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International monetary equilibrium with default

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ABSTRACT

We present an integrated framework for the study of the international financial economy with trade, fiat money, monetary and fiscal policy, endogenous default and regulation. Money is introduced via a cash-in-advance requirement and real trade is endogenous. The standard international finance pricing results obtain. Market incompleteness and positive default in equilibrium allow for the study of the transmission of default through the international financial markets and imply a positive role for policy. Finally, we present an example where, due to the trade-off between the non-pecuniary cost of default and the resulting allocation, a Pareto improvement occurs following an increase in interest rates.

1. Introduction

The study of the international financial economy has traditionally followed two distinct strands.[1] In the finance literature, the focus has been on international risk sharing, such as International CAPM. However the asset structure has predominantly either been complete, in the Arrow–Debreu sense, or incomplete by considering only a single bond. The open-economy macroeconomics literature, on the other hand, has focused on real quantities and terms of trade effects and has largely ignored the portfolio choice problem.[2] In both strands the role that monetary and fiscal policy could play within a fully integrated monetary, financial and real sector has not been studied. Here, we attempt to present such a framework within the general equilibrium paradigm: International Monetary Equilibrium with Default (IMED).

Our model extends Geanakoplos and Tsomocos (2002) and Tsomocos (2008) to incomplete markets and default. The interaction between market incompleteness and default allows monetary policy to be non-neutral and non-trivial (the optimal interest rate is not zero, for example). It is consistent with the asset pricing flavour of Lucas (1982), however has several advantages over it. The requirement there that agents sell all of their endowment has several major shortcomings including specifying global transactions beforehand. We focus on the interaction between nominal and real variables by removing the requirement that agents sell all of their endowment. As a result, the financing constraint (ability to borrow money from a national monetary–fiscal authority at a positive interest rate) interacts with the cash-in-advance constraint, allowing monetary policy to have non-neutral effects.

Money is the stipulated medium of exchange in both goods and assets in IMED. Trade is facilitated by the monetary–fiscal authority offering loans before the commodity markets open and are repaid afterwards. Trade within countries must occur in the fiat currency of that country. Foreign currency can be obtained via a foreign exchange market at market prices. Repayments are made by selling a fraction of their commodity endowments or by rolling over obligations to the future. Thus, the demand for money in our model stems from the immediate transactions need as well as intertemporal and speculative motives.

The ability to roll over monetary obligations implies an endogenous term structure that will be determined in equilibrium. Although the profit of the monetary–fiscal authority will always be the seigniorage revenue (since all fiat money exits the system in the end) different patterns of the term structure will have different consequences on trade and consumption and vice versa. Moreover, this results in the financing cost being an addition to the correlation between aggregate consumption and real asset payoffs in determining the risk-premia in asset prices as in Espinoza et al. (2009). This risk premia exist whenever the volume of trade is positive and is independent of aggregate uncertainty, unlike in representative agent models. Financing costs are generated within the framework of a monetary general equilibrium model, with cash-in-advance constraints built along the lines of Dubey and Geanakoplos

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1 See Pavlova and Rigobon (2010) for an excellent overview of recent work on international macro-finance.

2 See Geanakoplos and Tsomocos (2002) for an extended discussion of this.

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(1992, 2003b,a, 2006), Espinoza and Tsomocos (2014), Geanakoplos and Tsomocos (2002), Goodhart et al. (2006) and Tsomocos (2008). Demand for money is endogenous in our model and depends on commodity prices, exchange rates, yield curve and asset prices in the world economy. Given the existence of private monetary endowments in each state and positive default, nominal determinacy is obtained.[3] In an international context, Tsomocos (2008) shows nominal determinacy under the presence of private liquid wealth contrary to the result of Kareken and Wallace (1981).[4]

In the IMED, agents sell contracts (both real and nominal), but need not honour their contractual obligation. As markets are incomplete, by changing the span and asset prices, default may be desirable in equilibrium and, furthermore, may be affected by monetary policy. In our model the decision to default is a decision variable as agents weigh the costs of a non-pecuniary (utility) punishment against the benefits of defaulting. In this we follow Shubik and Wilson (1977) and Dubey et al. (2005). We could have modelled default using collateral such as in Geanakoplos (1997), Modica et al. (1998), Araujo and Páscoa (2002), Sabarwal (2003) and Geanakoplos and Zame (2007).[5] We chose the former modelling method for two reasons. First, almost always international default is partial, see for example the current Eurozone sovereign debt crisis, and is associated with reputation costs that are reflected in higher sovereign bond yields and Credit Default Swap (CDS) spreads. Second, we endeavour to introduce welfare improvements by designing the appropriate monetary policy (as in the numerical example in Section 3), in the spirit of Dubey et al. (2005) which considers variations in default penalties.

New Open Economy Models (NOEM), inspired by Obstfeld and Rogoff (1995), study the transmission of domestic shocks via purchasing power parity and uncovered interest rate parity through the interaction of nominal rigidities and imperfect competition. In our model, markets are perfectly competitive and prices are fully flexible yet exchange rate movements play a similar role, though via a different channel. This is because monetary policy not only affects the price level, but also the interest rate and hence the liquidity available to facilitate the trading process. Expansionary monetary policy in IMED results in an increase in real exports by making export prices cheaper through depreciating the exchange rate, and also increases the real quantity of goods available for export by making them more liquid. In the numerical example presented in Section 3, we show that an increase in the nominal interest rate can Pareto improve because of the trade-off agents face between substituting between consumption and the non-pecuniary cost of default.[6]

Section 2 describes and defines IMED and the notion of a refined equilibrium whose existence we prove. In Section 3 we present a numerical example and describe the properties of IMED.

2. The model

The monetary economy within each country of our model is as follows. There is a monetary–fiscal authority in each period who lends money to agents at an endogenously determined interest rate. All agents in our model can only borrow from the monetary–fiscal authority of their country of origin. Households (endowed with goods and fiat money) will, given reasonable money market interest rates, borrow from the monetary–fiscal authority in each period. All goods transactions occur in the currency of the country of their origin.

2.1. The international monetary economy

We consider an exchange economy which extends over two dates, $t \in T = \{0, 1\}$, with the second period having S possible states of nature which we index with $s \in S = \{1, \dots, S\}$. Including date 0, there are $S + 1$ date-events lying in the set $S^* := \{0, 1, \dots, S\}$. There are C countries indexed by $c \in C = \{1, 2, \dots, C\}$ where trade occurs at prices denominated in the local currency.[7] At every $s \in S^*$ there are L perishable consumption goods in the world economy, indexed with $l \in L = \{1, \dots, L\}$ and traded at domestic nominal spot prices p_{sl}. The price vector at state $s \in S^*$ is $p_s = (p_{s1}, \dots, p_{sL}) \in \mathbb{R}^L_+$ and an overall price vector $p = (p_0, \dots, p_s, \dots, p_S) \in \mathbb{R}^{(S+1)L}_{++}$. We also associate each commodity with a single country, and we write for example $l \in L^\alpha$.[8] That is, $l \in L = \bigcup_{\alpha \in C} L^\alpha$.

The nominal exchange rate is the value of a unit of currency $\forall \alpha, \beta \in C$ in terms of currency 1 and, for $s \in S^*$, is $\pi_s = (1, \dots, \pi_{sC})$. The overall nominal exchange rate vector is $\pi = (\pi_0, \dots, \pi_S) \in \mathbb{R}^{(S+1)C}_{++}$. We find it convenient to use the notation $\pi_{s\alpha\beta}$ to denote the α-currency value of a unit of β-currency and trivially $\pi_{s\alpha\beta} = \frac{\pi_{s\beta}}{\pi_{s\alpha}}$.

At $t = 0$ there are asset markets for $J \leq S - 1$ financial contracts indexed with $j \in J = \{1, \dots, J\}$. We associate each asset with a country and write $j \in J^\alpha$ with the entire set being $j \in J = \bigcup_{\alpha \in C} J^\alpha$. Each asset is a promise to deliver A_{sj} ($A_{sj} \geq 0$ and $\sum_s A_{sj} > 0$) units of domestic currency at a price of ψ_j in the corresponding currency. The set of asset prices is $\psi = (\psi_1, \dots, \psi_J) \in \mathbb{R}^J_{++}$. Sellers of the assets may choose to default and will incur a private marginal cost of default of $\lambda \in \mathbb{R}^J_{++}$. Finally as contracts are nominal, we require an index through which to obtain the real value of default. For $j \in J^\alpha$, we denote this by v_j which is an exogenously specified L dimensional vector with L^α dimensional vector of positive numbers and the remainder zeros, which, when multiplied by the price of goods at a date-event, gives the price index. Note that $v = \{v_1, \dots, v_J\} \in \mathbb{R}^{JL}_+$. Consequently assets are defined by the vector (A, λ, v). The asset market is an anonymous market with promises between different sellers not allowed to be distinguished even though they may deliver differently. The possibility of default on assets means that the expected delivery rates, K, are macro variables taken as given by agents. All deliveries are pooled and buyers of the pool for each asset receive a pro rata share of the net deliveries. Each ownership share of the pool receives a fraction K_{sj} of the promised delivery A_{sj} for all $j \in J$. Formally $K_j = (K_{1j}, \dots, K_{SJ}) \in [0, 1]^S$ is the vector of delivery rates for asset j and $K = (K_1, \dots, K_J) \in [0, 1]^{SJ}$ is the overall set of delivery rates of financial contracts. The perfectly competitive and anonymous nature of asset markets means that creditors face both moral hazard and adverse selection as they are unable to induce debtors to honour their obligations fully nor can they identify relatively worse credit risks. The existence of sufficiently large non-pecuniary punishments for default means that the market does not fully unravel.

[3] Lin et al. (2014) show how default alone, without initial private monetary endowments, can support a determinate equilibrium in a monetary economy.

[4] See Woodford (1994) for the fiscal theory of price level. Bloise and Polemarchakis (2006) gives an overview on the non-neutrality of monetary policy and price level determinacy with non-Ricardian fiscal policy.

[5] Moreover, since we focus on competitive, mass, anonymous markets with perfect information we refrain from addressing issues of restricted participation as they relate with more realistic default penalties.

[6] Another numerical example of IMED in Peiris (2010) shows that expansionary monetary policy (lowering interest rates) can result in terms of trade moving away from the home country, lower long term yields domestically, and can transmit abroad resulting in higher leverage, and ultimately default, globally when interest rates eventually rise.

[7] Where we generically denote a country $\alpha \in C$ we denote another country as $\beta \in C \setminus \alpha$. Note that countries will be synonymous with the location of a market.

[8] For the sake of simplicity, we claim there is a single type of good in the international economy but that is endowed in both countries and hence is characterized by the country of origin. For example the good may be cars but the cars in the UK would be British Cars and would be distinct from American Cars.