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International Transmission of Monetary Shocks in a Ricardian World

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Abstract:
This paper investigates how monetary shocks are transmitted internationally. It shows that where a national currency is used as an international medium of exchange, the international money is non-neutral. In particular, an increase in the supply of international money leads to a transfer of real resources to the international money-issuing country from its trading partner. It induces an expansion of the non-tradable sector in the international money-issuing country, and an expansion the tradable sector in its trading partner. The real impact of a monetary shock is greater under a fixed exchange rate system than under a flexible exchange rate system.

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1. Introduction

What is the mechanism through which monetary policy decisions affect output and prices? This is a perennial question that has generated a large literature offering different perspectives. According to standard textbooks, monetary policy affects short-term interest rates, which in turn affect investment and consumption decisions. Extending this standard position, the lending view observes that given information asymmetry and other frictions in credit markets, a monetary policy that raises (lowers) market interest rates tends to raise (lower) the external finance premium (which is the difference between the costs of external and internal finance), thereby amplifying the impact on borrowing (Bernanke & Gertler, 1995). In contrast, the monetarist's view contends that a monetary impulse, by changing the stock of money, changes the marginal utility of money relative to other goods and assets. To restore equilibrium, money holders adjust their spending and asset portfolios. Therefore, apart from the impact on interest rates, monetary shocks can directly influence consumer decisions (Meltzer, 1995).

In an increasingly globalised economy and in light of the recent global financial turmoil and subsequent stabilising policies implemented by various governments, it is timely to extend the traditional question and ask whether monetary policies in one country can affect output and prices of its trading partners and if so, through what mechanism. There is an extensive empirical literature that studies the international monetary transmission mechanism by examining movements of financial market prices including the exchange rates ((Taylor, 1995). However, to our knowledge, few theoretical studies have explicitly modelled the international transmission of monetary policy impulses through their impact on international trade. This is probably due to the fact that most trade models deal with "barter" rather than "monetary" transactions. The choice of barter models is reasonable because if one accepts the "separability hypothesis" which states that in cases where the marginal rate of substitution between goods is independent of the demand for money, the analyses of the traditional barter models remain valid for monetary models (Anderson & Takayama, 1977). Of those trade models that do incorporate money, most adopt the "small country" assumption, and focus on how the small country's policies such as currency devaluation and monetary expansion can affect its own welfare (Kemp, 1982; Takayama & Anderson, 1978).

The purpose of this paper is to develop a set of monetary trade models to investigate how monetary policy shocks are transmitted internationally. In particular, we ask (1) how a monetary policy change in one country may affect itself and its trading partner; and (2) how the transmission mechanisms of monetary shocks may differ under different international monetary regimes.

We conduct our investigation in a simple 2-country, 3-good Ricardian framework and study the international transmission of monetary shocks under three different regimes. We start with a benchmark model of Regime One where two national currencies are used in international trade, but there is no demand in one country for holding another country's currency. In this benchmark model, money is shown to be neutral, which is consistent with the findings of the mainstream literature.

In light of the observation that most international trade is mediated by a few currencies, of which the US dollar is dominant (Goldberg & Tille, 2008), we develop two other models of Regime Two and Regime Three, where only country 2's national currency is used in international trade. A flexible exchange rate system operates in Regime Two, and a fixed exchange rate system operates in Regime Three.

Suppose international trade is mediated by the national currency of country 2. Since country 2's national currency becomes an international currency, there will be a demand for holding it in country 1 as well. Consequently a change in the supply of the international currency will not only affect economic decisions in country 2, but also affect those in country 1. Specifically, an increase in the supply of money in country 2 tends to increase the nominal demand for imports from country 1, which in turn increases country 1's nominal income and its demand for country 2's currency. As this increased demand for country 2's currency can only be satisfied by increased exports to country 2, there must be a transfer of real resources from country 1 to country 2. The increased exports also mean that the tradeable sector in country 1 has to expand at the expense of the non-tradable sector; correspondingly the tradable sector contracts in country 2 as some of import needs are financed by the newly created money instead of export revenue. Therefore in contrast to the benchmark model in which money is neutral, when a national currency also serves as an international currency, the international money is no longer neutral even in the absence of any price rigidities. In particular, an increase in the supply of international money leads to a real resource transfer to the international money-issuing country and structural changes in both countries.

The extent to which an international monetary shock has real effects may be affected by exchange rate systems. Under a flexible exchange rate system, an increase in country 2's money supply tends to lower the exchange rate (i.e., the price of country 2's currency in terms of country 1's currency). This downward pressure is however partly offset by the increased demand for country 2's currency in country 1; hence the exchange rate does not fall to the same extent as the increase in the money supply. Under a fixed exchange rate system, an increase in country 2's money supply puts downward pressure on the exchange rate, which compels country 1's monetary authority to intervene by buying country 2's currency using its own created money. The upshot is that both foreign exchange reserve and money supply in country 1 go up. Since the increase in foreign exchange reserve also has to be backed by an increase in exports to country 2, the real transfer to country 2 is larger, and consequently a greater structural change needs to take place under a fixed exchange rate system.

In the following, we develop a set of three models which formalise the above narrative. Section 2 presents the benchmark model in which two freely convertible national currencies are used in international trade. Section 3 adapts the benchmark model by assuming that international trade is mediated by one of the national currencies. It investigates the international transmission mechanism of monetary shocks under a flexible exchange rate system and a fixed exchange rate system, respectively. Section 4 concludes.

2. Regime One: The Benchmark Model

Consider a Ricardian world with two countries, country 1 with a population of $N_{1,}$ and country 2 with a population of $N_{2.}$ There are three goods, X, Y and Z. Country 1 specialises in the production of good X, and country 2 in good Y. Good Z is non-tradable good produced in both countries, and is not traded internationally. Labor is assumed to be immobile between the countries.

International trade between the two countries is meditated by the currencies of both countries. The currencies are freely convertible. Individual consumers in both countries are assumed to derive utility from the consumption of the three goods and from the holding of real balances of their own currencies[3]. The decision problem of a representative consumer in country is:

$$\max_{x_1, y_1, z_1, m_1/P_{1xyz}} U_1 = U_1(x_1, y_1, z_1, \frac{m_1}{P_{1xyz}}) = x_1^{\alpha_1} y_1^{\alpha_2} z_1^{\alpha_3} (\frac{m_1}{P_{1xyz}})^{\alpha_4}$$

s.t. $\quad p_{1x}x_1 + (p_{2y}e)y_1 + p_{1z}z_1 + m_1 = w_1 + \overline{m}_1$

$$\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 1$$

where x_1, y_1, z_1 are quantities of goods X, Y, and Z; p_{ij} (*i=1, 2; j=X, Y, Z*) is the price of good *j* in country *i*, and is denominated in the currency of the country producing the good; P_{1xyz} is the average price of all three goods in country 1; m_1 / P_{1xyz} is the demand for

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[3] If both national currencies are used in international trade, then arguably there should be a demand for holding both currencies in both countries. However, we have chosen the simpler benchmark where there is no separate demand in one country for another country's currency because this seems to be the assumption implicit in much of the existing literature, see, for instance, Kemp (1982), Dusansky (1989) and Palivos and Yip (1997).

real balances; and e is the exchange rate (i.e., the price of country 2's currency in terms of country 1's currency).

The decision problem for a representative consumer in country 2 is similar:

$$\max_{x_2, y_2, z_2, m_2/P_{2xyz}} U_2 = U_2(x_2, y_2, z_2, \frac{m_2}{P_{2xyz}}) = x_2^{\beta_1} y_2^{\beta_2} z_2^{\beta_3} (\frac{m_2}{P_{2xyz}})^{\beta_4}$$

s.t. $\quad (p_{1x}/e)x_2 + p_{2y}y_2 + p_{2z}z_2 + m_2 = w_2 + \bar{m}_2$

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 = 1$$

Solving the decision problems give us the demand functions for goods and real balances in both countries:

$$x_1 = \frac{\alpha_1(w_1 + \bar{m}_1)}{p_{1x}}; \qquad y_1 = \frac{\alpha_2(w_1 + \bar{m}_1)}{p_{2y}e}; \qquad z_1 = \frac{\alpha_3(w_1 + \bar{m}_1)}{p_{1z}}; \qquad m_1 = \alpha_4(w_1 + \bar{m}_1)$$

(2.1)

$$x_2 = \frac{\beta_1(w_2 + \bar{m}_2)e}{p_{1x}}; \qquad y_2 = \frac{\beta_2(w_2 + \bar{m}_2)}{p_{2y}}; \qquad z_2 = \frac{\beta_3(w_2 + \bar{m}_2)}{p_{2z}}; \qquad m_2 = \beta_4(w_2 + \bar{m}_2)$$

(2.2)

On the production side, we assume that all goods are produced with labor only. The production functions are:

Country 1: $\quad X_1 = a_{1x}L_{1x}; \quad Z_1 = a_{1z}L_{1z}$

Country 2: $\quad Y_2 = a_{2y}L_{2y}; \quad Z_2 = a_{2z}L_{2z}$

Assuming perfect competition, we obtain the money prices of goods which, in equilibrium, are equal to the labor cost of production:

$$p_{1x} = \frac{w_1}{a_{1x}}, \qquad p_{1z} = \frac{w_1}{a_{1z}}, \qquad p_{2y} = \frac{w_2}{a_{2y}}, \qquad p_{2z} = \frac{w_2}{a_{2z}}$$

(2.3)

In equilibrium, all markets clear, which means the following conditions are met:

Labor markets: $L_{1x} + L_{1z} = N_1$; $L_{2y} + L_{2z} = N_2$

(2.4)

Markets for good Z: $N_1 z_1 = Z_1$; $N_2 z_2 = Z_2$

(2.5)

Market for good X: $N_1 x_1 + N_2 x_2 = X_1$

(2.6)

Market for good Y: $N_1 y_1 + N_2 y_2 = Y_2$

(2.7)

Foreign exchange market: $N_1 p_{2y} y_1 = N_2 (\frac{p_{1x}}{e}) x_2$

(2.8)

Solving equations (2.1)-(2.8), we obtain the equilibrium exchange rate, wages, prices, and quantities of goods consumed in each country:

$$e^* = \frac{\alpha_2 \beta_4 N_1 \overline{m}_1}{\alpha_4 \beta_1 N_2 \overline{m}_2}, \qquad w_1^* = \frac{1-\alpha_4}{\alpha_4}\overline{m}_1, \qquad w_2^* = \frac{1-\beta_4}{\beta_4}\overline{m}_2,$$

$$p_{1x}^* = \frac{w_1^*}{a_{1x}}, \qquad p_{1z}^* = \frac{w_1^*}{a_{1z}}, \qquad p_{2y}^* = \frac{w_2^*}{a_{2y}}, \qquad p_{2z}^* = \frac{w_2^*}{a_{2z}}$$

$$x_1^* = \frac{\alpha_1 a_{1x}}{(1-\alpha_4)}, \qquad y_1^* = \frac{a_{2y}\beta_1 N_2}{(1-\beta_4)N_1}, \qquad z_1^* = \frac{\alpha_3 a_{1z}}{(1-\alpha_4)}$$

$$x_2^* = \frac{\alpha_2 a_{1x} N_1}{(1-\alpha_4)N_2}, \qquad y_2^* = \frac{\beta_2 a_{2y}}{1-\beta_4}, \qquad z_2^* = \frac{\beta_3 a_{2z}}{1-\beta_4}$$

Clearly,

$$\frac{\partial e^*}{\partial \bar{m}_2} < 0, \qquad \frac{\partial w_2^*}{\partial \bar{m}_2} = a_{2y}\frac{\partial p_{2x}^*}{\partial \bar{m}_2} = a_{2z}\frac{\partial p_{2z}^*}{\partial \bar{m}_2} > 0, \qquad \frac{\partial w_1^*}{\partial \bar{m}_2} = a_{1x}\frac{\partial p_{1x}^*}{\partial \bar{m}_2} = a_{1z}\frac{\partial p_{1z}^*}{\partial \bar{m}_2} = 0$$

That is, an increase in the supply of country 2's currency weakens the currency, raises the wage rate in country 2 and the prices of goods produced in country 2, but has no impact on the wage rate in country 1 or the prices of goods produced in country 1.

Moreover, it is easy to see that the quantities of goods consumed in each country are independent of the money supply of either country ($\bar{m}_1, \bar{m}_2$), which means money is neutral.

To summarize, we have

Proposition 1. *If both national currencies are used in international trade, and if there is no demand in one country for holding another country's currency, then money is neutral. That is, an increase in the supply of one country's currency leads to a depreciation of that currency and raises the nominal wage rate and prices in that country; but has no effects on real variables in either country.*

3. International trade mediated by a single national currency

In the last section, we assume that both currencies are used in international trade, and that there is no demand in either country for holding another country's currency. This is not, in our judgement, a realist assumption. As mentioned earlier, only a few currencies are routinely used in international trade, of which US dollar enjoys a dominant position. Consequently in most countries, there is a demand for holding these international currencies. In light of this observation, we assume in this section that international trade is mediated by one national currency, namely the currency of country 2. We also assume that since country 2's currency becomes an international currency, there is a demand in country 1 for holding it as well.

3.1. Regime Two: Flexible exchange rates

First consider the case under a flexible exchange rate system. Since, by assumption, there is a demand in country 1 for holding country 2's currency, the decision problem of the representative consumer in country 1 changes to:

$$\max_{x_1, y_1, z_1, m_1/P_{1xz}, FX_1/p_{2y}} \quad U_1 = U_1(x_1, y_1, z_1, \frac{m_1}{P_{1xz}}, \frac{FX_1}{p_{2y}}) = x_1^{\alpha_1} y_1^{\alpha_2} z_1^{\alpha_3} (\frac{m_1}{P_{1xz}})^{\alpha_4} (\frac{FX_1}{p_{2y}})^{\alpha_5}$$

$$\text{s.t.} \qquad p_{1x}x_1 + (p_{2y}e)y_1 + p_{1z}z_1 + m_1 + FX_1 e = w_1 + \bar{m}_1 + \overline{FX}_1 e$$

$$\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 = 1$$

where P_{1xz} is the average price of good X and good Z (which are bought with country 1's own currency); m_1 / P_{1xz} is the demand for real balances in domestic currency; FX_1 / p_{2y} is the demand for real balances in foreign exchange (the currency of country 2); $\bar{m}_1$ and $\overline{FX}_1 e$ are initial money holdings in domestic and foreign currency, respectively; e is the exchange rate.

The decision problem for individuals in country 2 remains the same as in the benchmark model. Solving the consumer decision problems in both countries, we obtain the demand functions for goods, domestic moneys and foreign exchange:

$$x_1 = \frac{\alpha_1(w_1 + \bar{m}_1 + \overline{FX}_1 e)}{p_{1x}}, \qquad y_1 = \frac{\alpha_2(w_1 + \bar{m}_1 + \overline{FX}_1 e)}{p_{2y}e}, \qquad z_1 = \frac{\alpha_3(w_1 + \bar{m}_1 + \overline{FX}_1 e)}{p_{1z}} \tag{3.1}$$

$$m_1 = \alpha_4(w_1 + \bar{m}_1 + \overline{FX}_1 e), \qquad FX_1 = \frac{\alpha_5(w_1 + \bar{m}_1 + \overline{FX}_1 e)}{e} \tag{3.2}$$

$$x_2 = \frac{\beta_1(w_2 + \bar{m}_2)e}{p_{1x}}, \qquad y_2 = \frac{\beta_2(w_2 + \bar{m}_2)}{p_{2y}}, \qquad z_2 = \frac{\beta_3(w_2 + \bar{m}_2)}{p_{2z}}, \qquad m_2 = \beta_4(w_2 + \bar{m}_2) \tag{3.3}$$

The production side remains unchanged, so we have the same price-wage relationship as in the benchmark model (equations (2.3)). The market clearing conditions for labor and goods also remain unchanged (equations (2.4)-(2.7)). However due to the demand for holding foreign exchange in country 1, the clearing condition for the foreign exchange market changes to:

$$N_1(FX_1 + p_{2y}y_1) = N_2(\frac{p_{1x}}{e})x_2 + N_1\overline{FX}_1$$

(3.4)

Jointly solving equations (3.1)-(3.4) and (2.3)-(2.7), we obtain the equilibrium values of all the endogenous variables, which we discuss below.

(1) Quantities demanded for foreign exchange holdings and for goods

$$FX_1^* = \frac{\alpha_5[\beta_1 N_2 \bar{m}_2 + (\beta_1 + \beta_4 + \alpha_2\beta_1)N_1\overline{FX}_1]}{(\alpha_2\beta_4 + \alpha_5\beta_1 + \alpha_5\beta_4)N_1}$$

$$x_1^* = \frac{\alpha_1 a_{1x}[\beta_1 N_2 \bar{m}_2 + (\beta_1 + \beta_4 + \alpha_2\beta_1)N_1\overline{FX}_1]}{(1-\alpha_4)\beta_1 N_2 \bar{m}_2 + [(\alpha_1+\alpha_3)(\beta_1+\beta_4) + \alpha_2\beta_1]N_1\overline{FX}_1}$$

$$y_1^* = \frac{\alpha_2 a_{2y}(\beta_1+\beta_4)N_2[\beta_1 N_2 \bar{m}_2 + (\beta_1 + \beta_4 + \alpha_2\beta_1)N_1\overline{FX}_1]}{[\alpha_2\beta_1 + (\alpha_2\beta_4 + \alpha_5\beta_1 + \alpha_5\beta_4)(\beta_2+\beta_3)]N_1 N_2 \bar{m}_2 + \alpha_2(\beta_1+\beta_4)N_1 N_1\overline{FX}_1}$$

$$z_1^* = \frac{\alpha_3 a_{1z}[\beta_1 N_2 \bar{m}_2 + (\beta_1 + \beta_4 + \alpha_2\beta_1)N_1\overline{FX}_1]}{(1-\alpha_4)\beta_1 N_2 \bar{m}_2 + [(\alpha_1+\alpha_3)(\beta_1+\beta_4) + \alpha_2\beta_1]N_1\overline{FX}_1}$$

$$x_2^* = \frac{\beta_1 a_{1x} N_1[\alpha_2 N_1\overline{FX}_1 + (\alpha_2+\alpha_5)N_2\bar{m}_2]}{(1-\alpha_4)\beta_1 N_2 N_2 \bar{m}_2 + [(\alpha_1+\alpha_3)(\beta_1+\beta_4) + \alpha_2\beta_1]N_1 N_2\overline{FX}_1}$$

$=$