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Trend Shocks and Sudden Stops[*]

Hernán D. Seoane[†]

Universidad Carlos III de Madrid

Emircan Yurdagul[‡]

Universidad Carlos III de Madrid

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Abstract

Sudden Stops are characterized by large output drops, current account reversals and real exchange rate depreciation followed by a slow recovery, a pattern that has proven to be hard to capture with standard open economy models. This paper extends the standard models with endogenous collateral constraints to include permanent income (trend) shocks and studies the optimal policy design in this setting. We find that shocks to the trend play an important role in generating a Sudden Stop followed by a slow recovery, a result that is also supported by the data. With trend and transitory shocks, optimal capital control policy is procyclical, although less so than under transitory shocks only.

Keywords: Borrowing constraints; trend shocks; Sudden Stops; optimal capital controls.

JEL Classification: F32, F34, F41.

1 Introduction

Macro-financial crisis in small open economies, usually called "Sudden Stops", became frequent episodes during the last 30 years. The distinguishing features of these crisis are large output drops, sudden and sizable current account reversals and real exchange rate depreciation that has usually been followed by a slow recovery, i.e. a highly asymmetric dynamic where the crisis unravels quickly affecting financial and real variables, with sluggish recovery.

Even though understanding these dynamics has been of first order importance, they have proven to be hard to capture with standard open economy models. A promising line of research has been developed by Bianchi (2011) following the seminal work of Mendoza (2002) by modeling a small open economy subject to collateral constraints with endogenous borrowing limits.[1] However, these models that are the building blocks of models currently used to study macro-prudential policies, have not been able to generate the observed persistence and sluggishness in the recovery after the crisis. This lack of persistence in the recovery after a Sudden Stop can be observed in Schmitt-Grohé and Uribe (2017) and in Bianchi et al. (2016) for the case of a model with news shocks.[2]

In this paper, we extend the standard models with endogenous collateral constraints to include trend shocks and contribute to the literature in two ways. First, we study the role of permanent income shocks in generating Sudden Stops in a model where the collateral constraint depends on the tradable value of domestic income. Second, we review optimal tax policy implications for economies with trend shocks.

We find that transitory shocks alone can generate a sizable depreciation of the real exchange rate but imply counterfactual persistence in the real exchange rate and the trade balance-to-output ratio. On the other hand, permanent income shocks can be relevant factors as they produce plausible Sudden Stop dynamics. To study this, we extend the model with stationary output shocks to include both transitory and trend shocks as in Aguiar and

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[1]In this class of models, borrowing limits depend on market prices and, consequently, are subject to general equilibrium effects, usually called "pecuniary externalities".

[2]In this paper, we restrain our attention to two-sector models as this allows us to study the real exchange rate. It is important to highlight that capital accumulation in one sector models can generate substantially more persistence when combined with working capital constraint and imported inputs, see Mendoza (2010).

Gopinath (2006).[3] We estimate the trend and transitory shocks using Argentinean data from 1876 to 2004, and we feed the estimated parameters into the model to simulate Sudden Stops as defined in the data. We find that the model with trend shocks produces realistic Sudden Stop dynamics. This positive result is in line with Aguiar and Gopinath (2006) and Aguiar and Gopinath (2007) who highlight the importance of trend shocks in generating the observed business cycle dynamics in emerging economies. In a way, our paper complements theirs by focusing on a two-sector economy with occasionally binding collateral constraints.

Our positive finding is not only important from a quantitative point of view. It has significant economic implications in the way we understand this type of crisis as trend and transitory shocks generate very different debt dynamics in small open economy models. The intuition for these differences comes from the Permanent Income Hypothesis that suggests that a negative transitory shock increases debt to smooth consumption, while a negative trend shock leads to a permanent fall in consumption. Consequently, the trend shock model exhibits a deleveraging effect after the Sudden Stop that happens because the household recognizes itself as permanently poorer. This is in contrast with the deleveraging in the model only with transitory shocks, which instead arises due to hitting the borrowing constraint tightened by the low output level.

Besides looking at unconditional moments and the dynamics around Sudden Stops, we test our model in a key dimension. As a by-product of our estimation strategy we can recover the estimates of transitory tradable and non-tradable income shocks and a common trend shock. If Sudden Stops were triggered by transitory shocks, we should observe a sequence of negative transitory shocks before these events. This is not the case in the data. Instead, we find mixed evidence on this dimension and, in general, persistent drops in income do not precede Sudden Stops. On the other hand, we find that the economy is growing in the years prior to Sudden Stops and, every Sudden Stop in our sample is preceded by a large negative trend shock, more than two standard deviations below average in most of the cases, suggesting that Sudden Stop dynamics are mainly driven by permanent shocks.

We find that the trend shocks model can generate overborrowing compared to the con-

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[3]Trend shocks capture the role of permanently perceived changes in income that can be driven by changes in trade policies or changes in the way fiscal and monetary policies are conducted, as discussed by Aguiar and Gopinath (2007).

strained efficient economy, in line with the findings of Bianchi (2011), in the sense that the competitive equilibrium exhibits larger levels of debt than the constrained planner's solution. However, as opposed to Bianchi (2011), considering trend shocks introduces a new aspect of overborrowing. In the model with only mean reverting shocks the economy tends to suffer more overborrowing during bad times, i.e. when the economy issues debt to smooth consumption. Meanwhile, with trend shocks households tend to issue debt in good times to increase consumption today on behalf of future higher income and tend to overborrow largely during good times too.

We then study optimal taxation on external borrowing. In line with the existing literature, i.e. Bianchi (2011), Benigno et al. (2016) and others, we also find that capital controls are macroprudential, in the sense that they are positive on average. We find that trend shocks imply higher degree of macroprudential policy as it implies consistently higher average taxes, both in good and bad times, than with only transitory shocks. Additionally, in line with Schmitt-Grohé and Uribe (2017) we find that they are also procyclical, meaning a high (low) tax on foreign debt issuance when output growth is low (high), i.e. consistent with what the authors refer to as the second dimension of macroprudentiality. However, complementing the results in Schmitt-Grohé and Uribe (2017), a simple accounting exercise shows that the degree of procyclicality is lower with trend shocks than with transitory shocks. This is because with trend shocks, the planner issues less debt than the households during the booming part of the cycle.

In order to put the contribution of our paper further in context, we turn to a more detailed review of the existing literature.

Related literature. The positive analysis in this paper contributes to the literature on financial crisis with Fisherian deflation established by Mendoza (2001), Mendoza (2002) and Mendoza (2010) by considering the role of permanent income shocks in Sudden Stop dynamics. In this way, we also relate to Aguiar and Gopinath (2006) and Aguiar and Gopinath (2007), who study the role of trend shocks in emerging economies in the contexts of sovereign default and business cycle analysis, respectively. Moreover, our paper takes part in the recent debate about the importance of trend shocks and financial frictions in the

business cycle of emerging economies by Aguiar and Gopinath (2007) and García-Cicco et al. (2010). An implication of our findings is that the revisions of permanent income, driven by permanent income shocks, may be key to capture the dynamics of Sudden Stops in this type of models.

Our normative analysis contributes to the literature on optimal capital controls such as Bianchi (2010), Benigno et al. (2011), Benigno et al. (2012), Bianchi (2011), Jeanne and Korinek (2010), Korinek (2010a), Korinek (2010b), Korinek (2011), Ottonello (2012), Uribe (2006) and Schmitt-Grohé and Uribe (2016) by considering the implications of trend shocks in optimal policy design in the presence of overborrowing. On the empirical side there has been a renewed interest on the determinants and properties of observed capital controls, for instance Fernández et al. (2015a) and Fernández et al. (2015b) study the behavior of capital controls over the business cycle. These streams of the literature intend to shed light on the role of policymaking in preventing overborrowing cycles and mostly focus on the role of macroprudential policies. As such, one key aspect of our analysis is to identify macroprudential policies and to quantify how important are permanent vis-a-vis transitory shocks in their design.

The model in our paper is similar to the contemporary work of Flemming et al. (2019). Like us, they find that positive trend shocks induce agents to borrow more, and potentially more than what the planner would borrow. Differently from us, however, their study is fully normative, focusing on the size and timing of the optimal policy. Instead, our analysis is both positive and normative. In addition to studying the implications of permanent shocks on the optimality of capital controls, we aim to assess the adequacy of trend shocks for the dynamics of Sudden Stops in emerging small open economies. In contrast to Flemming et al. (2019), our quantitative exploration of the model includes both mean reverting and permanent shocks, and the full income process we use in our quantitative exercise is a result of our estimation of the unobserved shocks independently of the identifying restrictions of the DSGE model. Accordingly, our study provides an evaluation of the role of permanent shocks in matching the empirical features around Sudden Stops. As mentioned earlier, our findings provide strong suggestive evidence on the importance of trend shocks during Sudden Stop episodes.

This paper also relates to recent literature that studies Sudden Stops in endogenous growth models. Articles in this literature such as Ates and Saffie (2016), Guerron-Quintana et al. (2016) can rationalize the importance of permanent shocks in open economies subject to collateral constraints as these papers analyze the way transitory shocks can have permanent effects in productivity growth. Our point instead is wider, suggesting that other disturbances such as permanently perceived fiscal policy changes, changes in trade policies or political cycles that are likely to have major impact on the permanent income can affect the dynamics around Sudden Stops in a plausible way.

The remainder of the paper goes as follows. In Section 2, we document the main features of Sudden Stop episodes for various economies around the world. In Section 3, we introduce the model. In Section 4, we study the Sudden Stops implied by the model and discuss its various shortcomings. We present the trend shocks model with our preferred calibration in Section 5 and study its implications for the Sudden Stops. In Section 6, we focus on the overborrowing implied by our model. We conclude in Section 7.

2   Empirical Findings

As pointed out by Mendoza (2010) and Calvo et al. (2006) there are three main empirical regularities that are often used to identify Sudden Stop episodes. The first regularity is a sudden reversal in the dynamics of international capital flows, i.e. the trade balance and the current account switch rapidly from deficits to surpluses at the outset of the crisis. The second one is a drop in output. Finally, the third regularity is a fall in asset prices and peaks in spreads. In sum, the term "Sudden Stops" refers to the type of a financial crisis that occurs together with a deep recession, that is in fact the key denominator of most of the crisis in emerging economies over the last fifty years.

Defining Sudden Stops as episodes of at least 2% output fall jointly with an increase in the net export-to-output ratio of at least 2 percentage points, we identify 23 Sudden Stops for a panel of emerging countries.[4] Figure 1 plots the averages of a few relevant statistics around these episodes. It shows that the net exports-to-output ratio starts deteriorating as

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[4]We discard any episode for which there is another case that satisfies our criteria less than 5 years before.
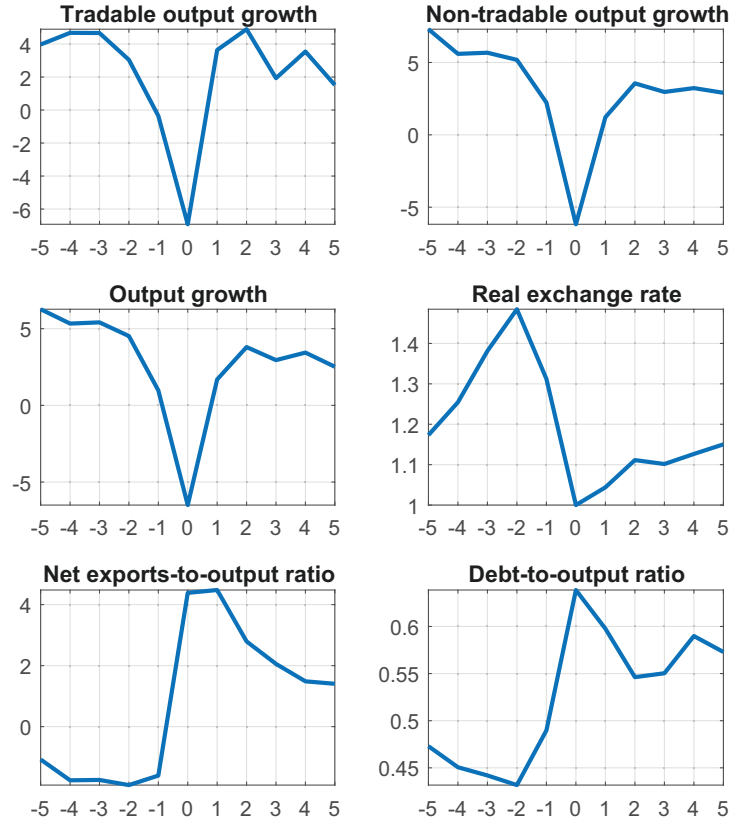
Figure 1: Sudden Stops

Note: The data is from the World Development Indicators (WDI) at annual frequency for the period 1960-2016. We use an unbalanced panel that, upon available data, includes Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Egypt, Guatemala, Honduras, India, Indonesia, South Korea, Malaysia, Mexico, Panama, Peru, Philippines, South Africa and Uruguay. The figure plots the averages around Sudden Stops. We define Sudden Stops as events of at least 2% output fall jointly with a net export-to-output ratio reversal of at least 2 percentage points and discard any event for which there is another case that satisfies our criteria less than 5 years before. The period 0 dates the Sudden Stop event. Tradable output is agriculture and manufacture value added and non-tradable output is the remainder of GDP. Debt is total external debt stocks. The real exchange rate is defined as the nominal exchange rate (US dollars per unit of domestic currency) multiplied by the domestic deflator and divided by the US GDP deflator, i.e. a depreciation when decreasing; normalized to 1 in period 0. Growth rates are in percentages.

early as five years before the Sudden Stop. This deterioration of the trade balance coincides with high output growth rates and strong appreciation of real exchange rate. During this period, there is also foreign debt accumulation for the economy as a whole at a similar rate to output growth, leading to a fairly constant debt-to-output ratio.

The Sudden Stop episodes in our database replicate the features highlighted by the existing literature. The trade balance-to-output ratio switches from a 2% of GDP deficit to a 4% surplus and only starts deteriorating slowly, remaining larger than zero for up to 5 years after the crisis. Additionally, output growth rate is larger than average before the Sudden Stop and is dramatically negative at the moment of the financial crisis. This strong output fall affects the debt-to-output ratio that increases substantially compared to the pre-crisis period. Importantly, the deleverage of the economy with international investors is also slow and after five years, the debt-to-output ratio does not return to the pre-crisis level. The real exchange rate depreciates substantially and does not recover in the short run.[5]

The empirical features of the Sudden Stops highlighted here have proved to be very hard to replicate with DSGE models in the business cycle literature because of the difficulties to capture asymmetries around the crisis. Specifically, even though the existing models generate the sharp real depreciation and current account reversals observed at the Sudden Stop, they cannot generate the preceding boom and the subsequent slow appreciation of the real exchange rate and the trade balance. As pointed out by Mendoza (2010), Sudden Stops literature that puts credit frictions as the key transmission channel amplifying technology shocks has more chances of generating the observed dynamics but its strongly dependent on the type of borrowing constraint. In particular, Mendoza (2010) assumes a stock borrowing constraint that depends on the market price of capital and the capital stock but includes also a working capital constraint and in that way is able to capture the persistence of some of the variables. In contrast, flow borrowing constraints with collateral tradable and non-tradable income as in Bianchi (2011) have a hard time in generating persistence together with an endogenous real exchange rate depreciation.

3   Small Open Economy with Collateral Constraints

Consider a small open endowment economy populated by a representative agent that derives utility from the consumption of tradable and non-tradable goods. The economy is stochastic

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[5]These dynamics do not change when Sudden Stops are defined in terms of changes in current account-to-output ratio instead of the trade balance-to-output ratio.

and the household has access to international asset markets that can be used for lending and borrowing at a fix rate. The household is subject to a borrowing constraint and international investors are risk neutral, deep pocket agents. The representative household maximizes the present discounted value of utility given by,

$$\max_{\{b_{t+1}, c_t^T, c_t^N\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^T, c_t^N)$$

subject to

$$b_{t+1} + c_t^T + p_t^N c_t^N = b_t(1+r) + p_t^N y_t^N + y_t^T$$

$$b_{t+1} \geq -\kappa \left(y_t^T + p_t^N y_t^N\right)$$

Here, c_t^T and c_t^N denote the household's consumption of tradable and non-tradable goods, respectively, in period t; y_t^N and y_t^T denote the exogenous and stochastic endowment of the non-tradable and tradable goods. Non-tradable goods are consumed only domestically but tradable goods can be consumed domestically or by the rest of the world. The collateral constraint that limits the household's borrowing decisions is occasionally binding and depends on the value of total income measured in tradable goods and limits the maximum debt-to-output ratio that can be issued to κ. As is standard in the literature, we assume that the preferences are represented by

$$u(c_t^T, c_t^N) = \frac{\left[\omega \left(c_t^T\right)^{-\eta} + (1 - \omega) \left(c_t^N\right)^{-\eta}\right]^{\frac{-(1-\sigma)}{\eta}} - 1}{1 - \sigma}.$$

The first order conditions for the households' problem are:

$$u_1(c_t^T, c_t^N) = \lambda_t \tag{1}$$

$$p_t^N = \frac{1 - \omega}{\omega} \left(\frac{c_t^T}{c_t^N}\right)^{\eta+1} \tag{2}$$

$$\lambda_t = \beta(1+r)E_t[\lambda_{t+1}] + \mu_t \tag{3}$$

$$b_{t+1} + c_t^T + p_t^N c_t^N = b_t(1+r) + p_t^N y_t^N + y_t^T \tag{4}$$

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$$\mu_t \left[b_{t+1} - \kappa \left(y_t^T + p_t^N y_t^N \right) \right] = 0; \quad \mu_t \geq 0 \tag{5}$$

Periods with binding borrowing constraints exhibit positive μ_t, which affects intertemporal consumption decisions. The endogeneity of the value of the collateral comes from the fact that p_t^N affects total output measured in terms of tradable goods. In periods of real depreciation, when the price of domestic non-tradable goods become cheaper in terms of tradable goods, the value of the collateral is smaller and, everything else equal, the constraint is more likely to bind. The real depreciation will endogenously drive the Sudden Stop episodes and its persistence depends on the persistence of the real exchange rate, hence on that of the tradable to non-tradable consumption ratio.

The recursive formulation

We can write the problem of the representative household in recursive form, which is convenient in order to clearly present our notion of equilibrium. Here, we use primes to denote future variables, V denotes the value function of the household, and upper case B denotes the aggregate level of debt. The recursive representation of the representative household's problem is then,

$$V(b, B, y^N, y^T) = \max_{b', c^T, c^N} u(c^T, c^N) + \beta E[V(b', B', (y^N)', (y^T)')]$$

s.t.
$$b' + c^T + p^N c^N = b(1+r) + p^N y^N + y^T$$
$$b' \geq -\kappa(y^T + p^N y^N)$$
$$p^N = \tilde{p}^N(B, y^N, y^T)$$
$$B' = \Gamma_B(B, y^N, y^T)$$

With this notation we are ready to present the Recursive Competitive Equilibrium.

Definition (Recursive Competitive Equilibrium). A RCE for this economy is a collection of price functions for non-tradable goods, $\tilde{p}^N(B, y^N, y^T)$, perceived law of motions $\Gamma_B(B, y^N, y^T)$, policy and value functions $\tilde{b}(b, B, y^N, y^T)$, $V(b, B, y^N, y^T)$, $\tilde{c}^j(b, B, y^N, y^T)$ for $j \in \{N, T\}$ for the household, such that:

- Policy and value functions solve the household problem given price functions.

- Perceived law of motions are consistent with the policy functions of the household:

$$\tilde{b}(B, B, y^N, y^T) = \Gamma_B(B, y^N, y^T).$$

- The price function satisfies:

$$\tilde{p}^N(B, y^N, y^T) = \frac{1-\omega}{\omega} \left[\frac{y^T + B(1+r) - \Gamma_B(B, y^N, y^T)}{y^N} \right]^{\eta+1}.$$

- Markets clear:

$$\tilde{c}^N(B, B, y^N, y^T) = y^N$$
$$\tilde{c}^T(B, B, y^N, y^T) = y^T - \Gamma_B(B, y^N, y^T) + B(1+r)$$

4 Dissecting the Model with Stationary Output Shocks

We study the implications of the model with mean reverting endowment shocks. We use the standard calibration in Bianchi (2011). In particular, we set the discount factor, β, to 0.91; risk aversion, σ, to 2; the relative weight of the tradable goods in preferences, ω, to 0.31; and the elasticity of substitution between the tradable and non-tradable goods, η, to $1/0.83 - 1$. The interest rate is set at 4 percent, and the parameter for the tightness of the borrowing constraint, κ is set at 0.32. Table 1 summarizes the calibration of this model. For income shocks we assume a bivariate autoregressive process using the parametrization, also from Bianchi (2011), represented by $\log \mathbf{y}_t = \rho \log \mathbf{y}_{t-1} + \epsilon_t$, with $\mathbf{y} = [y^T \ y^N]'$, $\epsilon = [\epsilon^T \ \epsilon^N]'$, where $\epsilon \sim N(\mathbf{0}, \mathbf{V})$, and

$$\rho = \begin{bmatrix} 0.901, & 0.495 \\ -0.453, & 0.225 \end{bmatrix}, \ \mathbf{V} = \begin{bmatrix} 0.00219, & 0.00162 \\ 0.00162, & 0.00167 \end{bmatrix}.$$

We approximate the income processes following the Tauchen algorithm with a grid of 4 points for each of the sectoral shocks as is the case in Bianchi (2011). We use a debt grid

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of equally spaced 400 points. Once the model is solved, we simulate 2000 samples for 500 periods, and drop the first 100 observations before obtaining model statistics.

Figure 2 presents the model and data dynamics around Sudden Stops. Given that the income process is calibrated to Argentina, we construct Sudden Stop dynamics for the model and compare them to the average Sudden Stop in Argentina from 1900 to 2004. The Sudden Stops implied by the model differ in two key dimensions from the type of crisis documented in the empirical literature and described in Section 2. First, output dynamics that give rise to a Sudden Stop in the model are counterfactual. In the data, the five years previous to the Sudden Stop, the economy is growing overall, but also in the tradable and non-tradable sectors. The growth rates of the aggregate and sectoral outputs only become significantly negative at the period of the Sudden Stop (and one period before for the tradable sector). On the other hand, in the model, the output dynamics leading to a Sudden Stop is a sequence of negative shocks that accumulate over a five years window.

Second, the real depreciation and the sudden decline of capital flows after the crisis takes a short time in the model while the effects of the crisis in the data are much more persistent. The increase in the net exports-to-output ratio at the Sudden Stop lasts only that period, followed by a strong deficit at period 1. Instead, the data shows that trade balance-to-output ratio deteriorates for about 5 years and after the Sudden Stop the trade balance dynamics tend to be very persistent. Moreover, even though the model can replicate the immediate real exchange rate depreciation that is one of the common denominators of these types of crisis, it cannot generate the right persistence of any macroeconomic variable of focus. The reason

Table 1: Calibration

Parameter	Value
Risk aversion, σ	2
Consumption share of tradables, ω	0.31
Elasticity of subs. N and T, η	1/0.83-1
Risk free interest rate, r	0.04
Discount factor, β	0.91
Borrowing constraint, κ	0.32

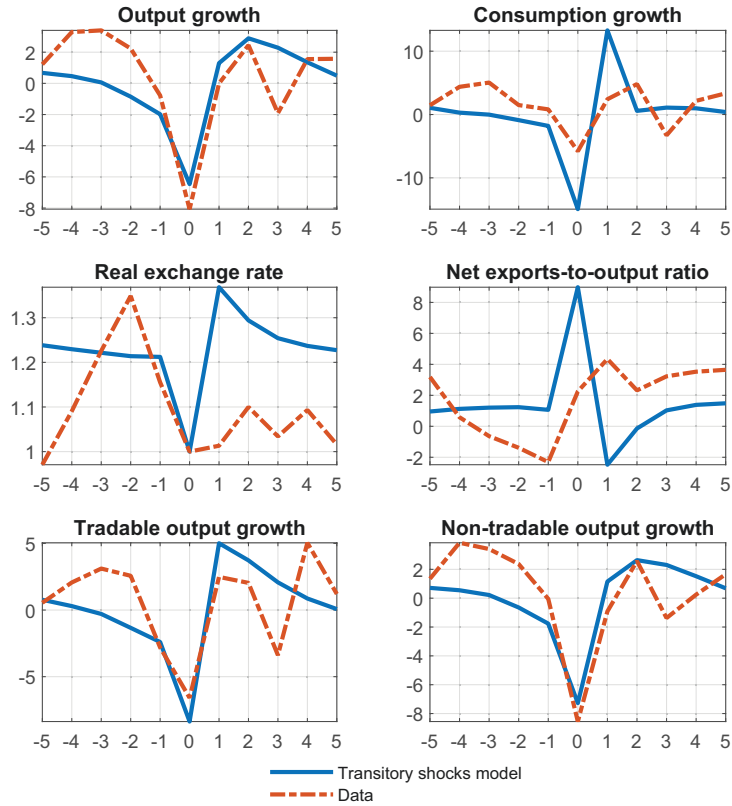Note: The calibration is based on Bianchi (2011).

Figure 2: Sudden Stops in the Model with Stationary Output Shocks and the Data

Note: The figure plots averages around Sudden Stop episodes (dated period 0) for Argentina between 1900 and 2004 together with the ones implied by the model. To compute Sudden Stops in the model we simulate the economy for 2000 samples of 500 periods each, dropping the first 100 periods. Both in the data and in our model simulations, we define Sudden Stops as episodes of at least 2% output fall jointly with a net export-to-output ratio reversal of at least 2 percentage points. We discard any episode for which there is another case satisfying our criteria less than 5 years before. Growth rates are in percentages. The real exchange rate is normalized to 1 in the Sudden Stop.

is that when the economy hits the borrowing limit and repays the outstanding debt, the ex-post deleveraging of the economy allows households to increase consumption of tradable goods, pushing up the price of non-tradable goods and implying an instantaneous relaxation of the borrowing limit. That is, the crisis and the tightening of the borrowing constraint in this model last for only one period.

5 Sudden Stops with Trend Shocks

This section extends the model with stationary output shocks by introducing an economy-wide trend shock, in the spirit of Aguiar and Gopinath (2007).

5.1 The Environment with Trend Shocks

The endowments of tradable and nontradable goods are assumed to follow the stochastic process:

$$y_t^j = z_t^j \Gamma_t.$$

where z_t^j for $j = \{T, N\}$ denotes the mean reverting TFP shock and Γ_t is the common trend shock. The trend is stochastic and its growth rate follows an AR(1) process as in Aguiar and Gopinath (2007), $\frac{\Gamma_t}{\Gamma_{t-1}} = g_t$ with:

$$\log g_t = (1 - \rho_g) \log \mu_g + \rho_g \log g_{t-1} + \nu_t, \ \nu_t \sim N(0, \sigma_g).$$

Given the existence of a trend, we need to rewrite all quantities along the balanced growth path of the economy. To do so, we stationarize period t quantities dividing them by Γ_{t-1} and denoting them as hatted variables, i.e. $\hat{x}_t^j \equiv \frac{x_t^j}{\Gamma_{t-1}}$ for $x \in \{c^T, c^N, b, y^T, y^N\}$.[6]

Using $\lambda_t \Gamma_{t-1}^{-\sigma}$ for Lagrange Multiplier for the budget constraint and $\mu_t \Gamma_{t-1}^{-\sigma}$ for the collateral constraint, we obtain the following equilibrium conditions for the household's problem:

$$u_1(\hat{c}_t^T, \hat{c}_t^N) = \lambda_t \tag{6}$$

$$p_t^N = \frac{1 - \omega}{\omega} \left(\frac{\hat{c}_t^T}{\hat{c}_t^N} \right)^{\eta+1} \tag{7}$$

$$\lambda_t = \beta g_t^{-\sigma} (1 + r) E_t[\lambda_{t+1}] + \mu_t \tag{8}$$

$$g_t \hat{b}_{t+1} + \hat{c}_t^T + p_t^N \hat{c}_t^N = \hat{b}_t (1 + r) + p_t^N \hat{y}_t^N + \hat{y}_t^T \tag{9}$$

$$\mu_t \left[g_t \hat{b}_{t+1} - \kappa \left(\hat{y}_t^T + p_t^N \hat{y}_t^N \right) \right] = 0; \quad \mu_t \geq 0 \tag{10}$$

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[6]For instance, $\hat{y}_t^j \equiv \frac{y_t^j}{\Gamma_{t-1}} = z_t^j g_t$ for $j \in \{T, N\}$.

5.2 Empirical Strategy

Our calibration follows Bianchi (2011) as closely as possible. In particular, we set the parameters not directly related to the income process as described in our Section 4, except the borrowing constraint tightness, κ, whose impact on the equilibrium largely depends on the imposed income process. We set this parameter to 0.36, which implies a debt-to-output ratio of 0.29 as targeted in Bianchi (2011) for Argentina (1970-1997).[7]

We estimate a model for the stochastic processes of transitory and permanent income shocks implementing full information Bayesian strategy. The estimation of this type of models is challenging given that identifying trend shocks requires long samples. Aguiar and Gopinath (2007) show that using a direct estimation of the relative variances of the trend and mean reverting shocks as in Beveridge and Nelson (1981) is not appropriate with short samples of quarterly frequency and they need to use the identifying restrictions imposed by the DSGE model. Full estimation with more than one hundred years data is, instead, a promising strategy as discussed in García-Cicco et al. (2010).[8]

The model for income process with transitory and permanent components can be written in state space representation as follows. The measurement equation given by,

$$
\begin{bmatrix} \log(\gamma_t^T) \\ \log(\gamma_t^N) \end{bmatrix} = \begin{bmatrix} \log(z_t^T) - \log(z_{t-1}^T) + \log(g_t) \\ \log(z_t^N) - \log(z_{t-1}^N) + \log(g_t) \end{bmatrix}
$$

and the state equation is

$$
\begin{bmatrix} \log(z_t^T) \\ \log(z_{t-1}^T) \\ \log(z_t^N) \\ \log(z_{t-1}^N) \\ \log(g_t) \end{bmatrix} = \begin{bmatrix} \rho_T & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & \rho_N & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \rho_g \end{bmatrix} \begin{bmatrix} \log(z_{t-1}^T) \\ \log(z_{t-2}^T) \\ \log(z_{t-1}^N) \\ \log(z_{t-2}^N) \\ \log(g_{t-1}) \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \sigma_T & 0 & 0 \\ 0 & \sigma_N & 0 \\ 0 & 0 & \sigma_g \end{bmatrix} \begin{bmatrix} \epsilon_t^T \\ \epsilon_t^N \\ \epsilon_t^g \end{bmatrix}
$$

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[7]Another potential target for this parameter could be the Sudden Stop frequency, hence we should note that the model generates a Sudden Stop frequency of 5.3% in line with the 5.7% frequency in our historical data for Argentina (1900-2004).

[8]An alternative strategy would be to implement a full information structural estimation of the model in line with Bocola (2016) or a partial information estimation such as Akıncı and Chahrour (2018). This is out of the scope of this paper but could be an interesting exercise for future research.

where γ_t^T and γ_t^N denote the demeaned growth rate of per-capita tradable income and non-tradable income. This model allows us to estimate the volatility and persistence of the trend and mean reverting shocks and as a by-product we can recover the smoothed estimates of all innovations.

For the estimation of income process for Argentina we use data from 1876 to 2004 from Ferreres (2010). Tradable sector includes: "Farming, livestock, hunting and forestry", "Fisheries", "Mine exploitation and quarries" and "Manufactures"; and non-tradable sector includes: "Electricity, gas and water", "Construction", "Wholesale and retail, and hotels and restaurants", "Transport, storage and communications", "Financial intermediation", "Real estate activities, business and rental" and "Other services". Output from each of these sectors are measured deflated by its sectoral price index and considered at fixed prices of 1993. Our measure of real tradable output is the sum of the aforementioned sectors (each sector being already in real terms), y_t^T in the model; and so is the measure of real non-tradable output, y_t^N in the model. Total GDP in the data is measured as the sum of tradable and non-tradable sectoral GDP. Total GDP in the model in terms of tradable goods would be equal to $p_t^c y_t = y_t^T + p_t^N y_t^N$, where p_t^c is the price of the domestic consumption bundle in terms of tradable goods, $p_t^c = \left(\omega + (1 - \omega) \left(p_t^N \right)^{\frac{\eta}{1+\eta}} \right)^{\frac{1+\eta}{\eta}}$.

Priors for the persistence of the trend shock are based on the estimates of the two-sector model in Seoane (2016), and we set all other priors for persistence of mean reverting processes to this same value. The priors for the standard deviation of technology shocks are centered around standard values and are assumed to be the same for all shocks. The details of the priors are shown in the note to Table 2.

Given that the posterior (or conditional posterior) distribution of the parameters is not of a known form and we cannot take draws directly from it, we estimate this model using a Metropolis-Hastings algorithm using data for the de-meaned log annual growth rate of per capita tradable and non-tradable output during the period 1876-2004. We first maximize the posterior mode and then do 100,000 draws. Posterior estimates are in Table 2.

Table 2 documents that trend shocks are fairly persistent and in line with estimates of Seoane (2016) and García-Cicco et al. (2010) for a version of a one sector model. Also, the estimates of standard deviation of the shocks are very different depending on the shock,

Table 2: Descriptive Moments of the Posterior Distribution

Parameter	Mean	St. Deviation
ρ_g	0.5499	0.0854
ρ_{z^T}	0.7501	0.1017
ρ_{z^N}	0.7963	0.0839
σ_g	0.0353	0.0069
σ_{z^T}	0.0532	0.0051
σ_{z^N}	0.0495	0.0052

Note: The table gives the mean and standard deviation of the posterior distribution for each parameter from 100,000 draws. We assume the following prior distributions for the persistence and standard deviations: ρ_j is $B(20, 6.4)$ and $\frac{1}{\sigma_j}$ is $G(10, 4)$, for $j \in \{z^T, z^N, g\}$. Here $B(a,b)$ denotes a Beta distribution with first and second shape parameters a and b, and $G(a,b)$ is a Gamma distribution with shape a and scale b.

suggesting that the data contains substantial information. Finally, in line with the data we set average growth in the model to 1%, i.e. $\mu_g = 1.01$.[9]

The second important piece of data is the real exchange rate. To construct this series we use the bilateral nominal exchange rate between Argentinean currency and US dollars (AR\$/US\$), Argentinean CPI (P_t^{AR}) and US CPI (P_t^{US}), both equal to 1 in 1993. The real exchange rate is defined as: $\frac{1}{RER_t} = \frac{NER_t P_t^{US}}{P_t^{AR}}$. Notice that this measure of the real exchange rate says how many US goods are needed to purchase one Argentinean good (i.e. an increase is a real apreciation for Argentina).

In terms of the model, the measure of the real exchange rate would be the price of the consumption bundle, i.e. p_t^c. Moreover, to write total output in the model in a consistent way to the one in the data we have to divide output measured in tradable goods ($y_t^T + p_t^N y_t^N$) by p_t^c.

We now feed the estimated processes for transitory income shocks for the two sectors, z_t^T, z_t^N, and the trend shock, g_t, into the model and evaluate its quantitative implications. We use grids of 25 points for the trend shocks, and 11 points for each of the transitory shocks. We use an asset grid of 400 points.[10]

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[9]The average growth rate for Argentina during 1876-2004 sample for the tradable output is 1.18% while the one of the non-tradable output is 0.95%.

[10]Our results are qualitatively and quantitatively robust to doubling or halving the sizes of these grids.

5.3   Quantitative Implications of the Model

Figure 3 compares the dynamics around Sudden Stops for our preferred model and the data. The model with permanent income shocks exhibits dynamics around Sudden Stops that are qualitatively in line with those observed in the data. While the standard model in the literature implies an increase of the net exports-to-output ratio lasting for only one period, the model with trend shocks can generate a persistent increase in the trade balance-to-output ratio lasting for three years. Additionally, the real exchange rate exhibits similar dynamics, only lasting for one period for the economy only with stationary shocks but a persistently depreciated exchange rate for the model with permanent trend shocks.

In the model with trend shocks, the economy typically has an aggregate and sectoral output growth that is higher than the average before the Sudden Stop. Importantly, this resembles closely the features of Sudden Stops in the data, which have positive growth in the aggregate and sectoral output prior to the crisis. In the model, it is a selection feature that is generated by the presence of permanent shocks behind these Sudden Stops. These dynamics suggest that the accumulation of foreign debt is not due to a sequence of negative shocks, but instead due to a sequence of positive permanent shocks that induce debt accumulation to smooth consumption. As economies that draw good permanent income shocks for a few periods accumulate high volumes of debt with the conjecture of being permanently richer, they become more prone to a crisis in case of drawing a bad permanent income shock. This sequence of good income shocks prior to the crisis induces a persistent deterioration in the net exports balance which starts three periods before the Sudden Stop. The positive pressure in tradable consumption implies an appreciation in the real exchange rate.

When the negative permanent income shock hits the economy, the fact that the economy is permanently poorer forces a decline in tradable consumption that contributes to an expansion of the net exports and depreciates the real exchange rate. Accordingly, in line with the Permanent Income Hypothesis, the model produces dynamics that resemble those in the data, suggesting that revisions of permanent income are key to the dynamics around Sudden Stop episodes.

As for the transmission channel of this model, it is key that the permanent shock triggers
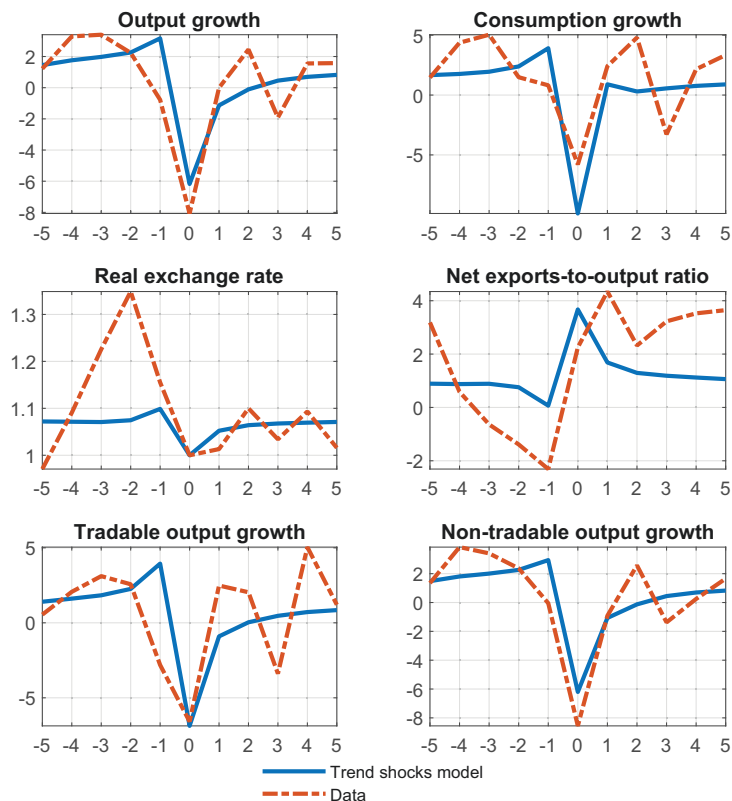
Figure 3: Sudden Stops in the Model and the Data

Note: The figure plots averages around Sudden Stop episodes (dated period 0) for Argentina between 1900 and 2004 together with the ones implied by the model. To compute Sudden Stops in the model we simulate the economy for 2000 samples of 500 periods each, dropping the first 100 periods. Both in the data and in our model simulations, we define Sudden Stops as episodes of at least 2% output fall jointly with an increase in the net export-to-output ratio of at least 2 percentage points. We discard any episode for which there is another case satisfying our criteria less than 5 years before. Growth rates are in percentages. The real exchange rate is normalized to 1 in the Sudden Stop.

a persistent drop in tradable consumption (and a drop that is indeed larger than tradable output drop) as this keeps the real exchange rate depreciated for a longer time than in the case of a mean reverting shock model.[11]

The model is able to match qualitatively various non-targeted unconditional first and

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[11]Moreover, this is also true given that non-tradable consumption falls by the same magnitude and persistence of non-tradable output.

second order moments for the case of Argentina. In particular, Table 3 shows under the column labeled "Competitive Equilibrium" that the model's average current account-to-output ratio is mildly negative, although not as much as in the data, and the net exports is positive and its size relative to output is of the same order of magnitude as in the data. Additionally, second order moments in the data and the model are also similar, except for the case of the volatility of the real exchange rate, for which the model can generate 12% of volatility, as in other models in this literature, about 1/4 of the real exchange rate volatility in the data.

Table 3: Model Comparisons of Moments

	Data	Model	
		Comp. Eq.	SP
Average (%)			
Current account / GDP	-1.7	-0.1	-0.1
Trade balance / GDP	2.2	1.0	1.0
Standard dev. (%)			
Consumption growth	6.4	7.6	7.4
Real exchange rate (log)	47	12	12
Current account / GDP	4.8	2.5	2.3
Trade balance / GDP	4.4	2.7	2.5

Note: The data statistics are from annual data for Argentina period 1900-2004 from Ferreres (2010). "(*log*)" denotes natural logs and the real exchange rate is computed using Argentina's GDP deflator and US CPI. "Comp. Eq." refers to the competitive equilibrium in our model calibration with transitory and permanent shocks and "SP" refers to the corresponding Constrained Social Planner equilibrium.

5.4 Testing the Model Implications: Sudden Stops and Income Shocks

In this subsection, we test the model implications further by decomposing the observed output process for Argentina into its fundamental sources, and study the behavior of these around the identified Sudden Stops. These components are obtained as a by-product of our estimation strategy outside of our model and have a direct mapping to the ones in the model. Figure 4 plots the smoothed estimates of trend and mean reverting shocks for the tradable and non-tradable sectors together with the Sudden Stop episodes in blue vertical lines.[12] We

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[12]We compute the smoothed estimates of the shocks using the Kalman Smoothing with the parameters evaluated at their posterior mean.

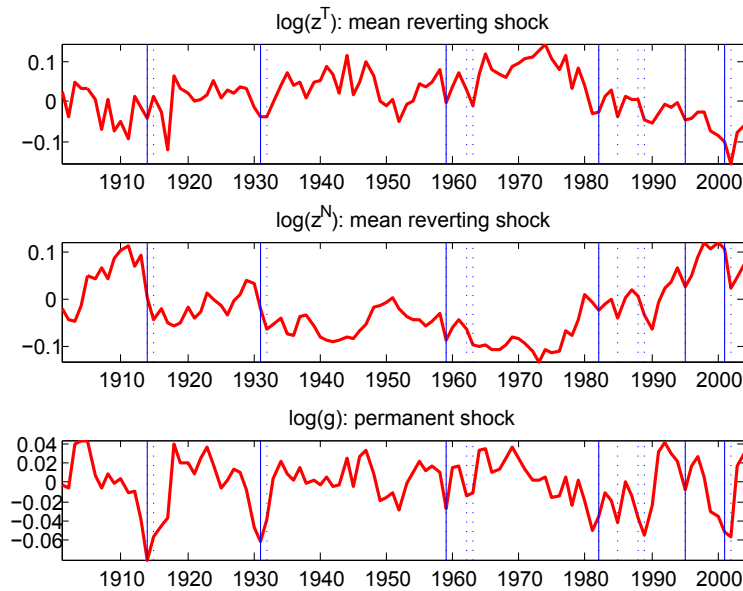identify 6 Sudden Stops in the last 100 years of the Argentinean economy.

Figure 4: Sudden Stops and the Smoothed Estimates of Shocks

Note: The figure plots the unobserved smoothed estimates of tradable and non-tradable stationary shocks and the common trend for Argentina. Blue vertical lines show the events of at least 2% output fall jointly with a net export-to-output ratio increase of at least 2 percentage points. The subset of these which we identify as Sudden Stops (solid blue) are those not preceded by any of these events by less than 5 years.

Figure 4 shows that there is no clear pattern regarding Sudden Stop episodes and mean reverting shocks. Even though the mean reverting shocks are negative during all Sudden Stops, the behavior before the crisis is heterogeneous. Transitory shocks to tradable income are increasing before some episodes, such as one period before 1914, 1959 and 1995, and they accumulate several periods of negative shocks before 1931, 1982 and 2001. In most of the episodes, non-tradable shocks are positive up to one period before the Sudden Stop.

On the other hand, the bottom panel of Figure 4 shows that all Sudden Stops occur together with a large drop in trend shock. Trend growth is largely negative in episodes such as 1914 and 2001, preceded by average or poor trend shock performance but does not need to be too negative when the crisis is preceded by a boom in the trend, such as 1959 or 1995. The key feature in all the observed Sudden Stops is that the permanent shock generates a big decline in the perceived permanent income of the household.
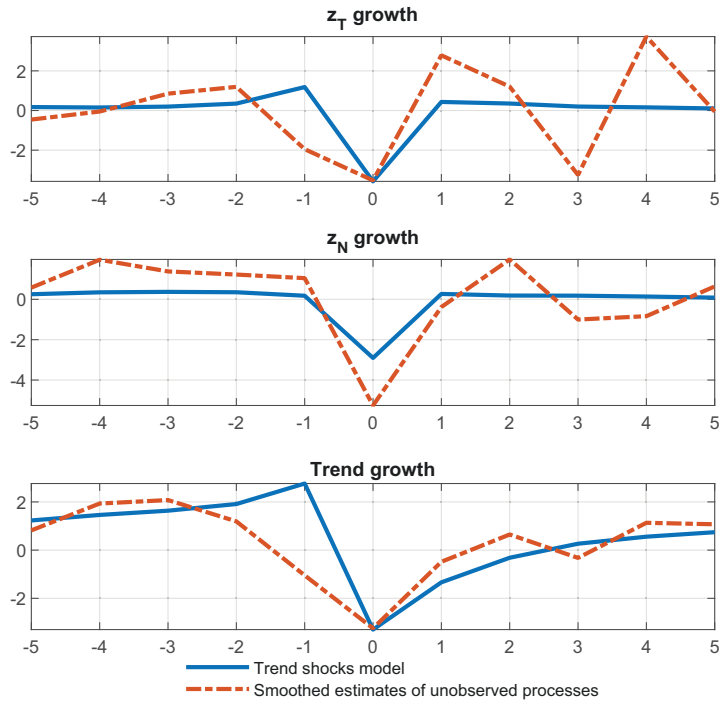
21

Figure 5: Shock Dynamics around Sudden Stops

Note: The figure plots shocks dynamics around Sudden Stop episodes in Argentina and in the model. Growth rates are in percentages.

Figure 5 plots the averages of each source of innovation in income around Sudden Stops in the data and in our model with trend shocks. The figure shows that the average growth of the transitory and permanent components of output are mostly positive before Sudden Stops. In other words, prior to the crisis the economy is, on average, booming and accumulating debt on behalf of future output growth, which is consistent with the previous section that points out that the role of permanent income shocks can be key to understand the Sudden Stop dynamics. As seen in the figure, the model mimics the qualitative behavior of the smoothed estimates, generating a higher than average trend growth prior to the crisis together with a drop of similar magnitude and the observed sluggish recovery.

To a lesser extent, transitory declines in tradable output also appear to contribute to the development of some of the observed crisis given that on average, both the model and the smoothed estimates, imply negative growth in the transitory component. However,

our findings suggest that Sudden Stops in the data are mainly driven by the path of the permanent component of income.

6 Overborrowing and Optimal Capital Controls

We now turn to the quantitative relevance of trend shocks in the overborrowing result and the properties of optimal capital controls. We follow Bianchi (2011) in first solving the constrained efficient allocation of a benevolent planner that internalizes the consumption decisions' impact on the price of non-tradable goods. Then we compute the optimal tax on debt in a decentralized equilibrium that would replicate the Social Planner's solution.

6.1 Overborrowing with Trend Shocks

The planner maximizes the household's objective function,

$$\max_{\{b_{t+1},c_t^T\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^T, y_t^N)$$

subject to the resource constraint of the economy and the borrowing limit, fully internalizing the effects of consumption decisions on market prices and on the consequent borrowing limit,

$$b_{t+1} + c_t^T = b_t(1+r) + y_t^T$$
$$b_{t+1} \geq -\kappa \left(y_t^T + \left(\frac{1-\omega}{\omega} \left(\frac{c_t^T}{y_t^N} \right)^{\eta+1} \right) y_t^N \right).$$

Table 3 shows a few key moments implied by the Social Planner allocation. Even though the current account and trade balance-to-output ratio are on average at similar levels compared to the competitive equilibrium allocation, the planner allocation implies lower volatility for the variables of interest by internalizing the effects of prices on the collateral constraint.

Figure 6 plots the distribution of debt for the competitive equilibrium (in red bars) and the constrained optimal allocation (in blue bars). Debt distributions coincide in a large share of the debt spectrum, but the competitive equilibrium generates a modest degree of overborrowing as it allocates slightly more mass of the distribution in higher levels of

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debt than the distribution under the planner's allocation. This finding is in line with the overborrowing result usually found in the literature with only mean reverting shocks, i.e. trend shocks do not necessarily imply higher degree of overborrowing.
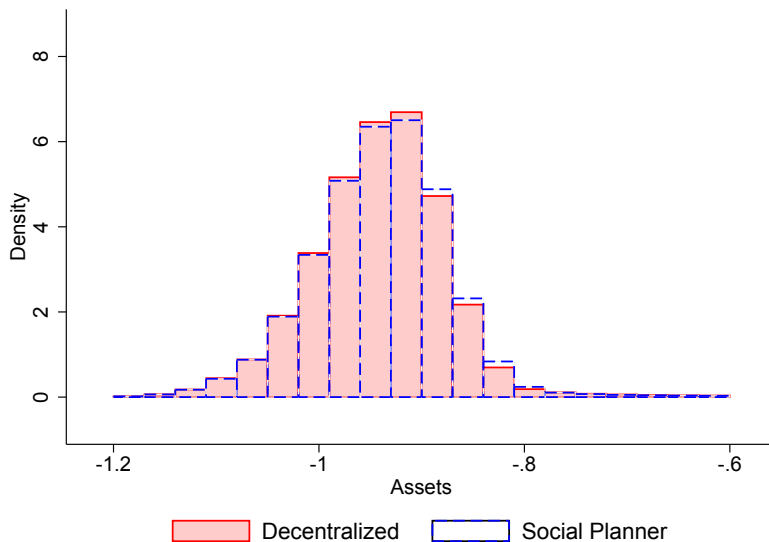

Figure 6: Debt Distribution for the Competitive Equilibrium and the Constrained Optimal
Note: Red solid-framed bars show the histogram of debt in the simulations of the decentralized equilibrium in our benchmark model. Blue dashed-framed bars give the same for the Social Planner's problem. The asset levels in the x-axis are detrended.

Nevertheless, trend shocks affect how the degree of overborrowing changes over the business cycle. With only transitory shocks overborrowing is stronger during bad times, as in those cases households tend to issue higher levels of debt. With trend shocks, the competitive equilibrium may issue higher levels of debt than the planner also during the expansion. We discuss this feature in the next section as this behavior is reflected on the optimal tax schedule.

6.2   Decentralization of the Constrained Optimal Allocation

A way to infer the degree of overborrowing is to study the size of the optimal tax over debt issuance that would make the competitive equilibrium mimic the constrained planner equilibrium. In this subsection we closely follow the methodology in Bianchi (2011) and compute this optimal tax by setting up the decentralized problem with a tax over new debt

issuance, such that the budget constraint is,[13]

$$(1 - \tau_t)b_{t+1} + c_t^T + p_t^N c_t^N = b_t(1 + r) + y_t^T + p_t^N y_t^N.$$

Then we solve the competitive equilibrium and set the tax rate such that the solution of the decentralized economy mimics the solution of the Social Planner's problem. The optimal tax is given by the following expression:

$$\tau_t = \frac{\beta(1 + r)g^{-\sigma}\mathbb{E}_t\left(\mu_{t+1}^{sp}\Psi_{t+1}\right) - \mu_t^{sp}\Psi_t}{u'_{T,t}}, \tag{11}$$

where $\Psi_t = \kappa\frac{p_t^N c_t^N}{c_t^T}(1 + \eta)$.

Consider Equation (11) and suppose that in period t the collateral constraint is not binding. Here, optimal capital controls are positive if there is a positive probability of hitting the collateral constraint in the following period. That is, intuitively, average taxes are positive (i.e. macroprudential) if and only if the collateral constraint is sometimes binding, and optimal taxes are large when binding of the collateral constraint is more likely. In what follows we study optimal taxes numerically.

Table 4 presents results for optimal taxes for the full model and the versions of the model with only transitory shocks and only trend shocks. First, in the full model with trend shocks, under the column "Full Model", it is optimal to establish a macroprudential policy (the average tax is positive), as the collateral constraint is binding in a non-negligible region of the state space. This is consistent with the existing findings in the literature that models only transitory shocks.

Besides the macroprudential feature of optimal policy, we can study the behavior of optimal taxes along the business cycle. Continuing the intuition that follows from Equation (11), the optimal tax in period t depends on how likely is the collateral constraint to bind in period $t + 1$. The constraint becomes tighter (i.e. the upper bound on debt goes down) with low output realizations, which holds by construction regardless of the underlying income process. In addition, there is a higher probability of hitting the collateral constraint in the near future if the economy had already accumulated a high debt burden. In the full model,

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[13]Bianchi (2011) shows that the Social Planner's allocation can be decentralized by a tax on debt returns.

Table 4: Decomposition of Capital Controls (Implied Optimal Tax in %)

	Full model	Only trend shocks	Only transitory shocks
Averages			
Overall	1.1	2.9	2.1
Good times	0.7	3.0	1.5
Bad times	1.5	2.8	2.7
Good growth	0.8	3.0	1.7
Bad growth	1.3	2.8	2.5
Good trend shock	0.9	3.0	-
Bad trend shock	1.3	2.9	-
Correlations with output			
Corr. with GDP	-0.29	0.07	-0.40
Elasticities			
Optimal tax to output	-8.0	-1.5	-13.0
Optimal tax to output (bad times only)	-8.6	-1.0	-10.6

Note: Good/bad times refer to the case in which the detrended GDP of the economy is higher/lower than the median detrended GDP. Good/bad growth refer to the case in which the economy grows at a rate higher/lower than the average growth rate of the economy. To compute the optimal tax elasticity to output we run a pooled regression in our simulated data specified as: $log(\tau_{i,t}) = \alpha_0 + \alpha_1 log(y_{i,t}) + \epsilon_{i,t}$. To compute the elasticity of optimal taxes to output during "bad times", we run the same pooled regression in our simulated data conditional on output being below its detrended median.

this may have happened during a sequence of positive permanent, or negative transitory shocks. Hence, whether the optimal taxes are larger during times of good or bad output realizations is a quantitative question. Table 4 shows that, for our calibration, taxes are procyclical as they tend to be larger during bad times than good times, which we define as the detrended output being below or above the median.[14]

As mentioned before, mean reverting shocks and permanent shocks operate in different ways and affect differently the design of the optimal tax.[15] An accumulation of negative transitory shocks leads to a Sudden Stop through higher debt during bad times together with a tightening of the collateral constraint. Additionally, an accumulation of positive

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[14]Our findings are robust to other definitions of good and bad times, as given in the note to the table.

[15]For a discussion on the properties of optimal tax in the model without trend shocks, see Schmitt-Grohé and Uribe (2016).

trend shocks that induces debt accumulation may also increase the probability of hitting the collateral constraint in the future as the economy becomes more vulnerable to trend drops. As the likelihood of hitting the constraint increases, our setting requires to charge optimal taxes to debt issuance, but in the former case this may occur when output is falling, and in the latter, it may occur when output is increasing and suffers a sudden drop.

In order to evaluate the role of each shock in the optimal tax patterns, we continue with an accounting exercise that shuts down one shock at a time and study the optimal capital controls. Third and fourth columns in Table 4 describe the optimal taxes assuming that the economy only suffers trend shocks or only suffers transitory shocks, respectively. In the economy with only transitory shocks, taxes tend to double during bad times (or bad growth) compared to those during the expansions. The decentralized economy tends to issue more debt than the planner during bad times making the constraint more likely to bind. In this way, the non-internalization of consumption decisions' impact on prices, and the subsequent tightening of the collateral constraint, affects debt over-accumulation more during bad times. This makes the implied taxes much larger during bad times than during good times.

Instead, in the economy with only trend shocks average taxes in what we define as good times (or times of good growth) are similar to those in the bad times. Debt accumulation tends to occur also during the expansion, because those are the episodes where agents largely revise their permanent income up and want to accumulate debt to smooth consumption. Periods of high growth deliver the information that the economy will be permanently richer in the future, which implies that tradable consumption should respond by more than the increase in output. This extra increase in tradable consumption is financed with higher debt levels. The higher debt makes the economy more vulnerable to negative growth shocks. This is reflected in the probability of hitting the collateral constraint in the future, which would require larger taxes. In this way, trend shocks require less procyclical optimal taxes to replicate the Planner's allocation. This result is also highlighted in Flemming et al. (2019) in a model with only trend shocks.

In order to shed further light into the discussion of cyclicality, the table also provides raw correlation between the optimal taxes and the detrended GDP, as well as two measures for the elasticity of taxes to output in the full model and in the two alternative models.

The correlations imply similar conclusions as the comparisons of good and bad time averages, with the corresponding correlation being mildly positive for the model with only trend shocks, strongly negative with only transitory shocks, and negative but less so for the full model. Looking at the elasticity measures, in all three models we see a negative taxes-output elasticity, verifying the procyclical optimal taxes. Nevertheless, with only transitory shocks, this measure of procyclicality is the highest, and with only trend shocks it is the lowest, with the full model in between. Hence, the transitory component of output in our model is more responsible for its procyclical behavior. Restricting the sample to only bad times, which have tighter constraints in all models, confirms the same pattern with a tax-output elasticity with only trend shocks that is about 10% of the one implied by the model with only transitory shocks.

Summing up, even though both transitory and permanent shocks imply procyclical optimal taxes, the presence of permanent shocks makes this procyclicality milder.

7   Final Remarks

Open economy models with collateral constraints had significant success in explaining various important features of financial crisis in emerging markets. In this paper, we evaluate the performance of an endowment version of this model in replicating the behavior of macroeconomic variables around the Sudden Stops. We argue that such a model fails to generate the right comovement and persistence of the trade balance adjustment and the real exchange rate behavior. Both variables are key to understand the dynamics and severity of macroeconomic adjustment process after periods of over-accumulation of foreign debt.

Introducing permanent output shocks to the model is a promising candidate to help the model account for the observed patterns around Sudden Stops, given that the dynamics in the data are in line with downward revisions of expectation of permanent income. We show that when the model is calibrated to match output moments of Argentina, the dynamics around the Sudden Stop replicates the qualitative behavior of the data.

We test the theory further by estimating and studying the evolution of transitory and trend income shocks around Sudden Stops and we find that the corresponding behavior of

these shocks is consistent with the implications of our model. Trend shocks can be key, combined with credit frictions, to model financial crisis dynamics. This result complements the findings in Aguiar and Gopinath (2007) who focus on the regular business cycle of emerging economies, by studying the dynamics around financial crisis.

We show that our model with trend and transitory shocks can generate overborrowing, giving room to optimal policy interventions. The optimal capital control tax has a macroprudential flavor as the optimal tax is positive on average. Moreover, the optimal tax is procyclical, i.e. taxes increase during bad times. Trend shocks imply, however, less procyclical taxes compared to transitory shocks.

In this paper we have focused on an endowment economy. Of course, considering production economies, in particular the role of investment, could be important for the understanding of the dynamics around Sudden Stop episodes, but out of the scope of this paper. Moreover, endogenizing the permanent income dynamics is a key avenue to consider. Ates and Saffie (2016) and Guerron-Quintana et al. (2016) are valuable steps in that direction. However, these authors focus on endogenizing the productivity while the permanent income in emerging economies might also suffer permanent changes due to policy changes or political instability. We consider these as possible extensions of the current framework that are plausible avenues to consider in future research.

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