



Real exchange rate variability in a two-country business cycle model



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ABSTRACT

This paper shows that introducing recursive preferences in a standard two-country business cycle model implies a real exchange rate as volatile as in the data. With recursive preferences the marginal utility of consumption today depends on innovations in future utilities. Productivity shocks with a unit root have long-term effects and home bias implies that the effects differ across countries. A positive shock in one country therefore leads to a larger drop in marginal utility in that country. There is then a strong depreciation of the real exchange rate and resources are transferred abroad due to risk-sharing between households. This leads to a volatile real exchange rate and can imply positive cross-country correlations in both investment and employment. Innovations to future utilities imply volatile stochastic discount factors which are necessary to price financial assets. The paper therefore bridges the gap between models in international macroeconomics and finance.

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1. Introduction

A central puzzle in international macroeconomics is the high volatility of the real exchange rate. A large literature has therefore developed concerning the cause of exchange rate fluctuations in international business cycle models.¹ However, these papers tend to ignore the implications for asset prices, and in international finance the view is that real exchange rates are not volatile enough. Brandt et al. (2006) argue that since real exchange rates are tied to stochastic discount factors that need to be very volatile to price financial assets, observed real exchange rate volatility is actually low. This paper bridges the gap between these two literatures and shows that a two-country business cycle model can generate both the high volatility in stochastic discount factors implied by financial data, and real exchange rate volatility in line with what we observe.

The key innovation is to introduce the recursive preferences from Epstein and Zin (1989) in the international business cycle framework. The real exchange rate is the relative price of consumption across countries, and in the standard international business cycle model, where agents have power utility over a composite of consumption and leisure, only the short-run differences in these quantities across countries affect the current currency value. Since these differences are not very volatile, and risk aversion tends to be low as the asset pricing implications are ignored, the implied standard deviation of the real exchange rate is much lower than observed in the data. In contrast, recursive preferences are non-separable over future states and imply that shocks that have a long-run effect on consumption and leisure also affect the current marginal

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¹ For example, Chari et al. (2002) consider monetary shocks and sticky prices. Raffo (2010) and Mandelman et al. (2011) introduce investment specific technology shocks. Corsetti et al. (2008) and Rabanal et al. (2011) study economies with incomplete markets.

utility of consumption. If the long-run effect of such shocks differs across countries, this is reflected in a movement of the real exchange rate.

Two more ingredients are required to deliver a volatile real exchange rate in the model. The first ingredient is a productivity process with a unit root which implies that shocks have long-run effects. However, to ensure balanced growth, productivity is cointegrated, so shocks eventually spill over to the other country. The difference in the levels of productivity across countries is then stationary, but persistent. The second ingredient is home bias. The two countries specialize in the production of intermediate goods that are traded internationally and used to produce final goods. Home bias implies that each country mainly uses the domestic intermediate good in final goods production. Hence, productivity shocks in one country shift the production possibilities for that country's final good by more than the foreign final good. The combination of the persistent difference in productivity and home bias leads to a difference in the future utilities of the two representative agents. Hence, households with recursive preferences value assets that pay out in the current state differently and the real exchange rate adjusts to reflect this difference.

This paper extends the results from Colacito and Croce (2011) to a two-country production economy with endogenous consumption and realistic levels of trade. Colacito and Croce (2011) address the connection between the volatilities of stochastic discount factors and real exchange rates pointed out by Brandt et al. (2006) by using recursive preferences in a two-country endowment economy. In their model there is no trade, and the exogenously given consumption processes feature small, but persistent long-run components as in Bansal and Yaron (2004). They assume that there is a high correlation in the long-run components of consumption across countries which implies a high correlation in the stochastic discount factors. Hence, their model delivers volatile stochastic discount factors combined with a relatively smooth real exchange rate. In contrast, in the production economy studied here, the stochastic discount factors are volatile because of the large variation in continuation utilities in response to the permanent productivity shocks. They are also correlated because of cointegration and risk-sharing between agents. The result is that the volatility of the real exchange rate is similar to the one we observe in the data.

With a production economy where agents trade, we can also consider how risk-sharing affects the dynamics of business cycle quantities. A striking result is that the model with recursive preferences delivers a positive correlation of investment across countries. Recursive preferences imply that marginal utilities can be changed through the continuation utility channel, and since continuation utilities are increasing functions of future capital stocks they can be altered by changing investment. Due to home bias productivity shocks affect the continuation utilities of domestic and foreign households differently, and in the optimal risk-sharing scheme foreign households are compensated after a domestic shock by a transfer of resources. In the benchmark calibration, home bias is strong and it is optimal to equate marginal utilities by increasing foreign as well as domestic investment to increase the future production of both intermediate goods.

Since Tallarini (2000) it is well known that recursive preferences enable a closed production economy to jointly match key moments of both quantities and asset prices. However, Tallarini (2000) obtains a separation result where risk aversion determines the asset pricing implications while the intertemporal elasticity of substitution governs quantity dynamics. This separation result does not hold in a two-country model since the quantity dynamics are affected by risk-sharing between agents.

As the model features complete financial markets, a social planner's problem can be solved for the optimal allocations, and then the prices in the decentralized equilibrium can be obtained. However, when agents have recursive preferences, an additional state variable is required to obtain a recursive formulation of the planner's problem. One interpretation of the additional state is that the Pareto weights on the two countries evolve over time. With this interpretation, the dynamics of the Pareto weights are driven by the heterogeneous responses of households' continuation utilities to productivity shocks and reflect the transfer of resources between countries in the optimal risk-sharing scheme. A productivity shock in one country leads to an increase in the Pareto weight on the other country which corresponds with an increase in the share of resources it receives. In the decentralized equilibrium heterogeneous effects on continuation utilities are instead reflected in real exchange rate movements, which are, therefore, tightly connected with the Pareto weight dynamics.

1.1. Related literature

There are several papers in the international macroeconomics literature that focus on real exchange rate fluctuations. One closely related paper is Rabanal et al. (2011) who also build on the framework introduced by Backus et al. (1992, 1994) and further extended by Heathcote and Perri (2002). The paper finds that in an international business cycle model where trade in financial assets is restricted to a non-contingent bond and productivity shocks are cointegrated, the volatility of the real exchange rate relative to output can be quite high. Corsetti et al. (2008) find that an incomplete markets model with non-traded goods and a distribution sector can also generate high exchange rate variability with trend-stationary shocks. The survey by Heathcote and Perri (2014) discusses how to assess the efficiency of observed allocations across countries. In this paper, a high real exchange rate volatility and a positive cross-country correlation of investment arise in a model with complete financial markets. Hence, these features of international data do not necessarily indicate that allocations are inefficient.

In international finance there are several related papers that focus on asset prices without studying the implications for international investment flows, labor and output. Colacito and Croce (2013) extend the setup in Colacito and Croce (2011) to an economy with trade in two specialized goods where there is long-run risk in the endowments. They find that risk-sharing

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