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Real exchange rates, asset prices and terms of trade: A theoretical analysis☆

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ABSTRACT

This paper develops a continuous-time two-country dynamic equilibrium model, in which the real exchange rates, asset prices, and terms of trade are jointly determined in the presence of nontradable goods. The model determines the relation between the financial markets and real goods markets in the world economy and their responses to various shocks under the home bias assumption. A positive domestic supply shock induces a positive return on the domestic asset markets and a deterioration of terms of trade that improves the foreign output and boosts the foreign asset markets. Demand shocks act in the opposite way. This model also analyses the impact of change in the relative price of nontradable to tradable goods on the terms of trade and asset markets. A higher productivity growth in tradable goods than in nontradable goods leads to a higher relative price of nontradable to tradable goods, which appreciates the real exchange rate, deteriorates the terms of trade, and depresses the domestic and foreign asset markets. A lower relative price of nontradable goods depreciates the real exchange rate, improves the terms of trade, and lifts both the domestic and foreign asset markets.

1. Introduction

This paper is a theoretical study of the determination of real exchange rates, asset prices, and terms of trade, set in a continuous-time two-country world that is subject to stochastic endowment shocks. This setting of a continuous-time pure-exchange world economy is along the lines of Lucas (1982).

In the international finance literature, four avenues have so far been explored in an attempt to capture exchange rate behaviour and determination. They are the flexible-price monetary model, the sticky-price monetary model, the portfolio balance model, and the general equilibrium model. The flexible-price model starts from the assumption that Purchasing Power Parity (PPP) always holds (Frenkel, 1976; Mussa, 1976). It is a straightforward extension of the PPP relation. The simplest version of the model links the exchange rate to the relative money supply, relative real output, and the relative nominal interest rate level. This model does not establish, however, a clear connection to expected future macro fundamentals. The sticky-price monetary model, also known as the overshooting model, has similar conceptual underpinnings to the flexible-price model (Dornbusch, 1976). The two monetary models share an essential ingredient in that their core is equilibrium in the money market. Two ingredients of the stick-price model, however, are departures from the flexible-price model. First, prices are sticky over the short-run, adjusting only gradually to the long-run flexible-price equilibrium. Second, PPP does not hold in the short-run, though it does hold in the long-run, once the price level has fully adjusted to its flexible-price level.[1] The sticky-price model is appealing not only because it relaxes the flexible-price model's uncomfortable assumptions, but also because it can amplify the effect of a change in fundamentals, referred to as exchange rate overshooting, which is best understood using the Uncovered Interest Parity (UIP) relation.[2] The portfolio balance model is a model that balances demand for various asset classes against supply. The exchange rate brings them into balance.[3] It departs from the monetary models in two essential ways. First, it is the only one without PPP as an ingredient in the four approaches. Thus, the long-run exchange rate must be pinned down in some other ways. Second, it does not impost UIP, so that the expected dollar returns on different-currency deposits need not be equal. This leaves room for a currency risk premium. The macroeconomic literature refers to this as imperfect substitutability between domestic and foreign assets. As, however, it is hard to measure the supply side assets levels with any precision, the model does not fare well empirically.[4]

The general equilibrium model of exchange rate determination begins with maximisation of a representative individual's utility.[5] Past theoretical work in this approach has evolved along several different

☆ Any errors are the responsibility of the authors.

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[1] Strictly speaking, PPP holds in the long-run only in the simpler version of this model.

[2] For a more recent discussion, which includes sticky prices, see Obstfeld and Rogoff (1996).

[3] See, Kouri and Porter (1974) and Branson and Henderson (1985) for details.

[4] See Branson and Henderson (1985) and Lewis (1988).

[5] Early theoretical work in this literature includes Lucas (1982) and Stulz (1987).

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modelling paradigms to examine a variety of issues. These paradigms include the international general equilibrium models that incorporate nominal pricing by agents holding money to alleviate some market friction and international general equilibrium models that examine real quantities (Stockman, 1980, 1987; Dumas, 1992; Uppal, 1993; Zapatero, 1995; Serrat, 2001). In the former stream, early models require individuals to hold domestic currency for purchasing domestic, or foreign, goods. This constraint is referred to as cash-in-advance (Lucas, 1982; Svensson, 1985). This requirement is important for exchange rate determination because it drives the demand for currencies. They can be seen as the generalisations of the flexible-price monetary model, allowing multiple goods and real shocks. Some other formulations include the overlapping generations and money in the utility function formulations. Later models produce demand for money from the tastes side by putting money directly in the utility function. They allow for sticky nominal prices, which permit departures from PPP, in much the same spirit as those departures from PPP that arise in the original sticky-price model. These more recent general equilibrium models are sometimes called new open economy macro models.[6] These methods have been well debated (LeRoy, 1984; Feenstra, 1986). Open market macroeconomic theory has advocated a more rigorous modelling of the dynamic real exchange rate and terms of trade. The international asset markets do not, however, play an important role in this framework.

Like the international cash-in-advance models, international general equilibrium models that examine real quantities also place restrictive assumptions on preferences. For instance, both Dumas (1992) and Uppal (1993) emphasise power preferences, while Zapatero (1995) emphasises logarithmic preferences. Most of the models in this group of studies are, however, cast in a single-good framework, in which forces of arbitrage equate the real exchange rate to unity. A couple of other multi-good asset pricing models in which the exchange rate is determined through terms of trade are Zapatero (1995), Serrat (2001), and Pavlova and Rigobon (2007). Zapatero (1995) argues that the equilibrium volatility of the exchange rate is the sum of the volatilities due to idiosyncratic factors in the financial markets and is a term that represents the difference of weights in the common international factor. Nevertheless, his model does not allow for demand shock, which is an essential element in our study. The focus of Serrat (2001) is different. He is primarily concerned with the home bias puzzle. His dynamic equilibrium model captures the heterogeneity created by nontradable goods and shows that the home bias arises not simply because of the presence of nontradable goods, but also because of a dynamic hedging mechanism sustained in equilibrium by differences in tastes and endowments. Pavlova and Rigobon's (2007) model is closely related to ours. Their two-country two-good model integrates the international trade elements into a standard asset pricing framework, however, they ignore the nontradable goods, which play an important role in our model.

A substantial growth in international trade and cross-border capital flow over the past decade fosters a degree of integration between financial and goods markets. The transmission of a shock across both markets has increased significantly as well. A shock in financial markets directly affects wealth of individuals and institutions and such impact is passed through to markets of tradable and nontradable goods. Similarly there is a feedback effect from the boom and bust of goods market that transmits into real economy and financial markets. While there are many studies that consider the linkages between financial assets such as stocks, bonds and exchange rates, there is little understanding of how innovations from financial assets affect goods markets and vice versa. This study aims to shed some light on the interaction between the real exchange rates, asset prices and terms of trade in the presence of nontradable goods using a continuous-time two-country dynamic equilibrium model.

Our model departs from the existing studies in international finance in several important dimensions. First, we allow for international trade in goods, in addition to trade in financial assets. Second, unlike the previous literature in which the terms of trade are assumed to be equal to unity, our framework fully endogenises the terms of trade as well as the real exchange rate and, thereby, allows a meaningful analysis of the correlation structure of asset returns relative to real exchange rate and terms of trade changes. Last, but not least, our most important structural assumption concerns the presence of nontradable goods.

A large body of theoretical literature has emphasised the importance of nontradable goods prices in explaining the real exchange rate movements in open economies.[7] In our model, the two countries in the world economy are fully specialised in producing their own goods. The stock market in each country is a claim to the country's real output. Bonds provide further opportunities for international borrowing and lending and their interest rates are uncovered endogenously within the model. Output shocks and the consumers' demand shocks in each country induce the uncertainty. A representative agent in each country consumes both tradable and nontradable goods and invests in the stock and bond markets. Home bias prevails in both goods and asset markets.[8] Booming tradable prices represent terms of trade improvements that can be viewed as a transfer of wealth from tradable importing to tradable exporting countries. These transfers of wealth can affect the nominal exchange rate directly as in Engel and West (2005) or they can affect the real exchange rate through the relative price of nontradable goods as in Dornbusch (1980), Edwards (1989), and Neary (1988). The introduction of nontradable goods in our model shows that terms of trade reduce the benefits of portfolio diversification, which is evident by Eqs. (36)–(40) in Appendix A.

The paper is organised as follows. In Section 2, we describe our model and solve for its equilibrium. We also present the diffusion coefficients that determine the relation between the financial markets and real goods markets in the world economy and their responses to various shocks under the home bias assumption. We summarise the most important implications in Section 3. Section 4 concludes and Appendices A and B contain the proofs.

2. The model

We follow Lucas (1982) to establish a continuous-time pure-exchange world economy with finite horizon, $[0,T]$. The domestic country and the foreign country are the only two countries in this exchange economy. A consumer–investor lives in each country. We refer to them as the domestic agent and the foreign agent. Agents are risk averse and different because their preferences, endowments, and consumption sets differ. Each agent consumes continuously during an interval of time $[0,T]$.

A filtered probability space $(\Omega, F, \{F_t\}, P)$ is defined as a 5-dimensional Brownian motion $\overline{\omega}(t) = (\omega_1(t), \omega_2(t), \omega_1^*(t), \omega_2^*(t), \omega^{\theta}(t))^T$, $t \in [0,T]$. All stochastic processes are assumed to be adapted to $\{F_t: t \in [0,T]\}$. All stated (in)equalities involving random variables hold P almost surely. We assume all of the processes introduced to be well-defined in the following analysis, without explicitly stating regularity conditions ensuring this. The market structure is summarised as follows:

Assumption 1. Goods market structure

There are four consumption goods in the world economy. Two tradable goods, domestic tradable and foreign tradable, are consumed by both agents and can be shipped across countries. The other two

[6] See Obstfeld and Rogoff (1995).

[7] Early theoretical work in this literature includes Swan (1960), Balassa (1964), and Samuelson (1964). For more recent discussions, see Engel (1999), Chari et al. (2002), and Burstein et al. (2005).

[8] See Serrat (2001) for the details.