Closing small open economy models with collateral constraints

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Abstract

We show that the alternative stationarity-inducing techniques proposed by Schmitt-Grohé and Uribe (2003), which are equivalent in frictionless small open economy models, deliver different results in the presence of binding collateral-type financial constraints. In particular, a small open economy model with credit constraints that embodies an endogenous discount factor can produce results consistent with the stylized facts of financially constrained economies or sudden stop events; in the financially constrained regime the steady state values of output, investment and hours of work decrease relative to the unconstrained regime. Under a debt-elastic interest rate, other things equal, these results are reversed.

Keywords: Small open economy; Stationarity; Borrowing constraints.

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1 Introduction

The equilibrium dynamics of standard small open economy (SOE) models with incomplete asset markets are characterized by a random walk component.[1] Schmitt-Grohé and Uribe (2003) (referred to as SGU) compared quantitatively five alternative ways of inducing stationarity of the equilibrium dynamics. All of them delivered identical results.

We extend the paper by SGU by including collateral-type financial frictions as in Mendoza (2002), and examine whether this equivalence still holds. Specifically, we work as follows. First, we present two variations of a SOE model with collateral constraints; a model with an endogenous discount factor (EDF) and a model with a debt-elastic interest-rate (DEIR). Absent credit frictions and under a specific parameterization (as in SGU), they predict identical steady states. Then, departing from the baseline solution, we assume that financial markets are not frictionless. In particular, we assume that the economies are at the financially unconstrained steady state equilibrium at the time a collateral constraint binds permanently. In that way we generate a sudden stop as in the literature (see e.g. Lorenzoni, 2014). We evaluate the predictions of the two models by comparing the steady state equilibria of the unconstrained and constrained regimes.

We find that, in contrast to frictionless models, the alternative stationarity-inducing techniques in a SOE model with collateral constraints affect its qualitative and quantitative predictions. This result arises because, depending on the way stationarity is induced, the Euler equation for foreign bonds pins down the steady state value of different variables; in the EDF model the Euler equation pins down the steady state value of consumption, whereas in the DEIR model the same equation pins down the steady level of foreign debt.[2] In the unconstrained regime, where the collateral constraint is loose, this fact makes no difference and the two models deliver the same steady state equilibria. On the other hand, in the constrained regime, the positive shadow cost of relaxing the constraint affects primarily consumption in the EDF model, while it affects debt on the DEIR model.

Our analysis is closely related to the literature on sudden stops (e.g. Calvo, 1998, Mendoza, 2002, Korinek and Mendoza, 2014) and several to other papers that analyze financial frictions in macroeconomic models (e.g. Carlstrom and Fuerst, 1997, Aguiar and Gopinath, 2007).

The rest of our analysis is organized as follows. Sections 2 and 3 present the EDF and DEIR models respectively. Section 4 conducts the comparison between the two models. Section 5 concludes.

[1] See Schmitt-Grohé and Uribe (2003, 2017).

[2] See also the Introduction in SGU.

2 Model 1: A model with endogenous discount factor (EDF)

We consider a small open economy model similar to SGU (Section 2), which will be used as the main reference for our results. The only difference is that the world credit markets are imperfect. In particular, households' borrowing ability is constrained by a fraction of their collateralized assets as in Mendoza (2002):

$$d_t \leq \phi k_t \tag{1}$$

where k_t and d_t denote end-of-period physical capital and one-period international bonds respectively. This constraint resembles a contract with imperfect enforcement, where foreign lenders cannot collect more than a fraction ϕ of the value of debtor's assets.[3]

Under the presence of the collateral constraint and absent, for simplicity, capital adjustment costs, the optimality conditions for capital and international bonds are:

$$\lambda_t - \phi\mu_t = \beta\left(\widetilde{c}_t, \widetilde{h}_t\right) E_t\lambda_{t+1}\left[A_{t+1}F_k\left(k_{t+1}, h_{t+1}\right) + 1 - \delta\right] \tag{2}$$

$$\lambda_t - \mu_t = \beta\left(\widetilde{c}_t, \widetilde{h}_t\right)(1 + r_t) E_t\lambda_{t+1} \tag{3}$$

where λ_t and μ_t denote the non-negative Lagrange multipliers associated with the budget and the collateral constraint respectively. In this model, the discount factor is a function of the aggregate levels of consumption, $\widetilde{c}_t$, and hours of work, $\widetilde{h}_t$, $\left(\beta_{\widetilde{c}} < 0, \beta_{\widetilde{h}} > 0\right)$. The foreign interest rate is assumed to be constant, $r_t = r$.

To solve the model, we borrow the parameterization of SGU (Table 1). Regarding the parameter ϕ in the collateral constraint, we set it at 0.2 as in Korinek and Mendoza (2014).

3 Model 2: A model with a debt-elastic interest rate (DEIR)

In this section we consider the same economy except that now stationarity is induced via a debt-elastic interest rate.

The optimality conditions for capital and foreign bonds are now:

$$\lambda_t - \phi\mu_t = \beta E_t\lambda_{t+1}\left[A_{t+1}F_k\left(k_{t+1}, h_{t+1}\right) + 1 - \delta\right] \tag{4}$$

[3] The collateral constraint is not derived as an optimal contract between borrowers and lenders, but imposed directly as in e.g. Kiyotaki and Moore (1997), Aiyagari and Gertler (1999) and Mendoza (2002, 2010).

$$\lambda_t - \mu_t = \beta (1 + r_t) E_t \lambda_{t+1} \tag{5}$$

where the foreign interest rate is an increasing function of aggregate level of foreign debt, $\widetilde{d}_t$, given by $r_t = r + \psi_2 \left(e^{\widetilde{d}_t - \overline{d}} - 1 \right)$, while the discount factor is constant (see SGU Section 3).

To solve the model, we use the same parameterization as above.

4 Results

In this section we perform a quantitative comparison of the EDF and DEIR models, to study whether the alternative ways of making a SOE model with collateral constraints stationary affect its quantitative predictions. Put differently, we examine whether the implications of binding credit constraints change, depending on the way stationarity is induced.

Specifically, for each of the two models, we assume that the economy is at its financially unconstrained steady state equilibrium at the time the collateral constraint binds permanently. A binding collateral constraint is a simple form of a sudden stop. Under the parameterization described in the previous section, we compute and compare the steady state solutions of the financially unconstrained and constrained regimes. We solve the dynamic system non-linearly using the Dynare toolkit.[4] Notice that the only source of transitional dynamics will be the imposition of a binding collateral constraint.

Table 1: Steady state solutions

variable	description	EDF unconstrained (1a)	EDF constrained (1b)	DEIR unconstrained (2a)	DEIR constrained (2b)
y	output	1.4865	1.4841	1.4865	1.4866
c	consumption	1.1170	1.1181	1.1170	1.1197
h	hours	1.0074	1.0063	1.0074	1.0075
i	investment	0.3397	0.3389	0.3397	0.3398
k	capital	3.3977	3.3886	3.3977	3.3983
d/y	foreign debt as a share of GDP	0.5007	0.4567	0.5007	0.4572
tb/y	trade balance as a share of GDP	0.02	0.0183	0.02	0.0183

[4] Our qualitative results do not change when we use the first-order perturbation method as described by Schmitt-Grohe and Uribe (2004).

Table 1 presents the steady state solutions of the financially constrained regimes for both models.[5] For comparison, we also include the steady state solution of the financially unconstrained regimes.

First,we look at the steady state solution of the financially unconstrained economies, columns (1a) and (2a). Both the EDF and DEIR models deliver the same unconstrained steady state equilibrium, as reported by SGU.

Then, departing from the unconstrained steady state, we study the implications of binding collateral constraints. The comparison between the steady state solutions of the financially unconstrained and constrained regimes in the EDF model (column (1a) vis-à-vis (1b)), and in the DEIR model (column (2a) vis-à-vis (2b)), imply that the constrained steady state equilibrium of two models differs substantially.[6] The reason behind this result is that when the collateral constraint binds it distorts the Euler equation for foreign bonds ($\mu > 0$), which determines the steady state values of consumption in the EDF model, whereas it determines the steady level of foreign debt in the DEIR model.

The EDF model can produce four empirical regularities of sudden stop events, namely the decrease in output, investment, capital and hours of work.[7] Inspection of equation (3) shows that a binding collateral constraint lowers the discount factor, which makes capital, investment and output to decrease in the steady state.[8]

On the other hand, the DEIR model, where debt liabilities are state-contingent, fails to generate any of the stylized facts of sudden stop events. In the financially constrained economy, lower foreign interest expenses, due to a lower level of foreign debt and a lower state contingent return paid on it, have positive consequences for the real economy. When the collateral constraint binds, the lower return on capital is associated with higher capital and hence output (to see this observe the Euler equation for capital, equation (4)).

However, it is worth adding here that both models suffer from a shortcoming, common to economies with financial frictions; there is a counterfactual increase in consumption following a borrowing tightening. In particular, a binding credit constraint lowers households' liabilities and allows them to consume more.[9]

[5] The magnitude of the results is sensitive to the value of the parameter ϕ.

[6] This result remains robust even under a different assumption on the borrowing limit, e.g. when it is a function of aggregate per capita consumption, like in Korinek and Mendoza (2014).

[7] See e.g. Ferretti and Razin (2000) and Mendoza (2010), for the description of the empirics of sudden stops.

[8] Mendoza (2010) and Korinek and Mendoza (2014) showed how the mismatch between non-state contingent debt liabilities and procyclical borrowing limit, drives the financial amplification effects.

[9] See Schmitt-Grohé and Uribe (2017).

5 Conclusions

In this paper we compared two modifications that made a SOE model with collateral constraints stationary; an endogenous discount factor and a debt-elastic interest rate. The main result is that when financial markets are imperfect the alternative stationarity-inducing techniques affect the solutions of the financially constrained economies. Specifically, only a SOE model with an endogenous discount factor, and not with a debt-elastic interest rate, yields qualitative predictions consistent with the stylized facts of financially constrained economies or sudden stop events. Thus, when SOE models are used to study the implications of financial frictions or sudden stop events, stationarity should be induced through an endogenous discount factor rather than an endogenous debt-elastic interest rate.

Appendix

Supplementary material related to this article can be found on line at:
https://warwick.ac.uk/fac/soc/economics/staff/vdimakopoulou/closing_soe_ff_appendix.pdf

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