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Unique equilibrium in the Eaton–Gersovitz model of sovereign debt☆

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ABSTRACT

A common view of sovereign debt markets is that they are prone to multiple equilibria. We prove that, to the contrary, Markov perfect equilibrium is unique in the widely studied model of Eaton and Gersovitz (1981), and we discuss multiple extensions and limitations of this finding. Our results show that no improvement in a borrower's reputation for repayment can be self-sustaining, thereby strengthening the Bulow and Rogoff (1989) argument that debt cannot be sustained by reputation alone.

1. Introduction

A common view of sovereign debt markets is that they are prone to multiple equilibria: a market panic may inflate bond yields, deteriorate the sustainability of government debt and precipitate a default event, justifying investor fears. Indeed, Mario Draghi's speech in July 2012, announcing that the ECB was "ready to do whatever it takes" to preserve the single currency, and the subsequent creation of the Outright Monetary Transactions (OMT) program, are widely seen as having moved Eurozone sovereign debt markets out of an adverse equilibrium: since then, bond spreads have experienced dramatic falls as fears of default have receded.

At the same time, in the last decade, a booming quantitative literature in the line of Eaton and Gersovitz (1981)—initiated by Arellano (2008) and Aguiar and Gopinath (2006), and summarized in Aguiar and Amador (2015)—has studied sovereign debt markets using an infinite-horizon incomplete markets model for which no result on equilibrium multiplicity was known. Many researchers suspected that the model might feature multiple equilibria,[1] yet in numerical computations the literature had not found any explicit case of multiplicity. In this paper we explain why, by proving that equilibrium is *unique* in the benchmark infinite-horizon model with a Markov process for the exogenous driving state and exogenous value from default. Although we emphasize Markov perfect equilibrium—the usual equilibrium concept in the literature, and one for which our argument is especially direct—we show that our core uniqueness result extends to subgame perfect equilibria more generally. We also extend our proof to several modifications of the benchmark model, as described below.

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[1] See Krusell and Smith (2003) for an example of multiple Markov perfect equilibria in an infinite-horizon economy.

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Why could multiplicity arise in the benchmark model we study? To build intuition, consider the simplest environment: one in which debt is restricted to be risk-free, as in Zhang (1997). A Markov perfect equilibrium of this model features a (constant) endogenous debt limit, which is the most that can be incurred today without the possibility that the government will want to default tomorrow. Suppose credit becomes tighter in the future—tomorrow's debt limit falls. Since the government is less able to smooth consumption fluctuations, its perceived benefit from access to credit is now lower, and so its willingness to repay today's debts falls. In response, investors lower today's debt limit as well.

Through this process, an equilibrium with loose credit and high willingness to repay debts could turn into one with tight credit and low willingness to repay. Similarly, in the full Eaton and Gersovitz (1981) model with risky debt, investors' pessimistic expectations about the likelihood of default could translate into higher risk premia on debt—which, by making debt service more costly and continued access to credit markets less valuable, would encourage default and validate the original pessimism. This mechanism sounds appealing, and in our view it captures an important part of the common intuition for equilibrium multiplicity in sovereign debt markets.

Our results rule it out. The intuition remains simplest in the Zhang (1997) environment. If there are two equilibria with distinct debt limits, we consider two governments that are each at the limit in their respective equilibria. We argue that the government with less debt must have a strictly higher value: starting from that point, it can follow a strategy that parallels the strategy of the higher-debt government, maintaining its liabilities at a uniform distance and achieving higher consumption at every point by economizing on interest payments. But this contradicts the assumption that both governments start at their debt limits, where each must obtain the (constant) value of default. In short, once both governments have exhausted their debt capacity, the one with a strictly lower level of debt is strictly better off—meaning that this government should be able to borrow slightly more without running the risk of default, and cannot have exhausted its capacity after all.

Interestingly, this proof strategy by replication has echoes of that used by Bulow and Rogoff (1989) to rule out reputational equilibria in a similar class of models where sovereign governments retain the ability to save after defaulting. The original Bulow–Rogoff result is cast in a complete markets setting. In a second modification of the benchmark model, we specify the only punishment from default as the loss of ability to borrow. As an immediate corollary to our Eaton–Gersovitz uniqueness result, we then obtain the *incomplete markets Bulow–Rogoff result*: under this specification of default costs, the no-borrowing equilibrium is the unique equilibrium. Hence our general uniqueness result nests a central impossibility result for the sovereign debt literature. Here, our paper complements parallel and independent work by Bloise et al. (2016), who explore the validity of the Bulow–Rogoff result in environments with general asset market structures.

We next explore the robustness of our uniqueness result to relaxing various model assumptions. We first consider a case where savings are exogenously bounded. Echoing a result of Passadore and Xandri (2014), we prove that multiple equilibria can exist when no savings is allowed. We also show, however, that uniqueness holds whenever the bound on savings is strictly positive even if arbitrarily small. Next, we consider a case where the value of default is endogenous because governments in default have a stochastic option to reenter markets (a typical assumption in the quantitative literature). In that case, we rule out multiplicity of the most widely suspected form—where bond prices in a favorable equilibrium dominate those in a self-fulfilling adverse one—and obtain complete uniqueness when shocks are independent and identically distributed. Finally, we discuss alternative assumptions that are known to generate multiple equilibria in related contexts, including modifying the timing and commitment assumptions, introducing long-term debt, or assuming low international interest rates.

Our objective is not to deny that sovereign debt markets can be prone to self-fulfilling crises, or that OMT may have ruled out a bad equilibrium. Instead, we hope that our results may help sharpen the literature's understanding of the assumptions that are needed for such multiple equilibria to exist. Our replication-based proof strategy may also be of independent interest, as a general technique for proving uniqueness of equilibrium in infinite-horizon games.

The rest of the paper is organized as follows. Section 2 lays out the benchmark Eaton–Gersovitz model, and establishes uniqueness of Markov perfect equilibrium and uniqueness of subgame perfect equilibrium. Section 3 adapts our main proof to two related models. Section 3.1 proves uniqueness in the Zhang (1997) model, where debt is restricted to be risk-free, and Section 3.2 derives the incomplete markets version of the Bulow and Rogoff (1989) result as a corollary of our main uniqueness result. Section 4 considers the robustness of our results as we relax various assumptions. Section 4.1 considers exogenous restrictions on savings. Section 4.2 considers the case where reentry is allowed after default. Section 4.3 discusses other extensions. Section 5 concludes. Proofs not included in the main text are collected in the online appendix.

2. Equilibrium uniqueness in the benchmark model

In this section we describe our benchmark environment, provide a proof of existence, and move on to establish the core uniqueness result of the paper.

2.1. Model description

We now describe what we call the *benchmark* infinite-horizon model with Markov income (see Aguiar and Amador, 2015). We focus first on Markov perfect equilibria, in which the current states b and s encode all the relevant history. In