income. r_t is defined as the difference between the nominal yield (on one period domestic financial assets) and anticipated inflation based on information at time t,

2.9 $$r_t = i_t - (E_t P_{t+1} - P_t)$$

where E_t is the conditional expectation based on information at time t.[4] Each period agents determine how much of their current absorption to allocate between domestic goods and foreign goods. The demands for x and y by home residents are derived from a C.E.S. utility function approximated in logs. These are respectively,

2.10 $$x_t^d = \alpha_2 \lambda_t + B_t \qquad \alpha_2 > 0$$

2.11 $\quad y_t^d = -\beta\lambda_t + B_t \qquad \beta > 0$.

The export supply schedule can be approximated (around the steady state) as $x = \psi(x^s - \theta x^d)$, where $\psi = (1 - \theta)^{-1}$. Using (2.1) and (2.10) this is,

2.12 $\quad x_t = -\theta\alpha_2\psi\lambda_t - \psi\theta B_t + \psi x_t^s$.

The foreign demand for home goods x^* depends positively on the terms of trade,[5]

2.13 $\quad x_t^* = \psi\alpha_2^*\lambda_t \qquad \psi\alpha_2^* > 0$.

Because the home country is small in the world y market, the price of y in foreign currency, P_y^* is exogenous to the home economy. Equations (2.1) - (2.13) describe the real side of the economy.

The money demand equation for domestic agents depends inversely on i_t and positively on x_t^s. The schedule is depicted as[6]

2.14 $\quad M_t^d = Px_t + x_t^s - bi_t \qquad b > 0$.

2.14 is the liquidity preference schedule along which agents optimally allocate their existing stock of wealth between interest bearing assets (domestic and foreign bonds) and noninterest bearing money.[7] Domestic and foreign bonds are perfect substitutes so that uncovered interest arbitrage holds at all times,

2.15 $\quad i_t = i_t^* + E_te_{t+1} - e_t$,

where e_t is the spot exchange rate defined as the unit price of foreign currency in terms of domestic currency. The foreign exchange market is fully flexible with no central bank intervention. $E_te_{t+1} - e_t$ is the expected rate of domestic currency depreciation based on information at time t. Any deviation from (2.15) will induce incipient international capital flows in the absence of government intervention.

Both the x and y market are perfectly arbitraged so that the law of one price holds for each good,

2.16 $\quad Px_t = Px_t^* + e_t$; and $Py_t = Py_t^* + e_t$.

Analogous to the price deflator P_t defined in (2.3), is the foreign price deflator, P^*_t,

2.17 $$P^*_t = \theta^* Px^*_t + (1 - \theta^*)Py^*_t \qquad 0 \leqq \theta^* \leqq 1.$$

Substitute (2.6) into (2.17) and (2.16) and obtain[8]

2.18 $$P_t - P^*_t - e_t = (\theta^* - \theta)\lambda_t.$$

2.19 says that deviations from purchasing power parity will exist and providing domestic agents have a greater preference for home relative to foreign goods, these deviations will be inversely related to the terms of trade, λ_t.

b. Equilibrium Conditions

The money market clears so that

2.20 $$M_t = M^d_t.$$

The supply of exports in (2.12) is equal to the demand for exports (2.20),

2.21 $$x_t = x^*_t.$$

(2.20) and (2.21) together with the interest parity condition (2.15) fully characterize equilibrium for the quasi small open economy. There is one more implied condition -- the interest parity equation (2.15) together with the deviations from PPP equation (2.18) imply that real rates of return will be equalized across countries only after adjusting for capital gains:

2.22 $$r_t = r^*_t + \theta(E_t\lambda_{t+1} - \lambda_t),$$

where $E_t\lambda_{t+1} - \lambda_t$ is the anticipated deterioration in the home country's terms of trade.[9]

c. The Solution

The model has two state variables, e_t and λ_t, which are functions of lagged and current output, u_t and the parameter ρ. Substitute the structural equations (2.12) and (2.13) into (2.21) and obtain

2.23 $\phi\lambda_t - \theta\delta_1 r_t - (1 - \theta\delta_2)x_t^s = 0$

where $\phi = \theta\alpha_2 + \alpha_2^* - \delta_2\theta(1 - \theta)$.

ϕ is the elasticity of the world excess demand for x_t with respect to λ_t. $\theta\alpha_2 + \alpha_2^*$ is the substitution effect while $\delta_2\theta(1 - \theta)$ represents the income effect. Throughout this paper I will assume that the substitution effect dominates the income effect, so that $\phi > 0$. Any supply disturbance must be met by either an adjustment in the real rate of return or in the terms of trade. A positive supply shock, $u_t > 0$ will initially raise real income and agents will increase their demand for the home product by $\delta_2 u_t$ according to the absorption effect. The excess supply $(1 - \theta\delta_2)u_t$ will induce a reduction in r_t or a worsening of the home terms of trade ($\lambda_t > 0$), so as to restore equilibrium.

The equilibrium condition in the money market is found by substituting the interest parity condition (2.15) into (2.14) and solving (2.20). By suppressing i* and M, this condition is,

2.24 $Px_t + x_t^s - b(E_t e_{t+1} - e_t) = 0.$

If the supply shock is positive, portfolio equilibrium will be restored by either a reduction in Px or/and an anticipated depreciation of domestic currency. Both of these adjustments would offset the initial increase in the transaction demand for money in the absence of monetary accommodation.

The solution of the model is found by utilizing the method of undetermined coefficients.[10] The dynamic paths of e_t and Px_t are as follows:[11]

2.25 $$Px_t = (1 - \rho)\sum_{j=0}^{\infty}\rho^j x_{t-1-j}^s - A_1^{-1}(1 + b)^{-1}[b\rho(1 - \theta\delta_2) + A_1 Z]u_t,$$ for all t

2.26 $$e_t = \phi^{-1}(1 - \theta\delta_2 - \phi)(1 - \rho)\sum_{j=0}^{\infty}\rho^j x_{t-1-j}^s$$

$$+ \phi^{-1}(1 + b)^{-1}A_1^{-1}[A_1 Z(1 - \theta\delta_2 - \phi) - \rho\delta_1\theta^2(1 - \theta\delta_2)]u_t,$$ for all t

where $A_1 = \phi + \delta_1\theta^2$ and $Z = 1 + b(1 - \rho)$.

λ_t can be derived by subtracting (2.25) from (2.26),

$$\text{2.27} \qquad \lambda_t = \frac{1 - \theta\delta_2}{\phi}[(1 - \rho)\sum_{j=0}^{\infty}\rho^j x^s_{t-j-1} + A \cdot A_1^{-1} u_t] \quad \text{for all } t$$

where $A = \phi + (1 - \rho)\delta_1\theta^2 \equiv A_1 - \delta_1\theta^2$

(2.25) supports the intuitive assertion that a negative (positive) supply shock, $u_t < 0$ (>0) will raise (lower) the nominal price of home goods. Moreover, according to (2.27) a negative (positive) supply shock will improve (worsen) the home country's terms of trade. In both the above cases, if the shock is perceived as permanent (i.e. $\rho = 0$), the adjustment to the long run is immediate. If the shock is nonpermanent $\rho \neq 0$, the intial response in Px_t, e_t and λ_t will be gradually reversed towards the initial equilibrium according to the decay function $(1 - \rho L)$.[12] Equation (2.26) shows that the movement in the exchange rate is ambiguous depending upon a general equilibrium Marshall Lerner (M-L) condition. Inspection of (2.26) implies that the condition $1 - \theta\delta_2 - \phi < 0$ $(\theta\alpha_2 + \alpha_2^* + \theta^2\delta_2 > 1)$ is sufficient (but not necessary) to guarantee that a positive supply side shock will appreciate domestic currency.[13] By noting the definition of ϕ, a sufficient condition for appreciation in response to a positive supply shock is that the sum of domestic and foreign demand elasticities be greater than unity (i.e. $\theta\alpha_2 + \alpha_2^* > 1$) -- <u>the traditional Marshall Lerner condition</u>.

The discussion above shows that <u>as long as $1 - \theta\delta_2 - A_1 < 0$ a positive supply shock will strengthen domestic currency while concommitantly worsening the terms of trade. This implies that given high enough demand elasticities</u> [i.e. <u>$A_1 > (1 - \theta\delta_2)$</u>] <u>supply shocks induce more short run volatility in domestic money prices than the exchange rate so as to achieve the new equilibrium terms of trade</u>.[14] The covariation between the exchange rate and the terms of trade in a frictionless economy could be either negative or positive depending on elasticity conditions. If the M-L elasticity condition holds ($A_1 > 1 - \theta\delta_2$), the above covariance is independent of the degree of permanence agents attach to the underlying movement in output.[15] If $1 - \theta\delta_2 - A_1 < 0$ a negative supply shock will depreciate the exchange rate as well as raise Px_t such that the measured price level will unambiguously rise. Thus the elasticities of goods entering international trade play a key role in the determination of domestic inflation. Finally, by subsitution of the dynamic path λ_t, (2.27) in (2.28) deviations from purchasing power parity can be derived,

2.28 $$P_t - P_t^* - e_t = (\theta^* - \theta)(1 - \theta\delta_2)\phi^{-1}[(1 - \rho)\sum_{j=0}^{\infty}\rho^j x_{t-1-j}^s + A\cdot A_1^{-1}u_t].$$

As long as $\theta^* \neq \theta$ and agents perceive supply side policy as nontransient ($\rho \neq 1$) then a sudden policy shock will induce deviations from PPP which persist.[16]

d. <u>Nominal and Real Interest Rates</u>

Agents' optimal forecast of the terms of trade in the following period can be found by leading (2.27) forward by one period,

$$\lambda_{t+1} = (1 - \theta\delta_2)\phi^{-1}[(1 - \rho)\sum_{j=0}^{\infty}\rho^j x_{t-j}^s + AA_1^{-1}u_{t+1}].$$

By taking the conditional expectation of λ_{t+1}, I obtain[17]

$$E_t\lambda_{t+1} = (1 - \theta\delta_2)\phi^{-1}[(1 - \rho)\sum_{j=0}^{\infty}\rho^j x_{t-j}^s], \text{ since } E_t u_{t+1} = 0.$$

The real rate of return r_t defined in (2.22) is then

2.28 $$r_t = \theta(E_t\lambda_{t+1} - \lambda_t) = -\theta\rho(1 - \theta\delta_2)A_1^{-1}u_t \qquad \text{for all } t.$$

All the lagged terms disappear since agents optimally forecast a once and for all permanent supply shock equal to $(1 - \rho)u_t$. In an analogous fashion the nominal yield i_t can be found by substituting (2.26) into the interest parity condition (2.15). The solution is,

2.29 $\quad i_t = - \rho(1 + b)^{-1}A_1^{-1}(1 - \theta\delta_2 - A_1)u_t \quad$ for all t.

Interest rate fluctuation in response to sudden supply side policies depend critically on the credibility of the policy. If a shock is perceived as permanent, according to (2.28) and (2.29), agents believe that Px_t, e_t and λ_t will adjust instantaneously to the new long run steady state.[18] Thus for $\rho = 0$, the supply policy will not induce any response in i_t and r_t. In contrast, government policies which lack credibility ($\rho \neq 0$) will induce volatility in both real and nominal rates. If a positive contemporaneous shock were regarded as transient, agents would anticipate an improvement in the terms of trade as the shock decayed and r_t would consequently decline according to (2.28). The nominal yield i_t could move either way depending again on the general equilibrium M-L condition. If $1 - \theta\delta_2 - \phi > 0$ (<0) agents will anticipate currency appreciation (depreciation) as the supply shock decays and as a consequence, i_t will decline (rise). Thus in the event of supply side policy rules lacking credibility, prices would all be expected to revert back to their previous steady state levels creating volatility in financial markets as well as in intertemporal plans of savings and investment. The terms of trade movement (2.27) becomes more pronounced when the disturbance is perceived as permanent. The reason being that λ_t bears the full burden of equilibrating the goods market in the absence of a real rate of return effect. The impact of ρ on the paths of Px_t and e_t in response to a supply shock is generally ambiguous. If however the Marshall Lerner elasticity condition holds ($1 - \theta\delta_2 - \phi < 0$) a positive supply shock will lead to a decline in i_t if $\rho \neq 0$. This will reinforce the transaction demand for money and the adjustment in Px_t would be stronger in contrast to a permanent shock. Thus if the M-L elasticity condition holds, supply side policies which are credible induce less volatility in domestic nominal prices than credible policies.[19]

III. Price Contracts

Each period agents negotiate one period (ahead) contracts set at the ex ante market clearing price based on information one period earlier. Although Px_t is not "rigid," since contracts are renegotiated period after period, it is invariant to contemporaneous disturbances.[1] The above anticipatory pricing mechanism implies the following path for Px_t,

3.1 $$Px_t = E_{t-1}Px_t.$$

The equilibrium condition for exports (2.21) is replaced by the ex ante market clearing condition,[2]

3.2 $$E_{t-1}x_t = E_{t-1}x_t^*.$$

The solution to the system is found by replacing (2.21) with (3.2), and solving using the method of undetermined coefficients.[3] The solution is,[4]

3.3 $$e_t = \phi^{-1}(1 - \theta\delta_2 - \phi)(1 - \rho) \sum_{j=0}^{\infty} \rho^j x_{t-1-j}^s + [(1 - \theta\delta_2 - \phi)\phi^{-1}(1 - \rho) - b^{-1}]u_t,$$

3.4 $$\lambda_t = (1 - \theta\delta_2)\phi^{-1}(1 - \rho) \sum_{j=0}^{\infty} \rho^j x_{t-1-j}^s + [(1 - \theta\delta_2 - \phi)\phi^{-1}(1 - \rho) - b^{-1}]u_t.$$

The distributed lags of x_{t-1}^s on e_t and λ_t are identical to the classical case, since contracts are renegotiated period after period. In the current period the exchange rate is the terms of trade, since Px_t is invariant to u_t. One role of e_t is to clear the money market (2.20) in the absence of a Px adjustment. In the absence of monetary accommodation, an increase (decrease) in the demand for money due to a positive (negative) supply shock must be unambiguously met by a rise (fall) in i_t, namely the anticipated rate of domestic currency depreciation (appreciation).[5] If agents believe that the supply shock is temporary ($\rho = 1$), an output expansion will necessarily appreciate the spot exchange rate as seen by inspection of (3.3). The movement in e_t is greater, the lower the interest elasticity in the demand for money and is independent of M-L elasticity conditions. However, if a policy rule has credibility ($\rho = 1$), again M-L elasticity conditions become important. A sufficient condition to guarantee appreciation is the same as the flexible case condition, namely, $1 - \theta\delta_2 - \phi < 0$.

The validity of e_t relative to the flexible price case is generally ambiguous and depends again on elasticity conditions. There are four propositions:

(1) If the shock is perceived as permanent ($\rho = 0$), the M-L condition $(1 - \theta\delta_2 - \phi) < 0$ is sufficient (but not necessary) to guarantee that e_t will exhibit more volatile behavior in the sticky price relative to the flexible price case.[6]

(2) If the shock is transient ($\rho = 1$), the sticky price model will exhibit more volatile exchange rate behavior if $1/b + 1 > |1 - \theta\delta_2 - A_1|A_1^{-1}$.

(3) If the shock is permanent ($\rho = 0$) and if the exchange rate depreciated in response to a positive supply shock, the terms of trade λ_t will be less volatile under sticky prices.[7]

(4) If the shock is transient, the sticky price model will exhibit more (less) volatile terms of trade behavior if $b^{-1} > (1 - \theta\delta_2)A^{-1}$ ($b^{-1} <$ $(1 - \theta\delta_2)A^{-1}$).

b. Interest Rates

Since contracts are renegotiated at the end of each period, the newly negotiated contracts ($E_t Px_{t+1}$) will incorporate contemporaneous disturbances. Agents' forecasts of λ_{t+1} and e_{t+1} will be identical to the classical case derived in section II. The solution of i_t can be derived directly from (2.20),

3.5 $$i_t = b^{-1}u_t.$$

i_t will decline in response to a positive supply shock irrespective of agents' assessment of credibility. This contrasts sharply with the classical results of section II. A supply shock effects the demand for money and i_t is the only variable free to equilibrate the money market.[8] Recalling that permanent disturbances ($\rho = 0$) have no impact on i_t under flexible prices, then price contracting induces greater volatility in interest rates under credible policy regimes. Comparing (3.3) with (3.5) a statement concerning overshooting can be deduced. If the M-L condition holds ($1 - \theta\delta_2 - \phi < 0$), a supply shock will necessarily induce overshooting of the exchange rate for credible policy regimes. A productivity expansion would appreciate e_t by more than the anticipated appreciation so as to raise the nominal interest rate.

r_t can be found by leading (3.4) forward by 1 period and taking the conditional expectation,

3.6 $$E_t\lambda_{t+1} = (1 - \theta\delta_2)\phi^{-1}(1 - \rho)(1 - \rho L)^{-1}x_{t-1} + (1 - \theta\delta_2)\phi^{-1}(1 - \rho)u_t.$$

Subtract (3.4) from (3.6) and obtain,

3.7 $$r_t = \theta(E_t\lambda_{t+1} - \lambda_t) = \theta[1 - \rho + b^{-1}]u_t.$$

r_t will unambiguously rise (fall) in response to a positive (negative) supply shock irrespective of agents' beliefs concerning ρ, since agents anticipate a worsening of the home terms of trade. If $\rho = 0$, overshooting of the terms of trade can never occur, since agents believe that the terms of trade (3.7) will worsen irrespective of the initial movement in λ_t, (3.4).

IV. Endogenous Output Supply and Imperfect Information

a. The Structure

Domestic output is produced in decentralized markets, where producers cannot directly observe the realized dispersion of prices across their competitors. When current prices observed by the firm fall below (rise above) the perceived average of competitors' prices, the firm will contract (expand) output. This is a cyclical phenomenon which disappears in the long run (Lucas 1972, 1973). The above supply curve is depicted as,[1]

4.1 $$Q_t = \gamma(Px_t - E_{t-1}Px_t) + x^s_t,$$

where γ is a coefficient depending on the covariance structure of stochastic shocks and x^s_t is defined according to 2.1.[2]

b. The Solution

Equation (4.1) is added to equation (2.1). Exports are redefined as $x = \psi(Q - \theta x^d)$. The system is again solved using the method of undetermined coefficients. The solution is,

4.2 $$Px_t = (1 - \rho)\sum_{j=0}^{\infty} \rho^j x^s_{t-1-j} - \Delta^{-1}[b\rho(1 - \theta\delta_2) + A_1 Z]u_t,$$

4.3 $$e_t = \phi^{-1}(1 - \theta\delta_2 - \phi)(1 - \rho)\sum_{j=0}^{\infty} \rho^j x^s_{t-1-j}$$

$$+ \phi^{-1}\Delta^{-1}\{[A_1 Z(1 - \theta\delta_2 - \phi) - \rho\delta_1\theta^2(1 - \theta\delta_2)]$$

$$+ \gamma(1 - \theta\delta_2)(1 - \rho)[b(1 - \theta\delta_2 - A_1) + (1 + b)\delta_1\theta^2]\}u_t$$

and

$$4.4 \qquad \lambda_t = \frac{1 - \theta\delta_2}{\phi}\{(1 - \rho)\sum_{j=0}^{\infty}\rho^j x_{t-1-j}$$

$$+ \Delta^{-1}\left[(1 + b)A + \gamma(1 - \rho)[b(1 - \theta\delta_2 - A_1) + (1 + b)\theta^2\delta_1]\right]\}u_t$$

where: $A_1 = \phi + \theta^2\delta_1$, $A = A_1 - \rho\delta_1\theta^2$, $z = 1 + b(1 - \rho)$,

$\Delta = (1 + b)A_1 + \gamma(A_1 + b(1 - \theta\delta_2))$.

Since the imperfect information disappears in the long run, the distributed lags on past values of x_t are identical to the classical case. Px_t will again decline (rise) in response to a positive (negative) supply shock. However, the imperfect information will tend to reduce the volatility of Px_t. Initially, firms respond to lower prices (relative to competitors' price) by reducing output. The demand for money then rises by less than in the classical case for any given nominal rate.[4] Interest rates will also be influenced by the cyclical output effect. The solution for the two polar cases is as follows:

$$4.5 \qquad r_t = \begin{cases} \gamma\theta(1 - \theta\delta_2)(1 + b)\Delta^{-1}u_t & \text{for } \rho = 0, \\ -\theta(1 - \theta\delta_2)(1 + b)\Delta^{-1}u_t & \text{for } \rho = 1. \end{cases}$$

$$4.6 \qquad i_t = \begin{cases} \gamma(1 - \theta\delta_2 - A_1)\Delta^{-1}u_t & \text{for } \rho = 0, \\ -(1 - \theta\delta_2 - A_1)\Delta^{-1}u_t & \text{for } \rho = 1. \end{cases}$$

c. The Terms of Trade

The coefficient γ enters both the numerator and denominator of the equilibrium paths in (4.3) and (4.4). Thus the effect of the endogenous supply response on the direction and volatility of e_t and λ_t is in general ambiguous without prior restrictions on the parameters. The expressions $b\gamma(1 - \theta\delta_2)(1 - \rho)(1 - \theta\delta_2 - A_1)$ and $\gamma(1 - \theta\delta_2)(1 - \rho)(1 + b)\delta_1\theta^2$ in the numerator of (4.3) and (4.4) reflect adjustments in e_t and λ_t created by changes in i_t and r_t.[5] If agents perceive the shock to be temporary ($\rho = 1$) these expressions will be zero and γ will then appear only in the denominators of (4.3) and (4.4). Thus if the supply shock is temporary, imperfect information will reduce the volatility of λ_t and e_t ($\partial \mathrm{Var}\ \lambda_t/\partial\gamma < 0$ and $\partial \mathrm{Var}\ e_t/\partial\gamma < 0$ for $\rho = 1$).

The derivative $\partial\lambda_t/\partial u_t$ is also ambiguous. If the shock is transient ($\rho = 1$) then $\partial\lambda_t/\partial u_t > 0$ so that a temporary positive supply shock will worsen the terms of trade as in the classical case.

When the shock is nontransient $\rho \neq 1$ and if $\partial i_t/\partial u_t < 0$ ($1 - \theta\delta_2 - A_1 < 0$), $\partial\lambda_t/\partial u_t$ is ambiguous.[7] However, if $1 - \theta\delta_2 - A_1 > 0$ and $\partial i_t/\partial u_t > 0$ then a positive supply shock will worsen the terms of trade ($\partial\lambda_t/\partial u_t > 0$). A necessary and sufficient condition for the terms of trade to deteriorate in the case of a permanent supply shock, is $A_1 > \gamma(\psi\mu - \delta_1\theta^2)$ where $\psi = b/(1 + b)$ and $\mu = -(1 - \theta\delta_2 - A_1)$. As long as $\partial Q_t/\partial u_t > 0$, this condition will always be satisfied.[8] If $\partial Q_t/\partial u_t > 0$, then imperfect information will reduce the volatility of the terms of trade, regardless of the value agents attach to ρ. The intuition is that suppliers initially react to the supply shock by reducing output in response to a perceived real price decline, offsetting the primary disturbance.[9]

d. The Exchange Rate and Nominal Interest Rate

As noted in section c, if $\rho = 1$, imperfect information will unambiguously reduce the volatility of the exchange rate ($\partial \mathrm{Var}\ e/\partial\gamma < 0$). Since i_t is the anticipated rate of depreciation then the above conclusion also applies to i_t that is $\partial \mathrm{Var}\ i_t/\partial\gamma < 0$ as seen in equation (4.6). The endogenous supply response reduces both the volatility of e_t and i_t for policy shocks perceived to be temporary.

For nontransitory supply shocks, imperfect information introduces a further real interest rate and nominal interest rate effect as noted in section

c. By comparing (4.3) with (4.4), these interest rate changes have an identical impact on e_t and λ_t. Thus despite the flexibility of Px_t, interest rate fluctuations induced by the endogenous supply response lead to mirror movements in e_t and λ_t. In the presence of these latter effects, the volatility and direction of e_t (relative to the classical case) are ambiguous. Since i_t is unresponsive to u_t when $\rho = 0$ in the classical case, the endogenous supply response due to imperfect information makes i_t more volatile.

M-L elasticity conditions are important in explaining the direction and volatility of the exchange rate response to a supply shock in the presence of imperfect information. If $1 - \theta\delta_2 - A_1 > 0$ then the exchange rate will depreciate and the nominal interest rate will rise in response to a positive and permanent supply shock. Since $E_t e_{t+1}$ is the same as in the classical case, then e_t must be less volatile under imperfect information relative to the classical model.[10] If on the other hand $1 - \theta\delta_2 - A_1 < 0$ and $|1 - \theta\delta_2 - A_1| > (1 + b)b^{-1}\delta_1\theta^2$, the exchange rate will appreciate, the nominal rate will fall and thus again e_t is less volatile than the classical case.[11] If $1 - \theta\delta_2 - A_1 < 0$ and the exchange rate depreciates ($\partial e_t/\partial u_t > 0$), the exchange rate will overshoot its long run equilibrium and will be more volatile than in the classical case.

e. The Real Rate of Return

When the shock is transitory, r_t declines as agents anticipate an improvement in the terms of trade. Imperfect information leads agents to believe that next period, production will expand as Px_t catches up to $E_{t-1}Px_t$. This reduces the derivative $|\partial r_t/\partial u_t|$ and therefore for $\rho = 1$, imperfect information reduces the volatility of r_t. When $\rho = 0$, the classical case implied that λ_t was expected to adjust immediately to its long run value so that r_t was unresponsive to the supply side disturbance. Under imperfect information, output is expected to expand next period as Px_t catches up to $E_{t-1}Px_t$. This will lead to an anticipated deterioration in the terms of trade and hence r_t will rise according to the arbitrage equation (2.22).

IV. Conclusions

In a simple stochastic general equilibrium model I have explored how supply side policies affect the dynamic paths of exchange rates, interest rates and the terms of trade. The outcome -- in direction and magnitude -- generally depends upon the type of pricing rule, the availability of information and the credibility of the policy. However, the Marshall Lerner elasticity condition is sufficient to guarantee that the exchange rate will initially appreciate (depreciate) in response to a positive (negative) supply shock, irrespective of the three factors above. And if all prices are fully flexible, more credible supply side policies would induce less volatile responses in nominal and real rates than less credible policies. Moreover, if nominal prices of domestic goods are insensitive to contemporaneous shocks due to the existence of nominal (unindexed) contracts, credible policies will induce more volatile exchange rate behavior than under fully flexible prices if the M-L elasticity condition holds.

The covariation between the exchange rate and terms of trade under flexible prices again depends on the M-L elasticity condition. If the M-L condition holds -- this is both a necessary and sufficient condition -- positive supply shocks will induce an appreciation of the exchange rate and a concommitant deterioration in the home terms of trade. This implies that the domestic price level would be more volatile than the exchange rate so as to establish the new equilibrium terms of trade. This relative volatility would be even more pronounced the more credible the supply side rule is. The reason being that under regimes not fully credible, agents anticipate a future output decline, which would improve the terms of trade. Arbitrage in financial markets would then lead to an instantaneous decline in the prevailing real rate of return. This stimulates aggregate demand thus absorbing the intial excess supply. Under credible policy rules, the terms of trade adjust immediately to the long run steady state precluding a real interest rate movement.

The introduction of imperfect information leads to a confusion as to the source of the shock. Agents attribute part of the perceived relative price decline to negative demand shocks instead of the true supply shock and consequently reduce output. This cyclical output response partially offsets the intial productivity stimulus if the shock is transient. The volatility of <u>all</u> prices (relative to the full current information or classical case) will be reduced. If, however, the policy is regarded as permanent, the cyclical output effect could dominate the initial supply shock. If this perverse result is ruled out, imperfect information would also act as a shock absorber for credible supply side policies.

*The author is Assistant Professor of Economics, Columbia Graduate School of Business, New York, NY 10027. I am indebted to Robert Z. Lawrence, Robert Flood, Joshua Aizenman and Guillermo Calvo for helpful conversations. The paper was written while I was a visiting scholar to the International Finance Division of the Board of Governors, Federal Reserve System. I am grateful to the Board for financial support. This paper represents the views of the author (authors) and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff.

I. Introduction

[1]For an empirical and theoretical analysis of the OPEC oil price shock on developed and developing nations see Sachs (1980).

[2]See for example I. Kravis and R. Lipsey (1978).

[3]The Meade model only considered aggregate demand side disturbances, but has supply side implications. If output rose (say due to a multiplier effect created by a shift in aggregate demand), the exchange rate would appreciate only if the sum of domestic and foreign demand elasticities was greater than unity. This has been called the Marshall Lerner (M-L) condition.

[4]See J. A. Frenkel and H. G. Johnson (1976) for a critique of the elasticity approach to the balance of payments under fixed exchange rates. For an analysis of the monetary approach to the exchange rate see J. A. Frenkel and H. G. Johnson (1978) and the references therein.

[5]A rise in domestic output would stimulate the demand for money. Under the assumption of purchasing power parity, this will unequivocally appreciate the exchange rate.

[6]This is ironic since the Keynesian model derives elasticity conditions for this particular case.

[7]This result should be compared to Obstfeld's (1980) paper in which he describes a perfect foresight equilibrium path with full price flexibility.

[8]Note that in traditional Keynesian type models such as Meade (1951) the exchange rate is in fact defined as the terms of trade in the short run.

II. The Classical Model

[1]The deterministic component of each variable has been deleted. In section IV the output exogeneity assumption will be relaxed.

[2]See Sargent (1979) pp. 310-311 for a derivation of ρ.

[3]ρ can have a Bayesian interpretation -- it can be defined as agents' prior probability that a shift in measure income is in fact transitory. As agents learn, ρ can be adjusted so as to incorporate new information. In the framework presented here I abstract from this learning process since I only seek to analyze the impact effect of a sudden policy shock.

[4]The real rate is defined in terms of a basket of <u>consumer</u> products. This is consistent with intertemporal substitution between present and future consumption by domestic agents.

[5]Strictly speaking the foreign demand x_t^* should also contain a term I_t^* representing foreign income to be symmetrical with the analysis. I assume that the substitution always dominates the income effect, so that $\psi\alpha_2^* > 0$.

[6]Money demand depends on x_t^s and not I_t thus we are ignoring the direct impact of the terms of trade on money demand, a point presumably justified for a transaction money demand. Anticipated terms of trade movements will however effect money demand through the real interest rate. The output elasticity is assumed to be unity so as to ease the cumbersome algebra without significant damage to the technical propositions advocated by the model.

[7]Currency substitution is ruled out by law, thus no stock demand for foreign currency exists. Domestic agents will however generate a derived flow demand for foreign currency as they purchase foreign goods and bonds. Likewise, a flow supply of foreign currency will be generated by foreign agents' purchase of domestic output and bonds.

[8]This result has been derived in an equilibrium context by Stockman (1978) and used in Flood (1981).

[9]For a similar equilibrium condition derived in an optimization context, see Oestfeld (1982). (2.22) could be interpreted in the following way: r_t is the return on indexed bonds denominated in the domestic product x, while r_t^* is the return on indexed bonds denominated in the foreign product, y.

[10]See for example Lucas (1973) and Barro (1976).

[11]Note that the lagged terms can be written in moving average form:

2.25 $$Px_t^s = -[x_{t-1}^s - \rho u_{t-1}] - (\quad)u_t$$

2.26 $$e_t = \phi^{-1}(1 - \theta\delta_2 - \phi)(x_{t-1}^s - \rho u_{t-1}) - (\quad)u_t$$

[12]L is a lag operator. The function $\frac{1}{1 - \rho L} = \sum_{j=0}^{\infty} \rho^j L^j$ describes the transition from the short run to the long run. If $\rho = 1$, the economy will return back to the long run steady state in the period following the shock.

[13]If the disturbance is permanent ($\rho = 0$), $\phi > 1 - \theta\delta_2$ is both a necessary and sufficient condition to insure that a positive supply shock appreciates domestic currency. If $\rho = 1$, a necessary and sufficient condition is that $A_1 > 1 - \theta\delta_2$. In general, a necessary and sufficient condition is that $\rho\delta_1\theta^2(1 - \theta\delta_2) > A_1 Z(1 - \theta\delta_2 - \phi)$.

[14]The converse of the proposition is untrue in general since $A_1 > 1 - \theta\delta_2$ is a sufficient condition. Thus if $A_1 < 1 - \theta\delta_2$ the volatility of Px_t relative to e_t is ambiguous.

[15]As long as $A > 1 - \theta\delta_2$, the exchange rate will appreciate and terms of trade worsen in response to a positive supply shock.

[16]The path of the deviations from PPP can be derived as an autoregressive moving average process. Rewrite 2.28 as

A1 $$q_t \equiv P_t - P_t^* - e_t = (\theta^* - \theta)(1 - \theta\delta_2)\phi^{-1}[\frac{1 - \rho}{1 - \rho L}x_{t-1} + A \cdot A_1^{-1}u_t]$$

The output process can be described as follows

A2 $$\lim_{\eta \to 1} x_t = \lim_{\eta \to 1}[\frac{1 - \rho L}{1 - \eta L}u_{t-1} + AA_1^{-1}u_t]$$

Substitute A2 into A1 and obtain

A3 $$q_t = (\theta^* - \theta)(1 - \theta\delta_2)\phi^{-1}[(1 - \rho)(\sum_{j=0}^{\infty} u_{t-1-j}) + A_1A_1^{-1}u_t].$$

[17]In fact, $E_t\lambda_{t+j} = E_t\lambda_{t+1}$ for all j. Thus $E_t\lambda_{t+1}$ is agents' forecast of the permanent terms of trade.

[18]When $\rho = 0$, a supply shock will induce a classical Patinkin result -- a once and for all increase in output will lead to an equiproportionate decline in the price level despite the presence of liquidity preference.

[19]Although the effect of ρ on e_t is ambiguous, some elasticity conditions can be derived. Differentiate e_t with respect to ρ and obtain $\text{sign}(\frac{\partial \frac{\partial e_t}{\partial u_t}}{\partial \rho}) =$ $\text{sign}[- A_1b(1 - \theta\delta_2 - \phi) - \delta_1\theta^2(1 - \theta\delta_2)]$. If $\phi > 1 - \theta\delta_2$ the first term is positive while the second is negative thus the result is ambiguous. If, however, $1 - \theta\delta_2 > \phi$ and $\partial e_t/\partial u_t$ is positive (negative) then the greater is ρ, the less (more) volatile the movement in e_t. If $\phi > 1 - \theta\delta_2$, then as ρ increases, volatility will decline only if $b > \delta_1\theta^2(1 - \theta\delta_2)A_1^{-1}|1 - \theta\delta_2 - \phi|^{-1}$.

III. <u>Price Contracts</u>

[1]Such contracts have been explored elsewhere, for example, Green and Lafont (1981) and Flood (1981). The length of the contract period will in general depend on the entire covariance matrix of stochastic disturbances. I assume that this structure remains constant.

[2]$E_{t-1}Px_t$ is derived from the ex ante equilibrium condition (3.2).

[3]The model presented is a disequilibrium model. If the product is durable, agents would derive an optimal inventory rule. I implicitly assume that the good sold is a service and avoid the inventory problem. See footnote 4 below.

[4]The critical assumption is the fact that x is a nondurable product. If x were durable the impact of u_t on e_t would be

$$e_t = \ldots [(1 - \theta\delta_2 - \phi)\phi^{-1}((1 - \rho) + kv) - b^{-1}]u_t$$

where vu_t is the volume of accumulated inventory at t and k is a parameter $0 \leqq k \leqq 1$ at which rate the inventory is dissipated. k would depend on parameters governing agents' optimal stochastic inventory rule. v depends on the parameters of the model and for temporary disturbances is unambiguously positive. The traditional M-L condition $\theta\alpha_2 + \alpha_2^* > 1$ is sufficient to guarantee that even in the presence of inventory accumulation, the exchange rate will appreciate.

[5]The result of course resembles Dorenbusch's (1976) celebrated overshooting hypothesis.

[6]Compute the short run variance of e_t in the sticky and flexible price models. The solution for the case where $\rho = 0$ is,

$$\frac{\sigma_e^2(\text{sticky})}{\sigma_e^2(\text{flexible})} = \frac{[(1 - \theta\delta_2 - \phi)\phi^{-1} - b^{-1}]^2}{[(1 - \theta\delta_2 - \phi)\phi^{-1}]^2} > 1.$$

[7]The variance of the terms of trade under sticky prices is identical to the variance of the exchange rate computed in footnote 6. The variance of λ_t under flexible prices is computed from (2.27). The relative variance for $\rho = 0$ is

$$\frac{\sigma_\lambda^2(\text{sticky})}{\sigma_e^2(\text{flexible})} = \frac{[(1 - \theta\delta_2)\phi^{-1} - (1 + b^{-1})]^2}{[(1 - \theta\delta_2)\phi^{-1}]^2}$$

If $(1 - \theta^2{}_2)\phi^{-1} > 1 + b^{-1}$, e will depreciate and proposition 3 will hold.

[8]This result does depend on the assumption that agents deflate their real rate by Px_t and not P_t. If (2.14) were respecified as $M^d = - bi + P + x$ the result would always hold if $\partial e/\partial u > 0$. If $\partial e/\partial u < 0$, the result would still hold if $\partial|e|/\partial u < (1 - \theta)^{-1}$. i.e. if the currency appreciated in response to a positive shock, the resultant increase in real balances would not be enough to satisfy the transaction demand for money.

[9]If $\rho = 0$ e_t could move either way. If e_t does rise, so does λ_t. Since the implication of 3.7 is that $\partial r/\partial u_t > 0$, λ_t can never overshoot its long run equilibrium.

IV. Endogenous Output and Imperfect Information

[1]Lawrence (1980) has constructed a rational expectation model of two countries trading in local markets for goods and global markets for foreign exchange and international financial assets. Although no closed form solution exists, simulation techniques generated dynamic equilibrium paths consistent with a specification like (4.1).

[2]The reader should be aware that stochastic shocks (other than supply shocks) are present in the above setting so as to create misperceptions in

relative price movements. Throughout the analysis, the covariance structure of these shocks is assumed to be constant.

[3]This can be verified by noting that γ appears in the denominator of (4.2) so that $\partial \mathrm{Var}\ Px/\partial\gamma < 0$.

[4]While the presence of imperfect information reduces output, it also has an effect on interest rates (equations (4.5) and (4.6)). If i_t falls in response to a positive realization of u_t, it will stimulate the demand for money. This cannot offset the imperfect information effect which reduces the demand for money. Thus $\partial \mathrm{Var}\ Px/\partial\gamma < 0$ for all values of $\gamma \geqq 0$.

[5]This can be seen by comparing these expressions to $\partial r_t/\partial u_t$ and $\partial i_t/\partial u_t$ in (4.5) and (4.6). The first expression is $b\partial i_t/\partial u_t$ and the second is $\delta_1\theta\partial r_t/\partial u_t$.

[6]γ is found in Δ which has been defined earlier in the text.

[7]This can be seen in equation (4.6).

[8]A proof of this is straightforward. Substitute (4.2) and (4.6) for $\rho = 0$ into the money market equilibrium condition (2.20). $\partial Q_t/\partial u_t > 0$ if $A_1 > \gamma(\psi\mu - \delta_1\theta^2)$, so that $\partial\lambda_t/\partial u_t > 0$.

[9]A fall in i_t created by a positive supply shock ($\partial i_t/\partial u_t < 0$) could reduce Px_t below $E_{t-1}Px_t$ to such an extent that the reduction in output, $\gamma[Px_t - E_{t-1}Px_t]$ is greater than the initial disturbance u_t. If this perverse case is ruled out, then the result in the text follows.

[10]The condition $1 - \theta\delta_2 - A_1 > 0$ is both necessary and sufficient to insure $\partial e_t/\partial u_t > 0$ and $\partial \mathrm{Var}\ e/\partial\gamma < 0$. The reason is that for $\rho = 0$, $\partial i_t/\partial u_t = 0$ in the classical case. Therefore, $\partial e_t/\partial u_t$ (classical) $> \partial e_t/\partial u_t$ (imperfect information).

[11]The condition $|1 - \theta\delta z - A_1| > (1 + b)b^{-1}\delta_1\theta^2$ is a sufficient condition.

References

Barro, R. J. "Rational Expectations and the Role of Monetary Policy." J. Mon. Econ. 2 (January 1976): 1-32.

Buiter, W. "Short Run and Long Run Effects of External Disturbances under a Floating Exchange Rate." Economica 45 (1978): 251-272.

Dornbusch, R. "The Theory of Flexible Exchange Rate Regimes and Macroeconomic Policy." Scan. J. Econ. 78 (May 1976): 225-275.

Findlay, R. and Rodriguez, C. A. "Intermediate Imports and Macroeconomic Policy under Flexible Rates." Can. J. Econ. 10 (1977): 208-217.

Flood, R. "Explanations of Exchange Rate Volatility and Other Empirical Regularities in Some Popular Models of the Foreign Exchange Market." Carnegie-Rochester Conference Series on Pubic Policy, J. Mon. Econ. 15 (1981): 219-250.

Frenkel, J. A. and Johnson, H. G. (eds.) The Monetary Approach to the Balance of Payments. Toronto: Toronto University Press, 1976.

Frenkel, J. A. and Johnson, H. G. (eds.) The Economics of Exchange Rates. Reading: Addison-Wesley, 1978.

Green, J. and Laffont, J. "Disequilibrium Dynamics with Inventories and Anticipatory Price Setting." Euro. Econ. Rev. 16 (1981): 199-221.

Katseli-Papdefstratiou, L. T. "Transmission of External Price Disturbances and the Composition of Trade." J. Int. Econ. 10 (1980): 357-375.

Kravis, I. and Lipsey, R. "Price Behavior in the Light of Balance of Payments Theories." J. Int. Econ. 8 (1978): 193-247.

Lawrence, C. Equilibrium Models of the International Business Cycle. Unpublished Ph.D. Dissertation, University of Chicago (December 1980).

Lucas, R. E., Jr. "Expectations and the Neutrality of Money." J. Econ. Theory 4 (June 1972): 103-124.

Lucas, R. E., Jr. "Some International Evidence on Output Inflation Trade Offs." Amer. Econ. Rev. 63 (June 1973): 326-334.

Meade, J. E. The Theory of International Economic Policy, Vol. I: The Balance of Payments. London: Oxford University Press.

Mundell, R. A. International Economics. McMillan, 1968.

Obstfeld, M. "Intermediate Imports, the Terms of Trade and the Dynamics of the Exchange Rate and the Current Account." J. Int. Econ. (1980): 461-480.

Obstfeld, M. "Intertemporal Price Speculation and the Optimal Current Account Deficit." Discussion Paper Series No. 166, Columbia University, 1982.

Sachs, J. D. "The Current Account and the Macroeconomic Adjustment in the 1970s." BPEA 12 (1981): 201-268.

Stockman, A.C. "A Theory of Exchange Rate Determination." J. Polit. Econ. 38 (August 1980): 673-398.