Monetary Policy Rules and Business Cycles

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Abstract

This study explores the implications of monetary policy rules in a general equilibrium two-country framework with sticky prices, and monopolistic competition. The monetary policy rules we use is adapted from Alvarez, Lucas, and Weber (2001). We derive a solution for the nonlinear model, by calibrating using standard international real business cycle techniques. There are two uncertainties in the economy: 1) money growth shock, 2) productivity shock. Specifically, the model using neoclassical framework with monetary rules fits the real small open economies well. The investigate also implies that ‘expenditure switching effect’ is performed not significant in a small open economy with the neoclassical monetary policy.

Keywords: Monetary policy rule; Exchange rate volatility; Sticky price

JEL classification: E52; F31

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1 Introduction

This study develops a simple dynamic general equilibrium model of a small country with staggered price-setting to investigate how alternative monetary policy rules can improve financial stabilities.

The aim of this work is to identify the main results of monetary policies on macroeconomic stabilities. The model contains two sectors, small open economy, where staggered prices are agents adjusting their prices infrequently. Staggered prices are one explanation commonly offered for these macroeconomic variables movements. Monetary shocks could induce an immediate change in the nominal variables, and this would translate into a change in the real variables if national price levels remain fixed (Bergin, and Feenstra 2001).

Our methodology is to analyze the properties and macroeconomic implications of monetary rule, in face of exogenous external shocks to a small country. In contrast with most of the existing literature—where monetary policy is known as Taylor rules, which assumes that policymakers concern about inflation, output level, and exchange rate stability\(^1\). In the present paper, the monetary policy, developed by Alvarez, Lucas, and Weber (2001), using a neoclassical framework that is also consistent with the quantity theory of money and money growth rate. The work also examines a rule under alternative velocities of money.

As mentioned above, the investigation considers the monetary policies under neoclassical model. The analysis of the optimal rule is meant to provide a helpful benchmark, allowing us to discuss a number of interesting issues under a normative light: What is the macroeconomic stability connected with the policy rule? Some interesting results emerge from the analysis.

The main result that comes out of the analysis is that the model using neoclassical framework with monetary rules fits the real small open economies, Switzerland and Canada, well. The intuitions are probably that the policy makers determine the optimal nominal interest rate by considering money growth control and velocity of money, and thus it can cushion the money growth shock more efficient. The model also demonstrates an 'expenditure switching effect' being not very significant in a

\(^1\)See, e.g., Gali and Monacelli (1999), Devereux (2001).
small country. The dynamic path of aggregate price level is staggered the same as our model setting.

The reminder of the paper is organized as follows. In section 2 we lay out the basic framework. Section 3 discusses sticky price. Section 4 analysis the monetary policy rules under a money growth disturbances. Section 5 presents the calibration and solution of the model. Finally, we make some concluding remarks.

2 The Basic Model

The framework is structured around that of Obstfeld and Rogoff (1995, 1996), Tille (2001), and Borondo (2002). There are two countries, home and foreign. The economy is populated by a continuum of identical infinite-lived households. Variables referring to the foreign country are denoted by an asterisk. Households in each country consume a group of differentiated commodities of total measure unity. Households over the [0,n) interval live in the home country, while over the [n,1] live in the foreign country. Hence, the sizes of the home and foreign economies are \( n \) and \( 1 - n \), respectively. However, we assume that the domestic population is small relative to the rest-of-the-world’s, so that \( n \) is small in the study.

2.1 Households

Households have identical preferences over a consumption index, real money balances, and output. Consumers preferences in the home country are represented by the intertemporal utility function:

\[
U_t = \sum_{s=t}^{\infty} \beta^{s-t} u_s(C, \frac{M}{P}, Y(z))
\]

where, \( C \) is a composite consumption basket, such that \( C = C(C_h, C_f) \). \( C_h \) denotes consumption of the home commodities, and \( C_f \) is consumption of the foreign goods. \( M \) represents the nominal money balances, and \( P \) is the consumer price index. \( Y(z) \) denotes the output; home output with \( z \in [0, n) \), and foreign output with \( z \in [n, 1] \). Let the specific functional form of felicity be given by
\[ U_t = \sum_{s=t}^{\infty} \beta^{s-t} \left\{ C_s^{1-\sigma} \frac{(M_s)^{1-\varepsilon}}{1-\varepsilon} - \eta Y_s(z)^{1+\psi} \right\} \]

where \( \beta < 1 \) denotes the rate of time preference, and \( \frac{1}{\sigma} \) and \( \frac{1}{\varepsilon} \) are the intertemporal elasticity of substitution in consumption and real balances, respectively. \( \psi > 0 \) is the degree of convexity of effort cost.

Additionally, if the model assumes composite consumption basket take a Dixit-Stiglitz-Spence form

\[ C_t = \left[ n^\rho C_{ht}^{\frac{\rho-1}{\rho}} + (1-n)^\rho C_{ft}^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \]

and then the consumption price index will be

\[ P_t = \left[ nP_{ht}^{1-\rho} + (1-n)P_{ft}^{1-\rho} \right]^{\frac{1}{1-\rho}} \]

where \( \rho > 0 \) represents the intratemporal elasticity of substitution between home and foreign commodities at time \( t \), and \( P_{ht}, P_{ft} \) denote the prices of the home and foreign commodities in home currency.

Assume that consumption is differentiated at the individual commodities level, so that

\[ C_{ht} = \left[ n^\theta \int_0^n C_{ht}(z)^{\frac{\theta-1}{\theta}} d_z \right]^{\frac{\theta}{\theta-1}} \]

\[ C_{ft} = \left[ (1-n)^\theta \int_n^1 C_{ft}(z)^{\frac{\theta-1}{\theta}} d_z \right]^{\frac{\theta}{\theta-1}} \]

Finally, there are sub-price indices of the home country defined as

\[ P_{ht} = \left[ \frac{1}{n} \int_0^n P_{ht}(z)^{1-\theta} d_z \right]^{\frac{1}{1-\sigma}} \]

\[ P_{ft} = \left[ \frac{1}{1-n} \int_n^1 P_{ft}(z)^{1-\theta} d_z \right]^{\frac{1}{1-\sigma}} \]

Notice that under our specification \( \theta > 1 \) measures the elasticity of substitution between commodities produced inside each country. Defining the foreign country sub-price indices in the same way, the terms of trade \( Q_t \) may be obtained as
\[ Q_t = \frac{P_{ht}}{S_t P^*_t} \]  

(2)

where \( S \) represents the nominal exchange rate (units of home currency per foreign currency).

### 2.2 Consumption Allocation

The household of home country will choose home and foreign goods to minimize expenditure condition on total composite consumption demand \( C_t^2 \). Demand for home and foreign goods are then

\[
C_{ht}(z) = \left[ \frac{P_{ht}(z)}{P_{ht}} \right]^{-\theta} \left[ \frac{P_{ht}}{P_t} \right]^{-\rho} C_t
\]

\[
C_{ft}(z) = \left[ \frac{P_{ft}(z)}{P_{ft}} \right]^{-\theta} \left[ \frac{P_{ft}}{P_t} \right]^{-\rho} C_t
\]

Analogous relationship holds for the foreign country.

\[
C^*_{ht}(z) = \left[ \frac{P^*_{ht}(z)}{P^*_{ht}} \right]^{-\theta} \left[ \frac{P^*_{ht}}{P^*_t} \right]^{-\rho} C^*_t
\]

\[
C^*_{ft}(z) = \left[ \frac{P^*_{ft}(z)}{P^*_{ft}} \right]^{-\theta} \left[ \frac{P^*_{ft}}{P^*_t} \right]^{-\rho} C^*_t
\]

where, \( P_h(z) \) denotes the domestic price of a home good \( z \), and \( P^*_f(z) \) represents the foreign price of a foreign commodity \( z \).

### 2.3 Prices and Optimal Conditions

We assume that absent natural or government imposed trade barriers in the model, so that a commodity should sell for the same price everywhere (while prices are

\(^2\)The contributions by Obstfeld and Rogoff (1995, 1996) considered the case where \( \theta = \rho \), while Tille (2001) discussed the case where \( \theta \neq \rho \). In additions, Corsetti and Pesenti (2001) focused on the situation where \( \theta > 1 = \rho \).
measured in the same numeraire). In other words, the law of one price must hold for goods, so that

$$P_h^*(z) = \frac{P_{ht}(z)}{S_t}$$

(3)

$$P_{ft}(z) = S_tP_{ft}^*(z)$$

(4)

A straightforward implication of law of one price is that consumption-based purchasing power parity holds as well, that is

$$P_t = S_tP_t^*$$

Integrating demand for commodity $z$ across all agents, and making use of the purchasing power parity, we see that the demand for commodity $z$ is obtained by aggregating private purchases across all households worldwide

$$Y_t(z) = \left[\frac{P_{ht}(z)}{P_{ht}}\right]^{-\theta}\left[\frac{P_{ht}}{P_t}\right]^{-\rho}C_{wt}$$

$$Y_t^*(z) = \left[\frac{P_{ft}^*(z)}{P_{ft}^*}\right]^{-\theta}\left[\frac{P_{ft}^*}{P_t^*}\right]^{-\rho}C_{wt}$$

where, world consumption $C_w$ is defined as $C_{wt} \equiv nC_t + (1 - n)C_t^*$.

To complete the specification of the agent’s problem, the study presents the individual’s intertemporal budget constraint

$$B_t + M_t = (1 + i_{t-1})B_{t-1} + M_{t-1} + P_{ht}(z)Y_t(z) - P_tC_t - T_t$$

(5)

Wealth that home agents take into the next period $B_t + M_t$, is accumulated from wealth brought into the current period $(1 + i_{t-1})B_{t-1} + M_{t-1}$ add current income $P_{ht}(z)Y_t(z)$ less consumption and taxes $P_tC_t + T_t$. Where $i$ denotes the nominal interest rate on bonds denominated in home currency, $B$ is the home agent’s holdings of nominal bonds. The variable $T$ represents lump sum taxes. Wealth is derived in a similar form by the foreign agent.
Note that, the existence of equilibrium requires the transversality condition always hold.³

\[
\lim_{t \to \infty} \beta^t \frac{B_{t+1}}{(1 + i_t)^t} = 0
\]

To solve the model, household chooses consumption, money holdings, and prices to maximize the felicity function Eqn. (1), subject to the budget constraints Eqn. (5). The first-order condition for the agent can be written as

\[
C_t^{-\sigma} P_t^{-1} = \beta E_t (1 + i_t) C_{t+1}^{-\sigma} P_{t+1}^{-1}
\]  

(6)

\[
\left( \frac{M_t}{P_t} \right)^{-\epsilon} = \frac{1}{\chi} \left( \frac{1}{C_t^{-\sigma}} - E_t \beta \frac{P_t}{C_{t+1}^{-\sigma} P_{t+1}^{-1}} \right)
\]  

(7)

\[
P_{ht}^{1+\theta \psi}(z) = \frac{\eta \theta}{\theta - 1} P_h^{\psi(\theta - \varphi)} P_t^{\psi(\theta - \varphi)} C_wt^{\psi} C_t^{-\sigma}
\]  

(8)

Equation (6) is, of course, the familiar first-order consumption Euler equation for the case where the intertemporal elasticity of substitution is $\frac{1}{\sigma}$. Equation (7) gives the implicit money demand function. The first order condition for the domestic price of a home good $z$ is Eqn.(8). Analogous equations hold for the foreign economy.

2.4 The Equilibrium Conditions

Market clearing condition for bonds requires the global net foreign assets to be in zero, so that⁴

\[
nB_t + (1 - n)B^*_t = 0
\]

In the aggregate, given the bonds market clearing condition, one can derive an aggregate world products market clearing condition as follows

\[
C_{wt} - Y_{wt} = 0
\]

³It states that the value of the agent’s bond holding discounted to time 0 must approach zero; that is, the household playing no Ponzi game schemes.

⁴The bond is available in zero net supply so that bonds held by foreigners are issued by home agents.
where,
\[ Y_{wt} = n \frac{P_{ht}Y_t}{P_t} + (1 - n) \frac{P^*_{ft}Y^*_t}{P^*_t} \]

The real interest rate, \( r \), between \( t \) and \( t + 1 \) is defined by the Fisher parity

\[ 1 + i_t = \frac{E_t P_{t+1}}{P_t} (1 + r_t) \tag{9} \]

The Fisher equation implies that the real rates of return on nominal and real bonds must be identical. Let \( i^*_t \) be the nominal interest rate on the foreign currency bonds. Then, absence of unexploited arbitrage conditions requires

\[ 1 + i_t = \frac{E_t S_{t+1}}{S_t} (1 + i^*_t) \tag{10} \]

, that is, uncovered interest rate parity holds in equilibrium\(^5\).

2.5 Government

Without loss of generality, the study assumes that the government runs a balanced budget each time. That is, all seignorage revenues are rebated to agents in a lump-sum fashion. The government budget constraint is therefore given by

\[ T_t = -(M_t - M_{t-1}) \]

As the nominal bonds require the net foreign assets to be in zero worldwide, each country may run the current account surpluses as

\[ B_t - B_{t-1} = i_{t-1}B_{t-1} + P_{ht}(z)Y_t(z) - P_tC_t \tag{11} \]

\[ -\frac{n}{1 - n}(B_t - B_{t-1}) = -\frac{n}{1 - n}i^*_{t-1}B_{t-1} + P^*_{ft}(z)Y^*_t(z) - P^*_tC^*_t \tag{12} \]

\(^5\)The consumption-based purchasing power parity and uncovered interest rate parity imply that the real interest rate parity also holds, that is \( r_t = r^*_t \).
3 Sticky Prices

The study now assumes that price setting is rigid. The model of staggered price adjustment is, as in Taylor (1979), Calvo (1983), and Yun (1996), etc. In the Taylor model, firms determine overlapping price contracts for the fixed durations, whereas in the Calvo (1983) and Yun (1996), price contracts are of stochastic duration for each firm, but in aggregate economy, a constant part of firms reset their prices each period. The work employs the Calvo assumption here\(^6\).

Suppose the agent sets its price to minimize a quadratic loss function that depends on the difference between its actual price \(p^a_{ht}\), and the optimal price \(\hat{p}_{ht}\), in time \(t\). The agent therefore faces an expected loss function of

\[
\frac{1}{2}E_t\sum_{j=0}^{\infty} \beta^j(p^a_{ht+j} - \hat{p}_{ht+j})^2
\]

If the agent cannot revise its price in each period with probability \(1 - \zeta\), and keep the price to be fixed from \(t\) to \(t+1\), then the terms in the above objective function involving the price set at time \(t\) are

\[
\frac{1}{2}(p^a_{ht} - \hat{p}_{ht})^2 + \frac{1}{2}(1 - \zeta)\beta E_t(p^a_{ht} - \hat{p}_{ht+1})^2 + \frac{1}{2}(1 - \zeta)^2\beta^2 E_t(p^a_{ht} - \hat{p}_{ht+2})^2 + \cdots (13)
\]

\[= \frac{1}{2}\sum_{j=0}^{\infty} (1 - \zeta)^j \beta^j E_t(p^a_{ht} - \hat{p}_{ht+j})^2
\]

Consequently, the first order condition for the optimal price setting at time \(t\) is

\[
p^a_{ht} \sum_{j=0}^{\infty} (1 - \zeta)^j \beta^j = \sum_{j=0}^{\infty} (1 - \zeta)^j \beta^j E_t\hat{p}_{ht+j}
\]

From the above condition of optimal price choice, the newly set price \(p^a_{ht}\) must satisfy

\[
p^a_{ht} = [1 - (1 - \zeta)\beta]\hat{p}_{ht} + (1 - \zeta)\beta E_t p^a_{ht+1} \quad (14)
\]

\(^6\)We draw on Walsh (1998) for the following procedure.
With a large number of agents, a fraction $\zeta$ of agents will get charged a new price and the other fraction $1 - \zeta$ must charge the previous period’s prices each time\(^7\). Therefore, the aggregate price level can be obtained as

$$p_{ht} = \zeta p_{ht}^a + (1 - \zeta)p_{ht-1}$$

(15)

4 Monetary Policy Rules

The discussion to this aspect has assumed that the money supply can be implemented as the instrument of monetary policy. Most central banks in the industrialized countries actually use monetary policy by controlling a short-run nominal interest rate\(^8\). Much recent debate of interest rate rule is focus on a class of policies known as 'Taylor rules'. The policy rule for nominal interest rate can be used with the aggregate supply and demand equations to determine equilibrium output and inflation\(^9\). However, the analysis was not derived directly from the assumption of optimizing behavior on the point of the typical agents in the economy. One disadvantage of these models is that there is no social welfare measure that can be used to evaluate alternative monetary rules. Among the more recent works employing general equilibrium, typical agent models to study interest rate rules are Carlstrom and Fuerst (1995, 1997), Woodford (1997), and Alvarez, Lucas, and Weber (2001). However, the study adopts the monetary policy rules developed by Alvarez, Lucas, and Weber (2001). They employed a cash-in-advance model in which markets are incomplete and consumption must be financed from money balance. The properties of Taylor rules can also be examined in their work by using a neoclassical framework that is also consistent with the quantity theory of money.

To complete the description of the system, the framework assumes that the monetary policy is specified by the per capita increase in money

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\(^7\)In a symmetric economy, because all agents are alike, they each change their price equal to the right hand side of Eqn. (14).

\(^8\)As discussed in Bernanke and Mishkin (1992) and Kasman (1993), the monetary authorities in the chief OECD countries implement short-term market interest rate as their instrument of policy.

\[ d_t = m_t - m_{t-1} \]  

(16)

Here, \( d \) denotes the nominal monetary growth rule, and \( m = \log M \). The study assumes that a temporary change in the growth rate of money influences on the artificial economy.

The quantity theory of money must hold in equilibrium,

\[ m_t + v_t = p_t(z) + y_t(z) \]  

(17)

the fraction \( v \) can be defined as the velocity of money, \( p(z) = \log P(z) \), and \( y(z) = \log Y(z) \). In the formulation of the model, if the behavior of the money supply is given, then prices, \( p(z) \), are fully determined by Eqn. (17).

In the analysis of monetary policy defined as monetary growth rate control and velocity of money, Alvarez, Lucas, and Weber (2001) introduces the rule as

\[ i_t = \phi(E_t d_{t+1} - d_t) + E_t d_{t+1} + E_t v_{t+1} - v_t \]  

(18)

With \( \phi > 0 \), the rule combines quantity-theoretic predictions for the behavior of monetary growth, inflation, and interest rates, with a key role for interest rates as a mechanism of inflation control in the short-term. When control of monetary aggregates is the chief player to low average inflation rate, an interest rate rule can improve the behavior of interest rates and prices. From Eqn. (18) one can know that the immediate influence of an open-market-operation bond purchases, \( d > 0 \), is to reduce interest rate by \( \phi d_t \).

## 5 Calibration and Solution

In the section, we will discuss the approximation method, the parameter values chosen, and the impulse responses to an external shock. These properties of the solution serve as a basis of comparison with empirical economies. Also, the results are applied to two small economies, Switzerland and Canada (Zimmermann (1997)). These features refer to moments of Hodrick-Prescott filtered variables.
The work derives a solution for the nonlinear model, by calibrating using the log-linear approximation techniques of King, Plosser, and Rebelo (1988)\(^{10}\). Thus, the nonlinear model can be solved by linearizing around an initial zero-shock steady state. Here the work illustrates the responses to an external shock.

### 5.1 Calibration

The parameter choices for the model are described in Table 1. Most values are very standard. Rather than calibrating to any closed economy’s data-set, the study adopts a set of parameter values that are generally applied to small open economies.

The rationale for the parameter values chosen is as follows. A value of \(\beta\) of 0.985 governs an annual interest rate of 6 percent, and the relative size \(n\) equals to 0.05 implies that home country is a small open economy. The both parameters \(\sigma\) and \(\varepsilon\) imply the consumption and interest elasticity of money demand to be set at 2. On the other hand, the elasticity of substitution between foreign and domestic goods \(\rho\) is equal to 1.5, the number is suggested by Backus, Kehoe, and Kydland (1994). The degree of liquidity effect, \(\phi\), in the monetary policy rule is tried in a series of parameters, and the results, however, are rather persistent. The following results are calibrated, when \(\phi\) is set to be 1\(^{11}\). Finally, to choose values of \(\zeta\) and \(\psi\) to be 0.2 and 1, respectively, we can solve the standard calibration in international real business cycles model directly.

### 5.2 Quantitative Evaluation of the Model

The model assumes that the economy is exposed to two types of external disturbances: a) shocks to money growth, b) shocks to productivity.

The vectors \(w_t = (w_{1t}, w_{2t})\) and \(a_t = (a_{1t}, a_{2t})\) are stochastic shocks to money growth and productivity, respectively, which we model as independent bivariate

\(^{10}\)Because, the model can not be solved analytically.

\(^{11}\)The volatilities in the model is relative small (large), when \(\phi\) is less (large) than 1, *ceteris paribus.*
autoregressions. The money growth shocks follow

\[ w_t = G w_{t-1} + \epsilon^w_t \]

where \( \epsilon^w = (\epsilon^w_1, \epsilon^w_2) \) is distributed independently and normally over time. Similarly, shocks to productivity follow\(^{12}\)

\[ a_t = H a_{t-1} + \epsilon^a_t \]

where \( \epsilon^a = (\epsilon^a_1, \epsilon^a_2) \) is also distributed normally and independently. Money growth shocks, \( w \), and productivity shocks, \( a \), are independent\(^{13}\).

Meanwhile, the study explores the characteristics of the calibrated framework by deriving the impulse responses to money growth disturbances. The figures demonstrate the responses of 12 major macroeconomic variables, nominal exchange rate, bond holding, terms of trade, current account, output level, consumption, nominal interest rate, real interest rate, inflation, consumer price index, aggregate price level, and world consumption. The responses for other variables, such as money holding or velocity of money can be inferred from the variables illustrated in the Figures.

Figures 1-3 display the impact of an unexpected, temporary one percent point expansion in the home country money growth rate, beginning in a steady state. The money growth expansion causes an immediate and permanent depreciation in the nominal exchange rate (Figure 1). We can have more intuition for the endogenous stable by monetary model. The monetary rule in the model suggested by Alvarez et. al. (2001) analyzes that the policy maker sets nominal interest rate by considering money growth control and velocity of money, and therefore it can cushion the money growth shock more efficient than others.

---Figures 1-2: about here---

Because aggregate price level take some time to change to the money growth shock (see, Eqn. (15)), the nominal exchange rate depreciation causes a movement

\(^{12}\)Following Obstfeld and Rogoff (1995), a positive disturbance will reduce the disutility of work, \( \eta \), in the felicity function.

\(^{13}\)The values of \( G \) and \( H \) of 0 imply no autocorrelation and no spillover effect in the two disturbances.
in the terms of trade. How does terms of trade react? The finding may be explained in a more intuitive term. Export prices are contracted in home currency and import prices in foreign currency. Consequently, a depreciation in nominal exchange rate causes a deterioration in the terms of trade (Figure 1) only to the degree that the aggregate price indexes in each country adjust in a staggered way (Figure 3). The drop in the terms of trade causes an 'expenditure switching effect' of world demands away from the foreign economy towards the home economy. Thus, there is an increase in home output level, and a decrease in foreign output level. However, an implication of this finding is that the effect of terms of trade changes might be relative weak. That is, a change in the terms of trade of home country, a small economy, might not lead to much substitution between domestically-produced goods and foreignly-produced goods\(^\text{14}\).

---Figures 3-4 :about here---

If foreign goods play a larger fraction in the home consumption basket, the overall home consumption price index will rise more. Further, if foreign goods represent a larger role of competitors in the home market, home agents will tend to rise their price in response. Note that even though outputs change in different ways, consumption changes in the same direction in both countries. Consumption increases immediately, whereas then gradually decreases back to its steady state level (Figure 2). But there is now a relatively higher increase in domestic consumption than foreign consumption (Figure 2). Because real interest rate can be derived directly from the rate of growth of consumption, we can deduce from Figure 2 that the home money growth expansion reduces real interest rate.

Figures 4-6 plots the responses of the economy to a temporary, one percent positive productivity shock in the home country. The productivity disturbance reduces optimal price, therefore decreasing the actual price of domestic commodities by a

\(^{14}\text{Thus, in a small open economy as well as the neoclassical monetary policy, as demand for exports picks up and domestic consumers switch their spending away from imported commodities and services, the overall current account improves. However, there was not a deep deterioration in foreign output level, since domestic economy is small. The beggar-thy-neighbor effect is therefore relative small.}
fraction (see, Eqn. (14)) reducing the consumer price index, and rising world demand for domestic commodities (Figure 6). As output increases in home country, the representative household increases its both consumption and net exports. However, the rise in consumption is far less than that in output as the agent aims at smoothing its consumption.

We also find that a positive productivity shock lead to a temporary reduction in the domestic interest rate under the monetary policy rule. Such a decline is largely mirrored by real interest rate, and accounts for the rise in consumption on impact.

Table 2 compares the quantitative implications of the model with the empirical evidences. The top portion of the table shows that correlation coefficients with output level provide a picture of how procyclical these domestic aggregates are; the second part of the table reports how the same aggregates move together across countries; the last one indicates relative volatilities of cyclical components. The numbers in the 'Switzerland and Canada' column is adopted from the empirical evidences of Zimmermann (1997)\(^\text{15}\). As shown in the first portion of Table 2 the correlation between consumption and output from 0.57 in Switzerland to 0.71 in Canada. In the same set of countries, the correlations between the terms of trade and output are positive for Switzerland, but negative for Canada. The model replicates fairly closely the correlation of 0.57 between Switzerland’s consumption and output. It overstates somewhat the negative correlation between terms of trade and output. The table also shows that the model driven by money growth and productivity shocks replicates the international comovement of output and consumption. The column labeled 'money growth shock' indicates the implications of the model driven by money growth impact. Similarly, the column labeled 'productivity shock' reports those driven by productivity disturbance. The model overpredicts the cross-country

\(^{15}\text{As noted in Zimmermann (1997), the first one defines Switzerland as a small country, the rest of Europe as the large neighbor. The second partition includes Canada as another small country, its neighbor, the United States as a large one.}\)
correlations of consumption for Canada by 30 percent\textsuperscript{16}, and it understates the cross-
country correlation of output not too much. Table 2 also shows that the model was
impacted by 2 shocks replicates the relative volatilities closely. Exception is that
the relative volatilities, terms of trade to output, is nearly half.

6 Conclusions

The study has built on a number of recent contributions, such as Obstfeld and Rogoff
(1996), Calvo (1983), and Alvarez et.al (2001), in international macroeconomics to
examine time-honored issues in the field.

The work also considers the model’s implications for interest rate rules. It is
found that dynamic paths can be replicated in the present work under plausible
parameter values, and has been to seek an explanation for the flexibility. This
might be attributed to the monetary policy rules using neoclassical framework. The
‘expenditure switching effect’ also displays in the small open economy model not
very significant by observing the dynamic paths of output level for home and foreign
countries.

In general, the study lends support to the idea that international macroeconomic
fundamentals can help explain other major variables’ behaviors.

Acknowledgment

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tent Effects of Nominal Shocks in Open Economies, CEPR No.2360.

Open Economies, the Manchester School of Economics, forthcoming.

\textsuperscript{16}The model would imply perfect correlation between consumption across countries.


Figure 1: Impulse Responses for Home to a Money Growth Shock

Figure 2: Impulse Responses to a Money Growth Shock (cont.).
Figure 3: Impulse Responses to a Money Growth Shock (cont.).

Figure 4: Impulse Responses for Home to a Productivity Shock.
Figure 5: Impulse Responses to a Productivity Shock (cont.).

Figure 6: Impulse Responses to a Productivity Shock (cont.).
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<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
<th>Definition</th>
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<tbody>
<tr>
<td>$n$</td>
<td>0.05</td>
<td>Size of the home country</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.985</td>
<td>Rate of time preference</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>0.2</td>
<td>Probability that the agent can adjust price</td>
</tr>
<tr>
<td>$\rho$</td>
<td>1.5</td>
<td>Intratemporal elasticity of substitution</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>2</td>
<td>Inverse of elasticity of substitution in consumption</td>
</tr>
<tr>
<td>$\epsilon$</td>
<td>2</td>
<td>Inverse of elasticity of substitution in real balances</td>
</tr>
<tr>
<td>$\psi$</td>
<td>1</td>
<td>Degree of convexity of effort cost</td>
</tr>
<tr>
<td>$\phi$</td>
<td>1</td>
<td>Liquidity effect</td>
</tr>
<tr>
<td>$G$</td>
<td>$\begin{bmatrix} 0 &amp; 0 \ 0 &amp; 0 \end{bmatrix}$</td>
<td>Money growth shock</td>
</tr>
<tr>
<td>$H$</td>
<td>$\begin{bmatrix} 0 &amp; 0 \ 0 &amp; 0 \end{bmatrix}$</td>
<td>Productivity shock</td>
</tr>
</tbody>
</table>
Table 2: Numerical Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Zimmermann(1997)</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Switzerland</td>
<td>Canada</td>
</tr>
<tr>
<td>Contemporaneous correlations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Corr(y, y)$</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>$Corr(c, y)$</td>
<td>0.57</td>
<td>0.71</td>
</tr>
<tr>
<td>$Corr(q, y)$</td>
<td>0.39</td>
<td>-0.18</td>
</tr>
<tr>
<td>International variables’ correlations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Corr(y, y^*)$</td>
<td>0.61</td>
<td>0.77</td>
</tr>
<tr>
<td>$Corr(c, c^*)$</td>
<td>0.25</td>
<td>0.71</td>
</tr>
<tr>
<td>Relative volatilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_c / \sigma_y$</td>
<td>0.87</td>
<td>0.95</td>
</tr>
<tr>
<td>$\sigma_{nx} / \sigma_y$</td>
<td>0.71</td>
<td>0.54</td>
</tr>
<tr>
<td>$\sigma_{nx} / \sigma_q$</td>
<td>0.51</td>
<td>0.33</td>
</tr>
<tr>
<td>$\sigma_y / \sigma_y$</td>
<td>1.39</td>
<td>1.64</td>
</tr>
</tbody>
</table>

Notes: Numbers in parentheses are standard deviations across replications. All series are detrended using the Hodrick-Prescott filter.