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Closing large open economy models ☆

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ABSTRACT

A large class of international business cycle models admits multiple locally isolated deterministic steady states, if the elasticity of substitution between traded goods is sufficiently low. I explore the conditions under which such multiplicity occurs and characterize the dynamic properties in the neighborhood of each steady state. Models with standard incomplete markets, portfolio costs, a debt-elastic interest rate, or an overlapping generations framework allow for multiple steady states, if the model features multiple steady states under financial autarchy. If the excess demand for the foreign traded good is increasing in the good's own price in a given steady state, the equilibrium dynamics around this steady state are unbounded. Otherwise, the dynamics are bounded and unique. By contrast, with Uzawa-type preferences, the steady state is always unique and the associated equilibrium dynamics are always bounded and unique. The same results obtain under complete markets.

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1. Introduction

The class of international business cycle models nested in the framework of Corsetti et al. (2008) admits multiple steady states with zero net foreign asset holdings, if the elasticity of substitution between traded goods is sufficiently low. This paper explores the conditions under which such multiplicity occurs and characterizes the models' dynamic properties in the neighborhood of each steady state.

Equilibrium multiplicity is a pervasive feature of models with heterogenous agents. To build intuition consider the case of a static two-country endowment economy with two traded goods that are imperfect substitutes as in Kehoe (1991) and Mas-Colell et al. (1995). For simplicity, let the countries be mirror images of each other with respect to preferences and endowments. One equilibrium always features a relative price of the traded goods equal to unity. With home bias in consumption and a low elasticity of substitution between the traded goods, two more equilibria occur. If the price of the domestic good is high relative to the price of the foreign good, domestic agents are wealthy compared to foreign agents. Under a low elasticity of substitution, foreigners are willing to give up most of their good in order to consume at least some of the domestic good, and domestic agents end up consuming most of both goods. The reverse is true as well. Foreign agents consume most of the goods, if the foreign good is expensive in relative terms.

This intuition carries over to richer models of the international business cycle that feature international borrowing and lending, endogenous production, intertemporal savings and investment decisions, or non-traded goods. For these models to feature multiple steady states with zero net foreign assets under an otherwise standard calibration the elasticity of substitution between traded goods has to lie below 0.5.[1] Whereas in most studies the elasticity of substitution between traded goods and the trade (price) elasticity coincide, the two concepts differ in the model of Corsetti et al. (2008) due to the presence of non-traded distribution services. If the model is parameterized as in Corsetti et al. (2008), multiple steady states occur for an elasticity of substitution between traded goods around unity, although the implied trade elasticity lies in the neighborhood of 0.5.

For a symmetric parameterization of the model I generally find three steady states. However, the model by Corsetti et al. (2008) can be shown to have at least five steady states for some parameterizations.[2]

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[1] Prominent examples of such models are found in Backus et al. (1995), Baxter and Crucini (1995), Heathcote and Perri (2002), and Stockman and Tesar (1995). However, none of these papers explores the possibility of multiple steady states, as the elasticity of substitution is generally assumed to be above unity.

[2] In the working paper version of Corsetti and Dedola (2005), the authors point out that for the case of an endowment economy a model with distribution costs admits multiple equilibria in the absence of international borrowing and lending. However, no systematic exploration of this feature is conducted.

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The multiplicity of the steady state price vector occurs whether international financial markets are absent from the model or one focuses on an incomplete financial markets framework with zero net foreign assets in steady state.[3] This problem is unrelated to the issues about incomplete market models addressed in Schmitt-Grohé and Uribe (2003) and many others. In standard incomplete markets model with one non-state-contingent bond the deterministic steady state of the net foreign asset position is not determined and the dynamics of the net foreign asset position as derived from a linear approximation of the model around a deterministic steady state are not stationary.[4] Absent arbitrage opportunities, the price of the non-state-contingent bond implies that expected marginal utility growth is equalized across countries. In the deterministic steady state, this condition contains no information about the steady state values of the system and the system of equilibrium conditions becomes underdetermined. In particular, any net foreign asset position is compatible with a steady state.

To determine the steady state position of net foreign assets and to remove the non-stationarity of its dynamics, I modify the original model similar to Schmitt-Grohé and Uribe (2003) by allowing for portfolio costs, a debt-elastic interest rate, or an endogenous discount factor. This list is augmented by the overlapping generations structure of Weil (1989) as implemented in Ghironi (2006) and Ghironi (2008). I show that the choice of a stationarity inducing device is not innocuous as it affects both the number of steady states in a low elasticity environment and the dynamics of the model around a steady state.

With portfolio costs, agents face a non-zero cost for bond holdings that differs from a reference level for international bond holdings specified exogenously by the researcher. Furthermore, the steady state is unique and stable only if the model with financial autarchy (or equivalently with incomplete markets and a zero net foreign asset position) has a unique steady state. If the original model has N steady states, the model with portfolio costs has N steady states. Those steady states for which the excess demand of the foreign good is decreasing in its relative price are associated with unique and locally bounded equilibrium dynamics. If the excess demand function is increasing in its relative price in a given steady state, the local equilibrium dynamics are not bounded. Interestingly, if multiple steady states occur under a symmetric calibration, it is typically the symmetric steady state that is associated with unbounded dynamics. Similar results are obtained for the cases of the debt-elastic interest rate and the overlapping generations framework.

Following Uzawa (1968), when the discount factor is assumed to be endogenous, an agent's rate of time preference is strictly decreasing in the agent's utility level. With strictly concave preferences and technologies the relative price of traded goods is uniquely pinned down under endogenous discounting given the function of the discount factor. The net foreign asset position is merely a residual. The equilibrium dynamics in the neighborhood of the unique steady state are always unique and locally bounded irrespective of the number of steady states in the original model with incomplete markets.[5]

Schmitt-Grohé and Uribe (2003) also analyze the case of complete markets. In this case, the net foreign asset position is a residual that does not enter the equilibrium dynamics as a state variable. The steady state of such a model is always unique and the associated equilibrium dynamics are unique and bounded.

Both Schmitt-Grohé and Uribe (2003) and Kim and Kose (2003) find that for the case of a small open economy the various approaches imply virtually identical dynamics. However, generalizing this finding to richer models as made by many researchers, may not be appropriate. Boileau and Normandin (2008) extend the analysis in Schmitt-Grohé and Uribe (2003) to a two-country model with one homogeneous good. Quantitative differences can occur in their setup depending on the persistence of technology shocks.

This paper exclusively analyzes the local dynamics around a given steady state. However, in the presence of multiple steady states, global solution techniques may find richer dynamics than local solution techniques. Bodenstein (2010) presents an analysis of the global dynamics in the model of Backus et al. (1995) under endogenous discounting when the elasticity of substitution between traded goods is sufficiently low.

The empirical relevance of models with low trade and substitution elasticities remains to be addressed. For aggregate data Whalley (1984) reports a trade elasticity of 1.5. Hooper et al. (1998) report a short-run trade elasticity of 0.6 for the U.S. and values between 0 and 0.6 for the remaining G7 countries, while Taylor (1993) finds a short-run trade elasticity of 0.22. Using lower levels of aggregation, Broda and Weinstein (2006) report mean estimates for the elasticity of substitution for various pairs of traded goods between 4 and 6.

Applied macroeconomic studies, have commonly parameterized the substitution elasticity between traded goods at a value between 1 and 1.5 (see e.g. Backus et al. (1995), Chari et al. (2002), and Heathcote and Perri (2002)). However, in line with the macroeconometric evidence, various authors have recently argued in favor of low values of the trade elasticity which coincides with the elasticity of substitution between traded goods for these studies. Heathcote and Perri (2002), Benigno and Thoenissen (2008) and Collard and Dellas (2007) show improved model performance with respect to key features of the international business cycle when allowing for substitution elasticities below 0.5.

Burstein et al. (2003), Corsetti and Dedola (2005), and Corsetti et al. (2008) refrain from assuming such low substitution elasticities directly, but instead introduce distribution costs in terms of non-traded goods to obtain a low implied value of the trade elasticity despite allowing the elasticity of substitution between traded goods to be around unity. The model in Corsetti et al. (2008) successfully addresses two important puzzles in international economics: the high volatility of the real exchange rate relative to fundamentals and the observed negative correlation between the real exchange rate and relative consumption (Backus and Smith (1993)).

As Kollmann (2006) shows, a low elasticity of substitution between traded goods may also be responsible for the apparent home bias in equity holdings. Rabanal and Tuesta (2010) estimate a DSGE model with sticky prices using a Bayesian approach. Their median estimates for the elasticity of substitution range from 0.01 to 0.91for different specifications of their model. Lubik and Schorfheide (2006) estimate the elasticity of substitution to be around 0.4.

The remainder of the paper is structured as follows. Section 2 introduces the issues considered in this paper in a simple model. Section 3 lays out the general model, which is parameterized in Section 4. Steady state multiplicity is discussed in Section 5, while the local dynamics of the model are discussed in Section 6. Concluding remarks are offered in Section 7. The paper is accompanied by a separate Technical Appendix.

2. Simple example

Consider a two-country, two-good endowment economy with incomplete international financial markets. The two countries are

[3] Multiplicity of the steady state price vector can also occur if the net foreign asset position differs from zero in steady state. However, the assumption of zero net foreign assets in steady state is widely made in the literature and implies that the steady states of the incomplete markets model coincide with those obtained in a model without financial markets.

[4] While throughout the analysis the only asset that trades internationally is one non-state-contingent bond, the issues raised carry over to environments with more assets such as those presented in Devereux and Sutherland (2008) as long as the available assets do not complete the market.

[5] If the discount factor was increasing in the agent's utility level, the dynamics around any steady state would always be unbounded.