The Expenditure Switching Effect and the Choice Between Fixed and Floating Exchange Rates*

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Abstract

A two-country sticky-price general equilibrium model is used to examine the implications of the expenditure switching effect for the welfare properties of fixed and floating exchange rate regimes. A comparison between the two regimes shows that the volatility of consumption is unambiguously lower in the floating exchange rate regime, but the volatility of home output can be higher or lower depending on the value of the elasticity of substitution between home and foreign goods. A utility-based welfare comparison of the two regimes concludes that a floating exchange rate regime yields higher welfare when the expenditure switching effect is relatively weak, but a fixed exchange rate regime is superior when the expenditure switching effect is strong.

Keywords: exchange rates, expenditure switching, welfare.

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1 Introduction

This paper analyses the macroeconomic implications of fixed and floating exchange rate regimes and presents a welfare comparison of the two regimes in the presence of stochastic foreign monetary shocks. The main focus of analysis is the role played by the expenditure switching effect of exchange rate changes in the choice of exchange rate regime.

Early proponents of floating exchange rates, such as Friedman (1953), argued that floating exchange rates are desirable because they provide a degree of insulation against foreign shocks. A floating rate regime allows a country to set monetary policy independently from monetary policy in other countries. This prevents the transmission of foreign monetary policy shocks to the domestic economy. Furthermore, when goods prices are sticky, a floating rate regime allows relative prices to adjust in response to country specific real demand and supply shocks. Thus, it was argued, floating exchange rates act as a 'shock absorber' which helps stabilise the domestic economy in the face of both monetary and real shocks.

Recently there has been a growing literature on the choice of exchange rate regimes based on welfare comparisons in general equilibrium models with sticky-prices. This new literature has allowed a re-examination of the shock-absorber role of the exchange rate. A particularly important issue that has emerged in the recent literature (see Devereux and Engel (1998, 2000), Devereux (2000) and Bachetta and van Wincoop (2000)) is the distinction between 'producer currency pricing' (where prices are fixed in the currency of the producer) and 'local currency pricing' (where prices are fixed in the currency of the consumer). One implication of local currency pricing is that the expenditure switching effect of exchange rate changes is much reduced (or even eliminated). This tends to reduce the ability of the exchange rate to act as a shock absorber in response to real demand and supply shocks and thus alters the welfare case for floating exchange rates.

The present paper also considers the implications of the expenditure switching effect for the choice of exchange rate regime, but here the important issue is the degree of substitutability between home and foreign goods (rather than the currency in which prices are set). Recent papers have focused on models where the elasticity of substitution between home and foreign goods is restricted to unity. They therefore implicitly restrict the strength of the expenditure switching effect. This issue is not relevant in the case of local currency pricing (because relative prices do not change) but it can be important in the case of producer currency pricing (as the results presented in this paper show).

The paper uses a two-country sticky price general equilibrium model (where prices are fixed in the currency of the producer) to compare the welfare properties of exchange rate regimes. The foreign country is subject to stochastic money supply shocks and the focus of interest is on the stabilisation and welfare implications of regime choice for the home country. A comparison between the two exchange rate regimes shows that, while the volatility of consumption is unambiguously lower in the floating exchange rate regime, the volatility of home output is only lower in the floating rate regime when the elasticity of substitution between home and foreign goods is low. Thus the ability of floating rates to insulate the home country from foreign monetary shocks depends on the strength of the expenditure switching effect. A floating rate regime allows the home economy to set its money supply independently and thus foreign money shocks are not transmitted to the home economy via home monetary policy. But a floating rate regime implies that foreign monetary shocks cause movements in the exchange rate which, in turn, affect home output through the expenditure switching effect. The strength of the expenditure switching effect therefore determines the relative stabilising properties of the two regimes.

The strength of the expenditure switching effect is also found to be important for determining the relative welfare performance of the two regimes. A floating exchange rate regime yields higher welfare when the expenditure switching effect is relatively weak, but a fixed exchange rate regime is superior when the expenditure switching effect is strong.

The paper proceeds as follows: Section 2 presents the model; Section 3 describes the solution method and approximation of the model; Section 4 derives expressions for consumption and output in fixed and floating exchange rate regimes and compares their volatilities under the two regimes; Section 5 presents the derivation of the welfare measure and a welfare comparison of different exchange rate regimes; and Section 6 concludes the paper.

2 The Model

The model is a variation of the sticky-price general equilibrium structure which has become standard in the recent open economy macro literature (following the approach developed by Obstfeld and Rogoff (1995, 1998)).[1] The main point at which the model differs from many others in the recent literature is that the elasticity of substitution between home and foreign goods can differ from unity. The only source of stochastic shocks in the model is the foreign money supply. Two possible regimes for the home monetary authority are considered. In a fixed exchange rate regime the home money supply is used to achieve the desired target exchange rate. In a floating exchange rate regime the home money supply is fixed.[2]

2.1 Market Structure

The world exists for a single period and consists of two countries, which will be referred to as the home country and the foreign country. There is a continuum

[1] See Lane (2001) for a recent survey of this literature.

[2] This is, of course, only one form of floating rate regime. There are many other options for the home monetary authority in a floating rate regime. In particular the home monetary authority could adopt a monetary rule which maximises home welfare. The fixed money assumption adopted here is, however, a natural benchmark which corresponds to the Friedman policy prescription (and also to the analysis of Devereux and Engel (1998)).

of agents of unit mass in each country with home agents indexed $h \in [0,1]$ and foreign agents indexed $f \in [0,1]$. Agents consume a basket of goods containing all home and foreign produced goods. Each agent is a monopoly producer of a single differentiated product. All agents set prices in advance of the realisation of shocks and are contracted to meet demand at the pre-fixed prices. Prices are set in the currency of the producer.

The detailed structure of the home country is described below. The foreign country has an identical structure. Where appropriate, foreign real variables and foreign currency prices are indicated with an asterisk.

2.2 Preferences

All agents in the home economy have utility functions of the same form. The utility of agent h is given by

$$U(h) = E\left[\log C(h) + \chi \log \frac{M(h)}{P} - \frac{K}{2} y^2(h)\right] \quad (1)$$

where χ and K are positive constants, C is a consumption index defined across all home and foreign goods, M denotes end-of-period nominal money holdings, P is the consumer price index, $y(h)$ is the output of good h and E is the expectations operator.

The consumption index C for home agents is defined as

$$C = \left[\left(\frac{1}{2}\right)^{\frac{1}{\theta}} C_H^{\frac{\theta-1}{\theta}} + \left(\frac{1}{2}\right)^{\frac{1}{\theta}} C_F^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \quad (2)$$

where C_H and C_F are indices of home and foreign produced goods defined as follows

$$C_H = \left[\int_0^1 c_H(i)^{\frac{\phi-1}{\phi}} di\right]^{\frac{\phi}{\phi-1}}, \quad C_F = \left[\int_0^1 c_F(j)^{\frac{\phi-1}{\phi}} dj\right]^{\frac{\phi}{\phi-1}} \quad (3)$$

where $\phi > 1$, $c_H(i)$ is consumption of home good i and $c_F(j)$ is consumption of foreign good j. The parameter θ is the elasticity of substitution between home and foreign goods. This is the key parameter which determines the strength of the expenditure switching effect.

The budget constraint of agent h is given by

$$M(h) = M_0 + p_H(h)\, y(h) - PC(h) - T + PR(h) \quad (4)$$

where M_0 and $M(h)$ are initial and final money holdings, T is a lump-sum government transfer, $p_H(h)$ is the price of home good h, P is the aggregate consumer price index and $R(h)$ is the income from a portfolio of state contingent assets (to be described in more detail below).

The government's budget constraint is

$$M - M_0 + T = 0 \tag{5}$$

Changes in the money supply are assumed to enter and leave the economy via changes in lump-sum transfers.

2.3 Price Indices

The aggregate consumer price index for home agents is

$$P = \left[\frac{1}{2}P_H^{1-\theta} + \frac{1}{2}P_F^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{6}$$

where P_H and P_F are the price indices for home and foreign goods respectively defined as

$$P_H = \left[\int_0^1 p_H(i)^{1-\phi}\, di\right]^{\frac{1}{1-\phi}}, \quad P_F = \left[\int_0^1 p_F(j)^{1-\phi}\, dj\right]^{\frac{1}{1-\phi}} \tag{7}$$

The law of one price is assumed to hold. This implies $p_H(i) = p_H^*(i)S$ and $p_F(j) = p_F^*(j)S$ for all i and j where an asterisk indicates a price measured in foreign currency and S is the exchange rate (defined as the domestic price of foreign currency). Purchasing power parity holds in terms of aggregate consumer price indices, $P = P^*S$.

2.4 Consumption Choices

Individual home demand for representative home good, h, and foreign good, f, are given by

$$c_H(h) = C_H\left(\frac{p_H(h)}{P_H}\right)^{-\phi}, \quad c_F(f) = C_F\left(\frac{p_F(f)}{P_F}\right)^{-\phi} \tag{8}$$

where

$$C_H = \frac{1}{2}C\left(\frac{P_H}{P}\right)^{-\theta}, \quad C_F = \frac{1}{2}C\left(\frac{P_F}{P}\right)^{-\theta} \tag{9}$$

Foreign demands for home and foreign goods have an identical structure to the home demands. Individual foreign demand for representative home good, h, and foreign good, f, are given by

$$c_H^*(h) = C_H^*\left(\frac{p_H^*(h)}{P_H^*}\right)^{-\phi}, \quad c_F^*(f) = C_F^*\left(\frac{p_F^*(f)}{P_F^*}\right)^{-\phi} \tag{10}$$

where

$$C_H^* = \frac{1}{2}C^*\left(\frac{P_H^*}{P^*}\right)^{-\theta}, \quad C_F^* = \frac{1}{2}C^*\left(\frac{P_F^*}{P^*}\right)^{-\theta} \tag{11}$$

Each country has a population of unit mass so the total demands for goods are equivalent to individual demands. The total demand for home goods is therefore $Y = C_H + C_H^*$ and the total demand for foreign goods is $Y^* = C_F + C_F^*$.

2.5 Optimal Price Setting

The first-order condition for price setting for home agents is derived in Appendix A and implies the following

$$P_H = \frac{\phi}{\phi - 1} \frac{KE\left[Y^2\right]}{E\left[Y/(PC)\right]} \tag{12}$$

A similar expression can be derived for foreign agents, as follows

$$P_F^* = \frac{\phi}{\phi - 1} \frac{KE\left[Y^{*2}\right]}{E\left[Y^*/(P^*C^*)\right]} \tag{13}$$

2.6 Financial Markets and Risk Sharing

The asymmetric structure of shocks and monetary policy, coupled with a non-unit elasticity of substitution between home and foreign goods, makes it necessary to adopt a more explicit structure for international asset markets than is usual in the recent literature.[3] It is assumed that sufficient contingent financial instruments exist to allow efficient sharing of consumption risks. All consumption is financed out of real income so the only source of consumption risk is variability in real income. Efficient sharing of consumption risk can therefore be achieved by allowing trade in two state-contingent assets, one which has a payoff correlated with home aggregate real income and one with a payoff correlated with foreign real income. For simplicity it is assumed that each asset pays a return equal to the relevant country's real income, i.e. a unit of the home asset pays $y = YP_H/P$ and a unit of the foreign asset pays $y^* = Y^*P_F/P$.[4] The portfolio pay-offs for home and foreign agents are given by the following

$$R(h) = \zeta_H(h)(y - q_H) + \zeta_F(h)(y^* - q_F) \tag{14}$$

$$R^*(f) = \zeta_H^*(f)(y - q_H) + \zeta_F^*(f)(y^* - q_F) \tag{15}$$

where $\zeta_H(h)$ and $\zeta_F(h)$ are holdings of home agent h of the home and foreign assets, $\zeta_H^*(f)$ and $\zeta_F^*(f)$ are the holdings of foreign agent f of home and foreign assets and q_H and q_F are the unit prices of the home and foreign assets.

It is important to specify the timing of asset trade. It is assumed that asset trade takes place after the choice of exchange rate regime. This implies that agents

[3] When θ is equal to unity the trade balance between the two countries automatically balances in all states of the world, in which case financial markets are irrelevant. When $\theta \neq 1$ it becomes necessary to consider the structure of financial markets. Additionally, when shocks are asymmetric and when the focus of interest is the policy choice and welfare of a single country, it becomes necessary explicitly to consider how policy choices affect asset prices and portfolio decisions.

[4] Note that asset pay-offs are correlated with aggregate income. Individual agents therefore treat pay-offs as exogenous. This implies that the existence of contingent assets has no direct impact on optimal price setting.

can insure themselves against the risk implied by a particular exchange rate regime but they can not insure themselves against the choice of regime.[5]

Appendix B shows that risk sharing implies the following relationship between consumption, asset prices and expected output levels in the two countries

$$\frac{C}{C^*} = \frac{q_H}{q_F} = \frac{E\left[\frac{y}{y+y^*}\right]}{E\left[\frac{y^*}{y+y^*}\right]} \tag{16}$$

2.7 Money Demand and Supply

The first-order condition for the choice of money holdings is

$$\frac{M}{P} = \chi C \tag{17}$$

The money supply in each country is assumed to be determined by the relevant national monetary authority. The foreign money supply is subject to stochastic shocks such that $\log M^*$ is symmetrically distributed over the interval $[-\epsilon, \epsilon]$ with $E[\log M^*] = 0$ and $Var[\log M^*] = \sigma^2$. In the case of a floating exchange rate the home monetary authority is assumed to keep the home money supply constant at $\bar{M}$. In the case of a fixed exchange rate the home monetary authority is assumed to use the home money supply to maintain the exchange rate at the target level, $\bar{S}$. For simplicity $\bar{M} = \bar{S} = 1$.

3 Model Approximation

It is not possible to derive an exact solution to the model described above.[6] The model is therefore approximated around a non-stochastic equilibrium.

Before proceeding it is necessary to define and explain some notation. The non-stochastic equilibrium of the model is defined as the solution which results when $M^* = 1$ with $\sigma^2 = 0$. For any variable X define $\hat{X} = \log\left(X/\bar{X}\right)$ where $\bar{X}$ is the value of variable X in the non-stochastic equilibrium. $\hat{X}$ is therefore the log-deviation of X from its value in the non-stochastic equilibrium.

The only exogenous forcing variable in the model is the foreign money supply, M^*, so all log-deviations from the non-stochastic equilibrium are of the same order as

[5] If, alternatively, asset trade takes place before the exchange rate regime is chosen, it would be possible for agents to insure themselves against the choice of regime. This could have very significant implications for the optimal choice of regime. The home monetary authority would be tempted to choose a regime which implies high volatility of demand for home goods. The high volatility of demand would discourage home labour supply and reduce home work effort but the level of home consumption would be protected by the risk-sharing arrangement. This alternative risk-sharing structure raises some interesting issues but it also involves some technical problems which go beyond the scope of this paper.

[6] The complication arising in this model is contained in equation (6). When θ is different from unity this equation is not linear in logs.

the shocks to $\hat{M}^*$, which (by assumption) are of maximum size ϵ. When presenting an equation which is approximated up to order n it is therefore possible to gather all terms of order higher than n in a single term denoted $O(\epsilon^{n+1})$. Thus, when the term $O(\epsilon^2)$ appears in an equation the variables in that equation should be understood to be accurate up to order one. While an equation which includes the term $O(\epsilon^3)$ should be understood to contain variables which are accurate up to order two. And an equation which does not include any term of the form $O(\epsilon^n)$ should be understood to hold exactly.

The analysis of the model proceeds in two stages. The first stage considers the implications of fixed and floating exchange rates for the volatilities of macro variables. The second stage considers a welfare comparison between fixed and floating exchange rates.

Variances are, by definition, at least of second order so an analysis of volatilities requires the derivation of at least second–order accurate solutions for variances. But second-order accurate solutions for variances can be obtained from first-order accurate solutions for the relationships between endogenous variables and the shock variable. The analysis of volatility therefore involves working with a log-linearised (i.e. first-order approximated) version of the model.

The expressions for second moments obtained in the analysis of volatility also enter into the analysis of welfare. But a full second-order expression for welfare requires second-order accurate solutions for *both* the first and second moments of variables. So a full analysis of welfare involves working with a second-order approximation of the model.

4 Macroeconomic Volatility

A first-order expansion of equation (16) shows that risk sharing implies the following relationship between consumption levels in the two countries

$$\hat{C} - \hat{C}^* = 0 + O\left(\epsilon^2\right)$$

where, as explained above, the term $O(\epsilon^2)$ indicates that the variables in this relationship should be understood to be accurate up to a first-order approximation. When combined with the purchasing power parity relationship (which implies $\hat{S} = \hat{P} - \hat{P}^*$) and the expressions for home and foreign money demand (which imply $\hat{M} = \hat{P} + \hat{C}$ and $\hat{M}^* = \hat{P}^* + \hat{C}^*$) the following expression for the exchange rate is obtained

$$\hat{S} = \hat{M} - \hat{M}^* + O\left(\epsilon^2\right) \tag{18}$$

This expression immediately shows that a fixed exchange rate implies that the home money supply is set equal to the foreign money supply, i.e. $\hat{M} = \hat{M}^*$, while a floating exchange rate implies that $\hat{S} = -\hat{M}^* + O(\epsilon^2)$.

The assumption of fixed goods prices implies

$$\hat{P}_H = \hat{P}_F^* = 0 + O\left(\epsilon^2\right)$$

so consumer prices are given by

$$\hat{P} = \frac{1}{2}\hat{S} + O\left(\epsilon^2\right), \quad \hat{P}^* = -\frac{1}{2}\hat{S} + O\left(\epsilon^2\right)$$

These expressions, combined with the money demand relationships imply that consumption levels are

$$\hat{C} = \hat{C}^* = \frac{1}{2}\left(\hat{M} + \hat{M}^*\right) + O\left(\epsilon^2\right) \tag{19}$$

Thus consumption in the two countries responds equally (because of risk sharing) to aggregate world monetary policy.

First-order approximations for home and foreign aggregate output levels yield

$$\hat{Y} = \frac{1}{2}\left(\hat{C} + \hat{C}^*\right) - \theta\left(\hat{P}_H - \hat{P}\right) + O\left(\epsilon^2\right) \tag{20}$$

$$\hat{Y}^* = \frac{1}{2}\left(\hat{C} + \hat{C}^*\right) - \theta\left(\hat{P}_F^* - \hat{P}^*\right) + O\left(\epsilon^2\right) \tag{21}$$

Combining these expressions with the solutions for consumption and price levels implies

$$\hat{Y} = \frac{1+\theta}{2}\hat{M} + \frac{1-\theta}{2}\hat{M}^* + O\left(\epsilon^2\right), \quad \hat{Y}^* = \frac{1+\theta}{2}\hat{M}^* + \frac{1-\theta}{2}\hat{M} + O\left(\epsilon^2\right) \tag{22}$$

These expressions reveal the importance of the expenditure switching effect (as measured by the parameter θ) for determining the impact of monetary policy on output. If θ is greater than unity monetary policy has a beggar-thy-neighbour effect. An expansion in the foreign money supply increases foreign output but reduces home output (and vice versa for an expansion of the home money supply). The beggar-thy-neighbour effect arises because of the impact of monetary policy on relative prices. An expansion of the foreign money supply causes an appreciation of the nominal exchange rate (see equation (18)) which, for given values of $\hat{P}_H$ and $\hat{P}_F^*$, causes a reduction in the relative price of foreign goods. Equations (20) and (21) show that the change in relative prices has an expenditure switching effect, i.e. there is a shift of demand from home goods to foreign goods. The size of this expenditure switching effect depends on the substitutability of home and foreign goods, i.e. it depends on the value of θ. The negative impact of the exchange rate change on home output is partly offset by the positive impact of foreign money on total world consumption (see equation (19)). Thus the beggar-thy-neighbour effect only arises when θ is greater than unity.

It is now simple to derive expressions for consumption and output levels in fixed and floating exchange rate regimes. In a fixed exchange rate regime (i.e. where $\hat{M} = \hat{M}^*$) it follows that consumption levels are given by

$$\hat{C} = \hat{C}^* = \hat{M}^* + O\left(\epsilon^2\right)$$

and output levels are given by

$$\hat{Y} = \hat{M}^* + O\left(\epsilon^2\right), \quad \hat{Y}^* = \hat{M}^* + O\left(\epsilon^2\right)$$

Therefore the variances of consumption and output in a fixed rate regime are given by

$$E\left[\hat{Y}^2\right] = E\left[\hat{Y}^{*2}\right] = E\left[\hat{C}^2\right] = E\left[\hat{C}^{*2}\right] = \sigma^2 + O\left(\epsilon^3\right) \tag{23}$$

In a floating rate regime (i.e. where $\hat{M} = 0$) consumption levels are

$$\hat{C} = \hat{C}^* = \frac{1}{2}\hat{M}^* + O\left(\epsilon^2\right)$$

and output levels are

$$\hat{Y} = \frac{1-\theta}{2}\hat{M}^* + O\left(\epsilon^2\right), \quad \hat{Y}^* = \frac{1+\theta}{2}\hat{M}^* + O\left(\epsilon^2\right)$$

so the variances of consumption and output are

$$E\left[\hat{C}^2\right] = E\left[\hat{C}^{*2}\right] = \frac{1}{4}\sigma^2 + O\left(\epsilon^3\right) \tag{24}$$

$$E\left[\hat{Y}^2\right] = \left(\frac{1-\theta}{2}\right)^2 \sigma^2 + O\left(\epsilon^3\right) \tag{25}$$

$$E\left[\hat{Y}^{*2}\right] = \left(\frac{1+\theta}{2}\right)^2 \sigma^2 + O\left(\epsilon^3\right) \tag{26}$$

A comparison between the two exchange rate regimes shows that the volatility of consumption is unambiguously lower in the floating exchange rate regime but the volatility of home output can be higher or lower in the floating exchange rate regime depending on the value of θ. Equations (23) and (25) show that home output is less volatile in the fixed exchange rate regime when $\theta > 3$. Foreign output is more volatile in the floating rate regime for $\theta > 1$.

The explanation for these effects follows quite easily from consideration of the above equations. Equation (19) shows that consumption depends on aggregate world monetary policy. In a floating exchange rate regime home monetary policy is passive while a fixed exchange rate regime implies the home monetary authority must replicate foreign monetary developments exactly. World monetary policy must therefore be less active in the floating rate regime and hence consumption must be less volatile. The impact of the exchange rate regime on output volatility can be understood from equation (22) (which highlights the role of the expenditure switching effect of exchange rate changes). The expenditure switching effect becomes more powerful the higher is the value of θ. This implies that foreign monetary shocks, which are partly transmitted to the home economy via the expenditure switching effect, have a larger impact on home output when θ is larger than 3. A fixed exchange rate neutralises the expenditure switching effect and can therefore stabilise home output when $\theta > 3$.

5 Welfare

This section compares the welfare implications of fixed and floating exchange rates. Following Obstfeld and Rogoff (1998, 2002) it is assumed that the utility of real balances is small enough to be neglected. It is therefore possible to measure aggregate welfare of home agents using the following

$$\Omega = E\left[\log C - \frac{K}{2}Y^2\right] \tag{27}$$

As stated above, it is not possible to derive exact analytical solutions to the model. In order to analyse welfare it is therefore necessary to consider a second-order approximation of the welfare measure. This is given by

$$\tilde{\Omega} = E\left\{\hat{C} - K\bar{Y}^2\left[\hat{Y} + \hat{Y}^2\right]\right\} + O\left(\epsilon^3\right) \tag{28}$$

where $\tilde{\Omega}$ is the deviation of the level of welfare from the non-stochastic equilibrium.[7] Notice that this expression includes the first moments of output and consumption and the second moment of output. Welfare is increasing in the expected level of consumption and decreasing in the expected level and variance of output. A second-order accurate expression for the second moment of output has already been derived in the previous section. But it is now necessary to derive second-order accurate solutions for the first moments of output and consumption. This requires second-order approximations of the equations of the model.

5.1 Solving for first moments

It is useful to start by considering the first-order conditions for price setting. Second-order expansions of (12) and (13) yield

$$\hat{P}_H = E\left[\hat{Y} + \hat{P} + \hat{C}\right] + \lambda_{P_H} + O\left(\epsilon^3\right)$$

$$\hat{P}_F^* = E\left[\hat{Y}^* + \hat{P}^* + \hat{C}^*\right] + \lambda_{P_F^*} + O\left(\epsilon^3\right)$$

where

$$\lambda_{P_H} = \frac{1}{2}E\left[4\hat{Y}^2 - \left(\hat{Y} - \hat{C} - \hat{P}\right)^2\right]$$

$$\lambda_{P_F^*} = \frac{1}{2}E\left[4\hat{Y}^{*2} - \left(\hat{Y}^* - \hat{C}^* - \hat{P}^*\right)^2\right]$$

[7] In the non-stochastic equilibrium individual budget constraints imply that $\bar{P}\bar{C} = \bar{Y}\bar{P}_H$. Combining this expression with equation (12) shows that $\bar{Y} = \left[K\phi/\left(\phi - 1\right)\right]^{-1/2}$, thus $K\bar{Y}^2 = \left(\phi - 1\right)/\phi$. It will become apparent below that the main welfare results are independent of the value of $\bar{Y}$.

Notice that these expressions both include terms (denoted λ_{P_H} and $\lambda_{P_F^*}$) which depend on the second moments of output, consumption and consumer prices. These terms represent a form of risk premium which is built into goods prices by risk-averse agents who have to set prices before shocks are realised. The risk premium depends on the variances and covariances of work effort, the marginal utility of consumption and the consumer prices.

The expected values of $\hat{M}$ and $\hat{M}^*$ are both zero by assumption so it follows from the money demand relationships that

$$E\left[\hat{P}+\hat{C}\right]=0, \quad E\left[\hat{P}^*+\hat{C}^*\right]=0$$

(Note that the money demand relationships are linear in logs so they do not require any approximation.) The expressions for home and foreign goods prices therefore simplify to

$$\hat{P}_H=E\left[\hat{Y}\right]+\lambda_{P_H}+O\left(\epsilon^3\right), \quad \hat{P}_F^*=E\left[\hat{Y}^*\right]+\lambda_{P_F^*}+O\left(\epsilon^3\right)$$

These expressions can be combined with second-order expansions of the definitions of consumer prices to yield

$$E\left[\hat{P}\right]=\frac{1}{2}\lambda_{P_H}+\frac{1}{2}\lambda_{P_F^*}+\frac{1}{2}E\left[\hat{Y}+\hat{Y}^*+\hat{S}\right]+E\left[\lambda_{CPI}\right]+O\left(\epsilon^3\right)$$

$$E\left[\hat{P}^*\right]=\frac{1}{2}\lambda_{P_H}+\frac{1}{2}\lambda_{P_F^*}+\frac{1}{2}E\left[\hat{Y}+\hat{Y}^*-\hat{S}\right]+E\left[\lambda_{CPI}\right]+O\left(\epsilon^3\right)$$

where

$$\lambda_{CPI}=\frac{1}{8}(1-\theta)\hat{S}^2$$

Notice that the non-log-linearity of consumer prices gives rise to another second-order term (denoted λ_{CPI}). This term implies that the expected value of consumer prices is negatively affected by exchange rate volatility when $\theta>1$. This effect can be understood by considering the definition of the consumer price index. The CPI is concave in the prices of home and foreign goods so any volatility in the relative price of home and foreign goods (which would result from exchange rate volatility) will reduce the expected level of aggregate consumer prices. (Another way to understand this effect is to note that, when home and foreign goods are substitutable, agents can reduce the average cost of their consumption basket by switching expenditure towards whichever set of goods are cheapest *ex post*. Relative price volatility therefore reduces the average price of the consumption basket.)

The expressions for consumer prices can be combined with the money market equations to yield the following expressions for consumption

$$E\left[\hat{C}\right]=-E\left[\hat{P}\right]=-\frac{1}{2}\lambda_{P_H}-\frac{1}{2}\lambda_{P_F^*}-\frac{1}{2}E\left[\hat{Y}+\hat{Y}^*+\hat{S}\right]-E\left[\lambda_{CPI}\right]+O\left(\epsilon^3\right) \quad (29)$$

$$E\left[\hat{C}^*\right]=-E\left[\hat{P}^*\right]=-\frac{1}{2}\lambda_{P_H}-\frac{1}{2}\lambda_{P_F^*}-\frac{1}{2}E\left[\hat{Y}+\hat{Y}^*-\hat{S}\right]-E\left[\lambda_{CPI}\right]+O\left(\epsilon^3\right) \quad (30)$$

A second-order expansion of equation (16) shows that risk sharing implies that the first moments of consumption and output in the two countries are related as follows

$$E\left[\hat{C}-\hat{C}^{*}\right]=E\left[\left(\hat{Y}-\hat{Y}^{*}\right)+\left(\hat{P}_{H}-\hat{P}_{F}^{*}\right)-\left(\hat{P}-\hat{P}^{*}\right)\right]+O\left(\epsilon^{3}\right) \tag{31}$$

while second-order expansions of the home and foreign output relationships yield[8]

$$E\left[\hat{Y}\right]=E\left[\frac{1}{2}\left(\hat{C}+\hat{C}^{*}\right)-\theta\left(\hat{P}_{H}-\hat{P}\right)\right]+O\left(\epsilon^{3}\right) \tag{32}$$

$$E\left[\hat{Y}^{*}\right]=E\left[\frac{1}{2}\left(\hat{C}+\hat{C}^{*}\right)-\theta\left(\hat{P}_{F}^{*}-\hat{P}^{*}\right)\right]+O\left(\epsilon^{3}\right) \tag{33}$$

Combining (31), (32) and (33) with the purchasing power parity condition yields the following expression for the expected level of the exchange rate

$$E\left[\hat{S}\right]=\frac{\theta-1}{2\theta}\left(\lambda_{P_{H}}-\lambda_{P_{F}^{*}}\right) \tag{34}$$

Using the above equations it is possible to write consumption and output levels entirely in terms of λ_{P_H}, $\lambda_{P_F^*}$ and λ_{CPI} as follows

$$E\left[\hat{C}\right]=-\left(\frac{2\theta-1}{4\theta}\right)\lambda_{P_{H}}-\frac{1}{4\theta}\lambda_{P_{F}^{*}}-\left(\frac{1+\theta}{2}\right)E\left[\lambda_{CPI}\right]+O\left(\epsilon^{3}\right) \tag{35}$$

$$E\left[\hat{C}^{*}\right]=-\frac{1}{4\theta}\lambda_{P_{H}}-\left(\frac{2\theta-1}{4\theta}\right)\lambda_{P_{F}^{*}}-\left(\frac{1+\theta}{2}\right)E\left[\lambda_{CPI}\right]+O\left(\epsilon^{3}\right) \tag{36}$$

$$E\left[\hat{Y}\right]=-\frac{1}{2}\lambda_{P_{H}}-\frac{(1-\theta)}{2}E\left[\lambda_{CPI}\right]+O\left(\epsilon^{3}\right) \tag{37}$$

$$E\left[\hat{Y}^{*}\right]=-\frac{1}{2}\lambda_{P_{F}^{*}}-\frac{(1-\theta)}{2}E\left[\lambda_{CPI}\right]+O\left(\epsilon^{3}\right) \tag{38}$$

It is useful at this stage to consider what these expressions reveal about the determination of the expected levels of consumption and output. Equations (35), (36), (37) and (38) show that the risk premia, λ_{P_H} and $\lambda_{P_F^*}$, have a negative impact on expected output and consumption. Any factor which increases the risk faced by producers (such as an increase in the volatility of output) will discourage the supply of work effort and therefore depress output. By definition this also reduces the quantity of goods available for consumption and therefore reduces the expected level of consumption. Equations (35), (36), (37) and (38) also show that the λ_{CPI} term implies that, when $\theta > 1$, exchange rate volatility has a positive impact on the expected level of consumption and a negative impact on the expected level of

[8] In general the following equations should include terms which depend on the second moments of home and foreign consumption. However, the perfect cross-country correlation of consumption levels implies that these terms are equal to zero. They are therefore omitted from (32) and (33).

output. As discussed above, exchange rate volatility tends to reduce the average cost of the consumption basket when $\theta > 1$. This allows agents to reduce work effort and consume more goods.[9]

The only remaining task is to derive expressions for the second-moment terms λ_{P_H}, $\lambda_{P_F^*}$ and λ_{CPI}. This can be done simply by using the expressions for realised output, consumption, prices and the exchange rate derived in Section 4.

In the case of a fixed exchange rate, it follows that

$$\lambda_{P_H} = \lambda_{P_F^*} = 2\sigma^2$$

$$E\left[\lambda_{CPI}\right] = 0$$

so the expressions for the first moments of consumption and output in a fixed rate regime can be rewritten as

$$E\left[\hat{C}\right] = E\left[\hat{Y}\right] = -\sigma^2 + O\left(\epsilon^3\right) \tag{39}$$

In the case of a floating rate the following expressions for λ_{P_H}, $\lambda_{P_F^*}$ and λ_{CPI} are obtained

$$\lambda_{P_H} = \frac{3\left(1-\theta\right)^2\sigma^2}{8}$$

$$\lambda_{P_F^*} = \frac{\left(3 + 10\theta + 3\theta^2\right)\sigma^2}{2}$$

$$E\left[\lambda_{CPI}\right] = \frac{1}{8}\left(1-\theta\right)\sigma^2$$

so the expressions for the first moments of consumption and output in a floating rate regime can be rewritten as

$$E\left[\hat{C}\right] = \left(\frac{-6 + 3\theta - \theta^2}{8}\right)\sigma^2 + O\left(\epsilon^3\right) \tag{40}$$

$$E\left[\hat{Y}\right] = -\left(\frac{1-\theta}{2}\right)^2\sigma^2 + O\left(\epsilon^3\right) \tag{41}$$

5.2 Welfare

It is now simple to combine the above expressions to obtain the final expressions for welfare. Combining (23) and (39) yields the following expressions for welfare in the fixed rate regime

$$\tilde{\Omega}_{Fix} = -\sigma^2 + O\left(\epsilon^3\right) \tag{42}$$

[9] Note that this last point only relates to the effect of exchange rate volatility operating through the λ_{CPI} term. Exchange rate volatility affects λ_{P_H}, $\lambda_{P_F^*}$ and λ_{CPI} simultaneously, so, in equilibrium, it will not be possible to increase world consumption and reduce world output simply by making the exchange rate more volatile.

and combining (25), (40) and (41) shows that welfare in the floating rate regime is given by

$$\tilde{\Omega}_{Float} = -\left(\frac{6 - 3\theta + \theta^2}{8}\right)\sigma^2 + O\left(\epsilon^3\right) \tag{43}$$

It immediately follows from these expressions that the floating rate regime yields higher welfare than the fixed rate regime when $\theta(\theta - 3) < 2$ or when $\theta \lesssim 3.56$. Thus a floating exchange rate regime yields higher welfare when the expenditure switching effect is relatively weak, but a fixed exchange rate regime is superior when the expenditure switching effect is strong.

This result can be understood by considering the impact of exchange rate volatility and the expenditure switching effect on the three components of the welfare measure (i.e. the expected levels of consumption and output and the variance of output). Equations (41) and (40) show that the expected levels of output and consumption in a floating rate regime decline as the expenditure switching effect becomes stronger (at least for high values of θ). The decline in the expected levels of output and consumption is a direct result of the rise in the volatility of output that occurs in the floating rate regime as the expenditure switching effect becomes stronger. Higher output volatility raises the risk premia in goods prices (λ_{P_H} and $\lambda_{P_F^*}$) and therefore lowers work effort and the supply of consumption goods.

In summary, therefore, a strong expenditure switching effect (i.e. a high value of θ) implies a high variance of output (which has a negative effect on welfare), a low expected level of output (which has a positive effect on welfare) and a low expected level of consumption (which has a negative effect on welfare). Furthermore, a comparison of (25) and (41) shows that the positive welfare effect of the expected level of output exactly offsets the negative welfare effect of the variance of output. The net result is that welfare in the floating rate regime declines as the expenditure switching effect becomes stronger because of the negative impact of output volatility on the expected level of consumption. And, for large values of θ, this effect can become so strong that it implies that a fixed rate regime is welfare superior to a floating rate regime.

6 Conclusions

This paper has analysed the implications of the expenditure switching effect for the choice of exchange rate regime in the presence of foreign monetary shocks. A comparison between fixed and floating rate regimes shows that, while the volatility of consumption is unambiguously lower in the floating exchange rate regime, the volatility of home output can be higher or lower depending on the value of the elasticity of substitution between home and foreign goods. A welfare comparison of the two regimes concludes that a floating exchange rate regime yields higher welfare when the expenditure switching effect is relatively weak, but a fixed exchange rate regime is superior when the expenditure switching effect is strong.

It is necessary to conclude with some qualifying remarks. The results presented above are obviously derived in a restricted model. There are a number of highly relevant and feasible ways in which the model can be generalised. For instance, the preference function could be generalised to allow for variable degrees of risk aversion in consumption and labour supply. Given the trade-off between consumption and output volatility which arises when the expenditure switching effect is strong, the degree of risk aversion in consumption and labour supply will have important implications for the welfare comparison between regimes. It is also necessary to extend the analysis to consider other sources of shocks. The shock-absorbing role of floating exchange rates in the presence of real demand and supply shocks was an important element in Friedman's case for floating rates (and also in the analysis of Mundell (1960)). This is not addressed by the above model.

Finally, there is the issue of local currency pricing (or more generally the extent of exchange rate pass through). Devereux and Engel (2000) argue that local currency pricing is so prevalent that relative prices are insensitive to exchange rate changes. This implies that the elasticity of substitution between home and foreign goods is less relevant than the model of this paper implies. Indeed, when there is full local currency pricing, the elasticity of substitution becomes irrelevant. However, the assumption of full local currency pricing is an extreme case (just as our assumption of full producer currency pricing is an extreme case). A full analysis of this issue requires a more general model, which allows for a partial degree of pass-through (or partial local currency pricing)[10] and which also allows the elasticity of substitution to differ from unity. It would then be possible to analyse the welfare comparison between fixed and flexible exchange rates against the background of a realistic degree of pass-through coupled with empirically relevant values for the elasticity of substitution and risk aversion.

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Appendix

A. Optimal Price Setting

The price-setting problem facing representative home producer h is the following:

$$MaxU(h) = E\left\{\log C(h) + \chi \log \frac{M(h)}{P} - \frac{K}{2} y^2(h)\right\} \tag{44}$$

subject to

$$PC(h) = p_H(h)\, y(h) + M_0 - M(h) - T + R(h) \tag{45}$$

$$y(h) = c_H(h) + c_H^*(h) = (C_H + C_H^*)\left(\frac{p_H(h)}{P_H}\right)^{-\phi} \tag{46}$$

The first order condition with respect to $p_H(h)$ is[11]

$$E\left\{\frac{y(h)}{PC(h)} - \phi\left[\frac{p_H(h)}{PC(h)} - Ky(h)\right]\frac{y(h)}{p_H(h)}\right\} = 0 \tag{47}$$

In equilibrium all agents choose the same price and consumption level so

$$E\left\{\frac{Y}{PC} - \phi\left[\frac{P_H}{PC} - KY\right]\frac{Y}{P_H}\right\} = 0 \tag{48}$$

where

$$Y = C_H + C_H^* \tag{49}$$

Rearranging yields the expression in the main text. The derivation of the first-order condition for the representative foreign producer follows identical steps (and is omitted).

B. Portfolio Allocation, Asset Prices and Risk Sharing

There are four first-order conditions for the choice of asset holdings. After some rearrangement they imply the following four equations

$$E\left[C^{-1}y\right] = E\left[C^{-1}\right] q_H, \quad E\left[C^{-1}y^*\right] = E\left[C^{-1}\right] q_F \tag{50}$$

$$E\left[C^{*-1}y\right] = E\left[C^{*-1}\right] q_H, \quad E\left[C^{*-1}y^*\right] = E\left[C^{*-1}\right] q_F \tag{51}$$

The combination of the private and government budget constraints and the portfolio payoff functions for each country imply that aggregate home and foreign consumption levels are given by

$$C = y + \zeta_H (y - q_H) + \zeta_F (y^* - q_F) \tag{52}$$

[11] Notice that this first-order condition is unaffected by the existence of income contingent assets because the asset returns are assumed to be correlated with aggregate real income. Asset returns are therefore treated as exogenous from the point of view of individual agents.

$$C^* = y^* + \zeta_H^* (y - q_H) + \zeta_F^* (y^* - q_F) \tag{53}$$

where in a symmetric equilibrium $\zeta_H(h) = \zeta_H$ and $\zeta_F(h) = \zeta_F$ for all h and $\zeta_H^*(f) = \zeta_H^*$ and $\zeta_F^*(f) = \zeta_F^*$ for all f. Equilibrium in asset markets implies $\zeta_H + \zeta_H^* = 0$ and $\zeta_F + \zeta_F^* = 0$. These equations can be used to solve for q_H, q_F, ζ_H, ζ_F, ζ_H^*, ζ_F^*, C and C^* in terms of y and y^*.

Using the solution procedure outlined in Obstfeld and Rogoff (1996, pp 302-3) it is possible to show that the two asset prices are given by

$$q_H = \frac{E\left[\frac{y}{y+y^*}\right]}{E\left[\frac{1}{y+y^*}\right]}, \qquad q_F = \frac{E\left[\frac{y^*}{y+y^*}\right]}{E\left[\frac{1}{y+y^*}\right]} \tag{54}$$

and consumption levels in the two countries are given by

$$C = \frac{q_H (y + y^*)}{q_H + q_F}, \qquad C^* = \frac{q_F (y + y^*)}{q_H + q_F} \tag{55}$$

Thus

$$\frac{C}{C^*} = \frac{q_H}{q_F} = \frac{E\left[\frac{y}{y+y^*}\right]}{E\left[\frac{y^*}{y+y^*}\right]} \tag{56}$$

which is equation (16) in the main text.