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Monetary Policy and Financial Sustainability in a Two-State Open Economy

Yuwen Dai

International Business School, Zhejiang University, Hangzhou 310058, China; daiyuwen@gmail.com

Abstract: Monetary policy and financial sustainability are linked. However, the role of monetary policy and its implementation have come under particular scrutiny after the 2008 Global Financial Crisis (GFC) and the 2010 European sovereign debt crisis, where one of the main challenges was financial sustainability. In this paper, we contribute to the literature by improving our understanding of the influence of monetary policy on financial sustainability for a monetary union. To that end, we develop a two-state open economy macroeconomic model, in which the two state economies have the same monetary policy but maintain their fiscal independence. Examples include two countries in the eurozone, two states in the United States, core and periphery countries, etc. The linkages between these two state economies are inter-state trade in goods and inter-state borrowing in bonds. We apply the calibrated model and conduct economic experiments under alternative monetary policy regimes. The model simulation shows that monetary policy is incorrect if inflation differentials persist in a monetary union, and that incorrect monetary policy leads to real interest rates that are too low for high inflation countries, which become indebted after excessive borrowing. This study sheds light on how monetary policy should be implemented if inflation differs in countries within a monetary union. Our findings draw policy implications for those "two-state" economies considering alternative macroeconomic policy regimes to achieve financial sustainability and regional economic integration.

Keywords: monetary policy; financial sustainability; optimum currency area (OCA)

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1. Introduction

In international macroeconomics, the concept of the impossible trinity, developed by Mundell (1960, 1963) [1,2] and Fleming (1962) [3], states that it is not possible for an economy to simultaneously maintain monetary policy independence, exchange rate stability, and free access to international capital markets. There are three groups of economies. The first option is to have a floating exchange rate without capital control and maintain independent monetary policy. Examples include the United States, the United Kingdom, Australia, New Zealand, Japan, Korea, Thailand, Indonesia, Singapore, and the Philippines. The second option is to have a fixed exchange rate with capital control, in which case the country does not get full access to international capital markets. An example of a country that practiced this option was China before 2005, during which time the Chinese RMB was pegged to the USD from 1994 to July 2005. The third option is to have a fixed exchange rate without capital control and give up independence of monetary policy. Examples include Hong Kong and the eurozone.

The eurozone, also known as the European Economic and Monetary Union (EMU), has its theoretical foundation laid in Mundell (1961) [4], McKinnon (1963) [5], and Kenan (1969) [6] where the theory of the optimum currency area (OCA) was set forth. A new global monetary map from the regional (rather than the national) viewpoint was envisaged. Over the past two decades or so, the eurozone has been going through turbulent times, from the 2008 Global Financial Crisis (GFC) to the 2010 European debt crisis, after which the role of monetary policy, its implementation, and the influence on financial sustainability have come under particular scrutiny. This has cast doubt on the optimality of the eurozone as a monetary union. In the literature, similar concerns have been raised that at the inception of the eurozone, member countries did not satisfy the criteria for an OCA See, for example, Aizenman (2013, 2015, 2018) [7–9], Bayoumi and Eichengreen (1997) [10], Gibson, Palivos, and Tavlas (2014) [11], Goodhart (2007a, 2007b) [12,13], Krugman (2012) [14], Pisani-Ferry (2013) [15], Wyplosz, Nickell, and Wolf (2006) [16]. In addition, Frankel and Rose (1997, 1998) [17,18] consider the endogeneity of the OCA criteria for the EMU.

Wickens and Polito (2014) [19] argue that the euro crisis was an outcome of the EMU, which originated with the introduction of a single common currency and the setting of a common monetary policy for countries with different initial inflation rates. The crisis countries were those periphery economies with high inflation rates, which then had negative real interest rates and consequently borrowed more than what was supported by their economic fundamentals. Hence, an inflation differential is one potential cause. Another potential cause is a differential in inflation expectation (Bonam and Goy, 2019) [20]. Wickens (2007, 2010a, 2010b, 2016) [21–24] shows that the "one-size-fits-all" monetary policy of a fixed exchange rate and a single nominal interest rate may exacerbate the divergence in inflation rates and levels of competitiveness between countries within the eurozone, and lead to an unsustainable euro in the longer term.

Against this backdrop, we develop a two-state open economy macroeconomic model, in which the two state economies have the same monetary policy but maintain their fiscal independence. Examples include two countries in the eurozone, two states in the United States, core and periphery countries, etc. In our model, the two state economies have a fixed nominal exchange rate and a single nominal interest rate as set by their central monetary authority, but they have different inflation rates within each state economy. On the fiscal side, the two state economies have their own fiscal authorities, which can levy non-distorting lump-sum tax transfer, issue nominal risk-free debt to finance a given process of public spending in their economies, and respond to excessive change in the debt level with a fiscal policy rule. The linkages between these two state economies are inter-state trade in goods and inter-state borrowing in bonds. We apply the calibrated model and conduct economic experiments to examine the macroeconomic effects of monetary policy on financial sustainability for a monetary union.

The rest of this paper is structured as follows. In Section 2, we present our analytical framework by developing a two-state open economy macroeconomic model with microeconomic foundations. In Section 3, we conduct two economic experiments in the Home economy, with a supply-side shock and a demand-side shock. These two experiments are conducted under alternative monetary policy regimes: a single currency regime and a two-currency regime. Section 4 concludes and indicates policy implications.

2. The Model

In our analytical framework, we start from first principles and construct our model in the form of a macroeconomic model with microeconomic foundations, with as few restrictive assumptions as possible. We model household, firms, one central monetary authority, two separate fiscal authorities, and a trade sector. Building from that, we solve the inter-temporal optimization problems of our representative agents under their budget constraints, technological constraints, and institutional constraints. Given these constraints, our representative agents "rationally" solve their constrained optimization problems, and "optimally" respond to supply and demand shocks in different markets, which are the causes of economic fluctuations. The behavioral equations are thus derived to describe aggregate variables and are replaced by the first-order conditions from our inter-temporal problems. As a response, monetary policy and fiscal policy can play a role in alleviating the impact of these shocks, the extent of which can be studied by DSGE simulation, a central tool for our economic analysis.

2.1. Household

To model the demand side, we adopt a "representative agent" approach, by which we mean that there are a large number of homogeneous or identical agents in our model economy. Our representative agent is assumed to have an inter-temporal utility function, in which s/he derives positive utility from the goods that s/he consumes. The consumption part of the utility function is in the form of a power utility, which is also known as an iso-elastic utility. With this utility form, the representative agent has constant relative risk aversion (CRRA).

$$U(C_{i,t}) = E_t\left[\sum_{t=0}^{\infty} \beta^t \frac{(C_{i,t})^{1-\sigma} - 1}{1-\sigma}\right]$$

where the utility function $U(.)$ is bounded, continuously differentiable, strictly increasing, and strictly concave; the variable $C_{i,t}$ is the level of consumption; the subscript indexes $i = 1,2$ are State 1 (Home) and State 2 (Foreign), respectively; the parameter β is the discount factor of our representative agent, which captures her/his time preference; and the parameter σ is the degree of relative risk aversion, and is a constant that is positive for risk averse agents.

Our representative agent has a consumption set, which includes traded goods from both the Home economy and the Foreign economy. Following Wickens (2012) [25], we allow imperfect substitutability among tradeables from the Home and Foreign economies. We assume that total consumption $C_{i,t}$ is of a Cobb-Douglas form.

$$C_{i,t} = \frac{(C_{i,t}^{H})^{\kappa}(C_{i,t}^{F})^{1-\kappa}}{\kappa^{\kappa}(1-\kappa)^{1-\kappa}}$$

where $C_{i,t}^{H}$ and $C_{i,t}^{F}$ are the levels of consumption of tradeables produced in the Home and Foreign economies; and the parameter κ is the degree of substitutability between the consumption goods.

The consumption expenditures, in nominal terms, are:

$$P_{i,t}C_{i,t} = P_{i,t}^{H}C_{i,t}^{H} + P_{i,t}^{F}C_{i,t}^{F}$$

where $P_{i,t}$ is both the consumer price level and the general price level; and $P_{i,t}^{H}$ and $P_{i,t}^{F}$ are the prices of Home and Foreign tradeables. The terms of trade (TOT) is the relative price of exports in terms of imports, and is calculated as the ratio of export prices to import prices.

$$Q_{i,t}^{TOT} = \frac{P_{i,t}^{H}}{P_{i,t}^{F}}$$

The household's budget constraint, in nominal terms, is:

$$P_{i,t}C_{i,t} + M_{i,t} + B_{i,t} + T_{i,t} = W_{i,t}L_{i,t} + D_{i,t} + M_{i,t-1} + (1+R_t)B_{i,t-1}$$

where the left-hand side and right-hand side represent the total money outflows from and inflows to the household, respectively. In particular, $W_{i,t}L_{i,t}$ is the wage income from labor supply; $D_{i,t}$ is the dividend payment to the household; $M_{i,t}$ is the money holding of the household; $B_{i,t}$ is the total bond holding by the household; and $T_{i,t}$ is the lump-sum tax transfer.

2.2. Firms

To model the supply side, we assume that only one type of good is produced in each economy, where firms hire labor $L_{i,t}$ as their input in the output production process. The production function is assumed to take an "AL" form:

$$Y_{i,t} = A_i F(L_{i,t}) = A_i L_{i,t}$$

The general price level is determined via the wage-setting process by firms, in which the real wage rate $\frac{W_{i,t}}{P_{i,t}}$ is equivalent to the marginal productivity of labor $\frac{\partial Y_{i,t}}{\partial L_{i,t}} = A_i$ in the production process.

$$P_{i,t} = \frac{W_{i,t}}{A_i}$$

The firms' budget constraint, in nominal terms, is:

$$P_{i,t}Y_{i,t} = W_{i,t}L_{i,t} + D_{i,t}$$

The supply of goods that is produced by domestic producers is consumed by domestic residents, foreign residents, and the domestic government.

$$Y_{i,t} = C^H_{i,t} + C^F_{j,t} + G_{i,t}$$

2.3. Monetary Authority

An independent monetary authority has (at least) three conventional monetary policy tools: the (nominal) policy interest rate, the (nominal) money supply, and the (nominal) exchange rate. In a monetary union, a central monetary authority conducts monetary policy for all its member economies, with a fixed nominal exchange rate and a single nominal interest rate. We assume that the central monetary authority adopts a Taylor (1993) [26] monetary rule and sets the policy rate as follows:

$$R_t = \pi_t + r + \tau(\pi_t - \pi)$$

where R_t is the target short-term nominal interest rate, r is the assumed equilibrium real interest rate, π_t is the rate of inflation as measured by the GDP deflator, π is the desired rate of inflation, and the parameter τ measures how aggressively the monetary authority reacts to the deviation of the actual inflation rate relative to the inflation target. The inflation rate π_t is calculated from the weighted-average price level P_t between the Home and Foreign economies.

$$1 + \pi_t = \frac{P_t}{P_{t-1}}$$

The weighted-average price level P_t in turn is determined by the relative size of the real GDP level in each economy.

$$P_t = P^{\mu}_{1,t}P^{1-\mu}_{2,t}$$

where the parameter μ is a proxy for the relative size of the Home economy in the currency union.

Alternatively, we can take the weighted average of the inflation rates in each economy and calculate the average inflation rate for the currency union.

$$\pi_t = \mu\pi_{1,t} + (1-\mu)\pi_{2,t}$$

To facilitate transaction demand for money, we introduce the "cash-in-advance" (CIA) condition, which was proposed by Clower (1967) [27] and developed formally by Grandmont and Younes (1972) [28] and Lucas (1980) [29]. It is assumed that goods can be purchased only in exchange for cash. We follow Svensson (1985) [30] in having the goods market open first, such that agents have available for spending only the cash carried over from the previous period, and so cash balances must be chosen before agents know how much spending they will wish to undertake. Our CIA constraint takes the form:

$$P_{i,t}C_{i,t} \leq M_{i,t-1}$$

Expressed in real terms, the CIA constraint becomes:

$$C_{i,t} \leq \frac{M_{i,t-1}}{P_{i,t}} = \frac{1}{1+\pi_{i,t}} \frac{M_{i,t-1}}{P_{i,t-1}}$$

2.4. Fiscal Authority

In a monetary union, each economy has its own fiscal authority that retains its fiscal independence.

The fiscal authority purchases goods from domestic producers as part of its public expenditure. To finance its spending, the fiscal authority can levy a non-distorting lump-sum tax transfer on domestic residents, but if there is not enough tax revenue to meet the needs of its spending, then the fiscal authority can also issue nominal risk-free debt to domestic residents and foreign residents. The government's budget constraint, in nominal terms, is:

$$P_{i,t}^{H} G_{i,t} + (1+R_t) B_{i,t-1}^{G} + M_{i,t-1} = T_{i,t} + B_{i,t}^{G} + M_{i,t}$$

where the left-hand and right-hand sides of the constraint are the total money outflows from and inflows to the government, respectively. In particular, $G_{i,t}$ is the level of government spending, $(1+R_t)B_{i,t-1}^{G}$ is the repayment of government bond borrowing plus the interest on those bonds from the previous period, $B_{i,t}^{G}$ is government bond borrowing and $T_{i,t}$ is government tax revenue in the current period. Money M is included in the government's budget constrain, which implies that any seigniorage revenue will go to the fiscal authority in each economy.

2.5. Inter-State Linkages

2.5.1. Inter-State Goods Market

In our model system, we have a monetary union with two state economies. For the monetary union as a whole, the *BOP* condition has to hold. But within the monetary union, each economy can have a current account surplus or deficit. In the real world, there are other countries outside this monetary union. We can model our system to include a monetary union, and the rest of the world. For this new model system as a whole, the *BOP* condition has to hold. But within this new model system, the monetary union could run a current account surplus or deficit, whilst the rest of the world would run a current account deficit or surplus, which is of the same size but with the opposite sign as that of the monetary union.

The linkages between these two state economies include inter-state trade in goods. The balance of payments (*BOP*) condition can be written as:

$$BOP_i : \ P_{i,t}^{H} C_{j,t}^{F} - P_{i,t}^{F} C_{i,t}^{F} + R_t F_{t-1} = \Delta F_t$$

$$BOP_j : \ P_{j,t}^{H} C_{i,t}^{F} - P_{j,t}^{F} C_{j,t}^{F} - R_t F_{t-1} = -\Delta F_t$$

where $C_{j,t}^{F}$ is the amount of Home's exports to Foreign, $P_{i,t}^{H} C_{j,t}^{F}$ is the value of Home exports to Foreign (denominated in the common currency), $C_{i,t}^{F}$ is the amount of Home imports from Foreign, $P_{i,t}^{F} C_{i,t}^{F}$ is the value of Home imports from Foreign, and $P_{i,t}^{H} C_{j,t}^{F} - P_{i,t}^{F} C_{i,t}^{F}$ is the balance of trade for the Home economy. F_t is the net holding of foreign government-issued bonds by the household in economy i. For the two economies in our monetary union, their net holding of the other government-issued bonds is of the same size, but with the opposite sign. $R_t F_{t-1}$ is the interest payment on Home's net holding of Foreign bonds from the previous period, and ΔF_t is the change in Home's net holding of Foreign bonds between the previous period and the current period.

Alternatively, the balance of payments (*BOP*) condition can also be written as:

$$BOP_i : \ P_{i,t}^{H} C_{j,t}^{F} + (1+R_t) F_{t-1} = P_{i,t}^{F} C_{i,t}^{F} + F_t$$

$$BOP_j : \ P_{j,t}^{H} C_{i,t}^{F} - (1+R_t) F_{t-1} = P_{j,t}^{F} C_{j,t}^{F} - F_t$$

where the left-hand side of the equation is the total money inflows to the Home economy, including the value of Home exports to Foreign in the current period, the repayment of Home's net holding of Foreign bonds from the previous period, and the interest payments received from Home's net holding of Foreign bonds in the previous period. The right-hand side of the equation is the total money outflows from the Home economy, including the value of Home imports from Foreign in the current period, and Home's net holding of Foreign bonds in the current period.

2.5.2. Inter-State Bond Market

The linkages between these two economies also include inter-state borrowing in bonds. In the household budget constraint, $B_{i,t}$ is the total bond holding by the household, which includes holdings of both domestic and foreign government-issued bonds.

$$B_{i,t} = B^G_{i,t} + F_t$$

$$B_{j,t} = B^G_{j,t} - F_t$$

where $B^G_{i,t}$ is the holding of domestic government-issued bonds, and F_t is the net holding of foreign government-issued bonds.

2.6. Macro Dynamics

In our model economy, a representative agent's optimization problem is to maximize his utility:

$$U(C_{i,t}) = E_t\left[\sum_{t=1}^{\infty} \beta^t \frac{(C_{i,t})^{1-\sigma} - 1}{1-\sigma}\right]$$

subject to the economy-wide resource constraint, and the CIA constraint.

For each state economy in our monetary union, the economy-wide resource constraint is derived from the household budget constraint, the government budget constraint, the *BOP* condition, and the national account identity. The economy-wide resource constraint, in nominal terms, is:

$$P_{i,t}Y_{i,t} = P^H_{i,t}C^H_{i,t} + P^F_{i,t}C^F_{i,t} + T_{i,t} + B^G_{i,t} - (1+R_t)B^G_{i,t-1} + F_{i,t} - (1+R_t)F_{i,t-1} + M_{i,t} - M_{i,t-1}$$

Deflate this by the general price level to obtain the economy-wide resource constraint, in real terms.

$$Y_{i,t} = \frac{P^H_{i,t}}{P_{i,t}}C^H_{i,t} + \frac{P^F_{i,t}}{P_{i,t}}C^F_{i,t} + t_{i,t} + b^G_{i,t} - (1+R_t)\frac{b^G_{i,t-1}}{1+\pi_{i,t}} + f_{i,t} - (1+R_t)\frac{f_{i,t-1}}{1+\pi_{i,t}} + m_{i,t} - \frac{m_{i,t-1}}{1+\pi_{i,t}}$$

The CIA constraint is:

$$C_{i,t} \le \frac{m_{i,t-1}}{1+\pi_{i,t}}$$

If money is being held, the CIA constraint must be binding.

We set up the Lagrangian problem of our representative agent (with $s > 0$).

$$\mathcal{L} = \sum_{s=0}^{\infty}\{\beta^s U(C_{i,t+s})$$

$$+\lambda_{i,t+s}\Big[Y_{i,t+s} - \tfrac{P^H_{i,t+s}}{P_{i,t+s}}C^H_{i,t+s} - \tfrac{P^F_{i,t+s}}{P_{i,t+s}}C^F_{i,t+s} - t_{i,t+s} - b^G_{i,t+s} + (1+R_{t+s})\tfrac{b^G_{i,t+s-1}}{1+\pi_{i,t+s}} - f_{i,t+s}$$

$$+(1+R_{t+s})\tfrac{f_{i,t+s-1}}{1+\pi_{i,t+s}} - m_{i,t+s} + \tfrac{m_{i,t+s-1}}{1+\pi_{i,t+s}}\Big] + \lambda 2_{i,t+s}\Big(\tfrac{m_{i,t+s-1}}{1+\pi_{i,t+s}} - C_{i,t+s}\Big)\Big\}$$

where the choice variables are $C^H_{i,t+s}$, $C^F_{i,t+s}$, $b^G_{i,t+s}$, $f_{i,t+s}$, $m_{i,t+s}$; the time ($t-1$) values of the pre-determined variables are given at time t; the parameter β is the discount factor, with $\beta = \frac{1}{1+\rho}$; and the parameter ρ is the rate of time preference by our representative agent.

From the first-order conditions with respect to the choice variables, we derive the Euler equation:

$$\beta\left(\frac{C_{i,t+s+1}}{C_{i,t+s}}\right)^{-\sigma}\frac{1+R_{t+s}}{1+\pi_{i,t+s+1}}=1$$

In the long run, the Euler equation solves for the price level. This is because, at the steady state, the consumption variables disappear, the nominal interest rate is determined by the Taylor rule, the inflation rate is defined in terms of the price level, and the difference in the real interest rates is set equal to the risk premium.

2.7. Model Calibration

As a first step, we calibrate the model to be symmetric between the two economies as our baseline model, so as to check the stability of our model. Building from that, we calibrate the model to be asymmetric and distinct between the two economies. In both of the model setups, we find steady states for the two economies in our currency union. In our log-linearized model, the number of endogenous variables should equal the number of log-linearized equations, in order for the model system to be viable.

In Table 1, we list the calibration of the structural parameters in our model economy. The rate of time preference and the size of the discount factor are calibrated in consistency with the quarterly data in the empirical literature, such that when we run model simulation, each time period of the simulation represents a quarter, and the interpretation of the impulse response functions follow this timing convention accordingly. The inflation coefficient τ is calibrated to be >1. See, for example, Clarida, Gali, and Gertler (1998) [31].

Table 1. Baseline Model–Structural Parameters: Calibration.

Parameter	Value	Definition
ρ	0.05	the rate of time preference by the representative agent
σ	4	a non-negative constant in the power utility function
κ	0.5	the degree of substitutability between the consumption goods
τ	1.5	the degree of aggressiveness by the central monetary authority in the currency union
μ	0.7	the weight of the Home economy in the currency union

2.8. The Extended Model

In the previous subsections, we modeled the case of a currency union with two economies. As an extension, here, we consider the case of a two-currency regime. In the case of a single currency regime, there is one central monetary authority that conducts monetary policy for the currency union. In the case of a two-currency regime, we allow each economy to have its own monetary authority, which conducts an independent monetary policy, including a flexible exchange rate between the two economies, and a separate policy rate and money supply for each economy.

(a) Nominal Exchange Rate:

In a currency union, the nominal exchange rate is exogenous and is fixed at one. Without a common currency, the nominal exchange rate is endogenous and is allowed to float freely. It measures the rate at which one currency can be exchanged for another currency, $S_t=\frac{F\$}{H\$}$. In the case of a two-currency regime, the terms of trade (*TOT*) becomes: $Q_{i,t}^{ToT}=S_t\frac{P_{i,t}^H}{P_{i,t}^F}$. The consumption expenditures by the household become:

$$P_{i,t}C_{i,t}=P_{i,t}^H C_{i,t}^H+\frac{1}{S_t}P_{i,t}^F C_{i,t}^F$$

$$P_{j,t}C_{j,t}=P_{j,t}^H C_{j,t}^H+\frac{1}{S_t}P_{j,t}^F C_{j,t}^F$$

(b) Nominal Interest Rate:

With independent monetary policy, the monetary authority in each economy has the nominal interest rate as its monetary policy tool, and sets its own policy rate $R_{i,t}$ following the Taylor (1993) [26] monetary rule.

$$R_{i,t} = \pi_{i,\ t} + r_i + \tau(\pi_{i,t} - \pi_i)$$

We assume that the uncovered interest parity (UIP) condition holds, such that there is no international arbitrage opportunity in the bond market. The UIP condition involves expectation formation of the future exchange rate, which can be written as:

$$R_{i,t} = R_{j,t} + E_t \Delta s_{t+1}$$

where $R_{i,t}$ is the nominal interest rate of the Home economy, $R_{j,t}$ is the nominal interest rate of the Foreign economy, and s_t is the logarithm of the nominal exchange rate between the Home and Foreign economies. Solving the UIP condition forward, we obtain:

$$s_t = \sum_{t=0}^{\infty} E_t \left(R_{j,t+s} - R_{i,t+s} \right)$$

The intuition behind this equation is that the nominal exchange rate will respond to any new information on the current and expected future nominal interest rate differentials between the Home and Foreign economies.

3. Economic Experiments

In this section, we conduct two experiments in the Home economy, with a supply-side shock and a demand-side shock. These two experiments are conducted under alternative monetary policy regimes: a single currency regime and a two-currency regime. From our model simulation, we analyze the impulse response functions for the domestic variables and the open-economy variables (those linking the two economies) in the model, with joint behavior identifying the impact of the shocks.

3.1. Experiment 1: Productivity Shock

In this experiment, we simulate a productivity shock in the Home economy, which is a positive supply-side shock in the model. It could be, for example, due to some labor-augmenting technology which makes labor more productive, hence causing an increase in production.

There are two effects on the price level. On the one hand, there is the supply-side effect. Following a productivity shock, the improvement in Home's productivity level A_1 will lead to an initial increase in Home's production level Y_1, part of which will cause a surplus, putting downward pressure on the price level of Home-produced goods P_1^H, and contributing to a decrease in the general price level P_1 in the Home economy. This can also be shown via the relation of price determination: $P_{1,t} = \frac{W_{1,t}}{A_1}$. We take the partial derivative of $P_{1,t}$ with respect to A_1: $\frac{\partial P_{1,t}}{\partial A_1} = -\frac{W_{1,t}}{A_1^2} < 0$.

On the other hand, there is also the demand-side effect, which is like the wealth effect. A productivity gain will increase household income stream, which in turn will encourage consumption, exerting upward pressure on the price levels. For the Home economy, these two effects from the supply and demand sides counteract each other. In the short run, the supply-side effect dominates the demand-side effect, so the price level P_1 and P_1^H will decrease first, before climbing back to their steady-state levels, as shown in Figure 1.

Faced with the deflationary pressure from the productivity shock in the Home economy, the central monetary authority will ease its monetary policy for the currency union, as the Home economy dominates the decision-making process of the central monetary authority, due to its relatively larger size, which is similar to the case of Germany and

Greece in the eurozone. The cut in the common policy rate, combined with the change in the inflation rate in each economy, will cause real interest rates to behave differently for the two economies. From the model simulation, we find that the magnitude of the decrease in the policy rate is smaller than that in Home's price level, resulting in an initial increase in Home's real interest rate, followed by a drop in its real interest rate as the demand-side effect comes into force. Foreign's real interest rate will decline first, followed by a hike. This difference in the behavior of the real exchange rates is due to the relative magnitude of the change in the nominal interest rate and inflation rates, and the pace at which they are channeled in each economy.

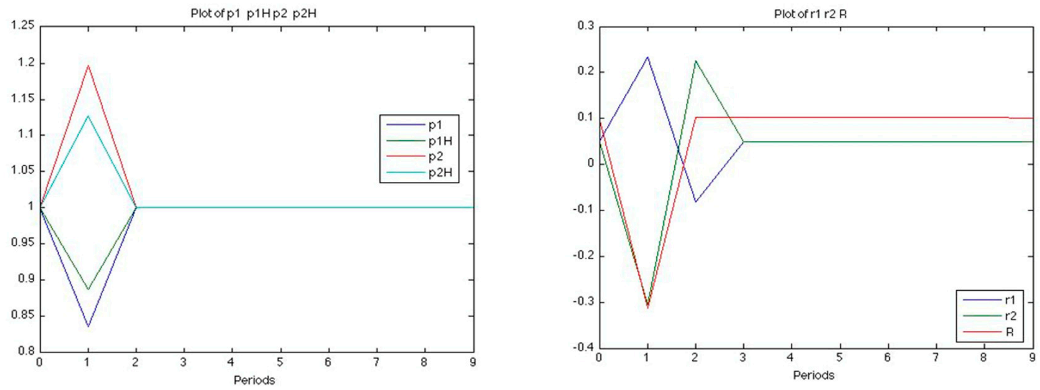

Figure 1. Single Currency Regime: Home Productivity Shock.

In contrast to the "internal revaluation" in a single currency regime, we have "external revaluation" in a two-currency regime, where the nominal interest rates for the Home and Foreign economies are linked via the UIP condition. The impulse response functions show that the deflationary pressure will make the central banks in the two economies cut their policy rates, the magnitude of which is smaller than the decrease in their price levels, such that their real interest rates will both drop first, before reverting back to their equilibrium levels (Figure 2).

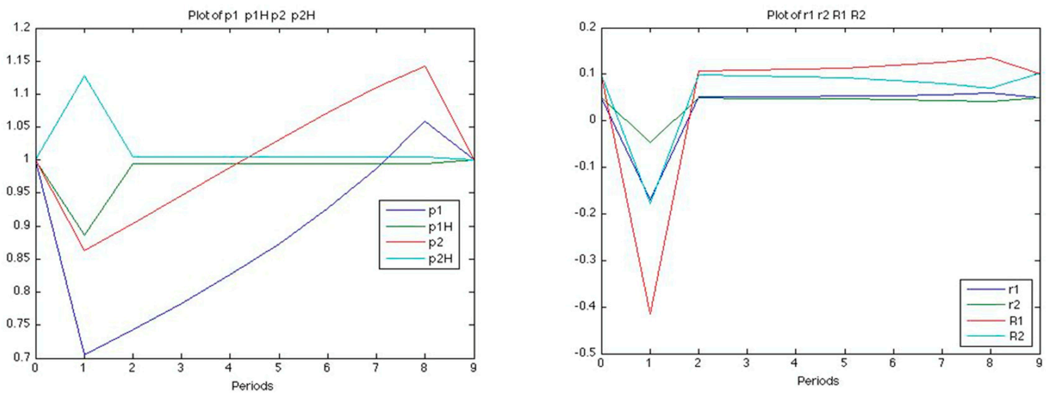

Figure 2. Two-Currency Regime: Home Productivity Shock.

Comparing our simulation results under alternative monetary regimes, we find that, in the case of a single currency regime, there will be an initial increase in Home's real interest rate and a decrease in Foreign's real interest rate, which will encourage borrowing in the Foreign economy. The policy implication is that monetary policy is incorrect if inflation differentials persist, and that incorrect monetary policy leads to real interest rates that are too low for high inflation countries, which become indebted after borrowing too much.

3.2. Experiment 2: Fiscal Austerity

John Maynard Keynes wrote in 1937 that "The boom, not the slump, is the right time for austerity at the Treasury". However, the real world is different from the ideal world.

In the real world, the eurozone rejected this view of Keynes, and instead it insisted on implementing fiscal austerity during the economic slump after its sovereign debt crisis in 2010, triggered by the Global Financial Crisis (GFC) after the collapse of Lehman Brothers in September 2008, after which the role of monetary policy and its implementation have come under particular scrutiny.

In this second economic experiment, we simulate a fiscal austerity shock in the Home economy, which is a negative demand-side shock. Jorda and Taylor (2013) [32] show that fiscal austerity is always a drag on economic growth. Following fiscal austerity, there will be a decrease in the demand for goods and services by the Home government, and a decline in aggregate demand for the Home economy, such that the real GDP level will fall. In the short run, there will be excess capacity in production, which will put downward pressure on the cost and the general price level in the Home economy. Faced with this deflationary pressure, the central monetary authority will cut the policy rate for the currency union. From the model simulation, we again find that, in the case of a single currency regime, there will be an initial decrease in Foreign's real interest rate, which will encourage borrowing in the Foreign economy. Should inflation differentials persist in a currency union, this "one-size-fits-all" monetary policy would lead to real interest rates too low for high inflation countries, with too much borrowing, which may in turn lead to a sovereign debt crisis (Figures 3 and 4).

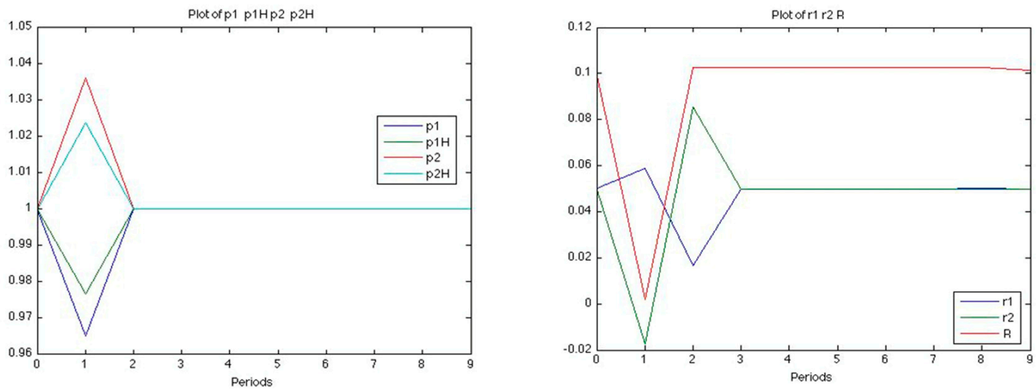

Figure 3. Single Currency Regime: Home Expenditure Shock.

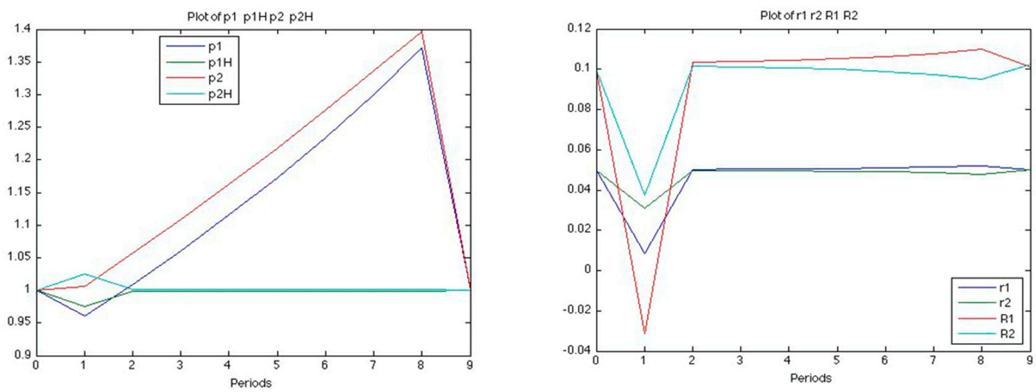

Figure 4. Two-Currency Regime: Home Expenditure Shock.

4. Conclusions

In this paper, we contribute to the literature by improving our understanding of the influence of monetary policy on financial sustainability for a monetary union. To that end, we develop a two-state open economy macroeconomic model, in which the two state economies have the same monetary policy but maintain their fiscal independence. Examples include two countries in the eurozone, two states in the United States, core and periphery countries, etc. The linkages between these two state economies are inter-state trade in goods and inter-state borrowing in bonds. We apply the calibrated model and conduct economic experiments: a supply-side shock and a demand-side shock in the Home economy, under alternative monetary policy regimes: a single currency regime and a two-currency regime. In contrast to the "internal revaluation" in a single currency regime, we have "external revaluation" in a two-currency regime, where the nominal interest rates for the Home and Foreign economies are linked via the UIP condition, as reflected in the relative movement of their bi-lateral nominal exchange rate.

From our model simulation, we find that, for countries with different initial inflation rates within a monetary union, the introduction of a single common currency with the setting of a "one-size-fits-all" monetary policy may exacerbate the divergence in inflation rates. As a consequence, those countries with high inflation rates would then have negative real interest rates with excessive private or public borrowing, which would cause further divergence in levels of competitiveness between countries within the monetary union. Therefore, monetary policy is incorrect if inflation differentials persist in a monetary union, and incorrect monetary policy leads to real interest rates that are too low for high inflation countries, which become indebted after borrowing too much. This in turn could lead to banking and debt crises. The study sheds light on how monetary policy should be implemented if inflation differs in countries within a monetary union. Our findings draw policy implication for those "two-state" economies considering alternative macroeconomic regimes to achieve financial sustainability and regional economic integration.

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