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Abstract

Debt limit is public debt-to-GDP ratio above which financial markets stop lending to a sovereign. How wide the fiscal space –the difference between the current debt ratio and the debt limit- is essential for policymakers. However, this information ceases to be useful regarding up to which point in the fiscal space policymakers can take fiscal stimulus measures. We define "fiscal stimulus debt limit" as the debt ratio, beyond which fiscal stimulus leads to output losses relative to a no fiscal response case. We use this concept in a DSGE model and show that the gap between two limits is significant.

Keywords: Debt limit, Fiscal space, Fiscal stimulus, Recession, Default risk

JEL Classification: E62 H62 H63

I Introduction

A critical question that confronts policymakers during recessions is whether there is a room for maneuver to take fiscal stimulus measures. Elevated sovereign debt levels in the aftermath of the global crisis lead to concerns about the sustainability of public finances and limited implementation of fiscal stimulus measures despite record low levels of real interest rates. Consequently, an interest in debt limit (hereafter *DL*) and fiscal space estimations has intensified. Nonetheless, while *DL* and the corresponding fiscal space provide a valuable information for fiscal authorities regarding how close they are about to lose market access, they do not shed light up to which point in fiscal space they can take fiscal stimulus measures. Fiscal space does not necessarily indicate the degree to which countries have room for fiscal maneuver. Moreover, unless sovereign debt is default risk-free, it is even not necessary to know *DL* for this purpose. What is necessary is to identify fiscal stimulus debt limit –the debt ratio beyond which fiscal stimulus leads to output losses rather than output gains. The aim of this study is to define and measure this limit.

DL is the public debt-to-GDP ratio above which financial markets stop lending to a sovereign, whereas fiscal space is the distance between *DL* and the current debt ratio (Ostry et al., 2010; Ghosh et al., 2013).[1] The underlying rationale is the fiscal fatigue concept. Ostry et al. (2010) argue that primary balances of a government cannot continually rise to offset higher interest payment burden of a sovereign due to political and economic reasons. Mendoza and Ostry (2008) show that there is a positive non-linear relation between primary balance and debt both for emerging economies (EEs) and advanced economies. Nonetheless, this evidence becomes weaker at high debt levels. *DL* is estimated in a model that combines debt dynamics equation with an arbitrage equation between the expected return on government debt and the risk-free rate,

[1] There are other definitions of fiscal space and debt limit as well. For example, Aizenman and Jinjarak (2010) define the concept of "de facto fiscal space" which is the tax-years needed to repay the public debt. Bi et al. (2016) define debt limit as the expected discounted sum of the maximum primary surplus that can be generated in the future.

and a fiscal reaction function that reflects the fiscal fatigue concept (Ostry et al., 2010; Ghosh et al., 2013; Barr et al., 2014; Kim and Ostry, 2018).

This literature has been silent about to what extent the fiscal space is at the disposal of policymakers for taking fiscal stimulus measures during recessions. Since beyond *DL* financial markets stop lending to a sovereign, there should be high levels of probability of default and associated sovereign borrowing rates close to *DL*.[2] Then, at this upper range of the fiscal space, a fiscal expansion can further upsurge output losses rather than mitigate them by further elevating already high interest rates and bringing existing debt level closer to *DL*. As the debt ratio approaches to *DL*, fiscal stress will rise at an accelerated rate and spill over to the rest of the economy. If this is the case, then there is a threshold level of debt as percent of GDP above which a counter-cyclical policy in the form of fiscal stimulus will be useless. We define this threshold as the fiscal stimulus debt limit (hereafter *FSDL*).

Our contribution to the literature is two-fold. First, we provide a computable definition of *FSDL*. Second, we apply this concept in a small open economy model that determines growth endogenously and provides various transmission channels of the sovereign default risk to the rest of the economy. Note that in the literature on *DL*, the GDP growth rate is exogenous and the sovereign default risk does not spill over to the rest of the economy. The core of the model is a fairly standard open economy New Keynesian DSGE model. There are adjustment costs for investment and price rigidities. Entrepreneurs face financial risk premium due to agency problems along the lines of Bernanke et al. (1999) (hereafter BGG). We consider two types of shocks: shock to risk-free foreign interest rate and a country spread shock. These shocks are found to be important determinants of the salient features of business cycles in EEs –countercyclical real interest rates

[2] Corsetti et al. (2013) present this convex relation for a set of the European Union countries during the 2011 European crisis whereas Çufadar and Özatay (2017) document it for a set of large EEs during the Argentinean default at the end of 2001. In these studies, the convex part of the relation occurs in a wide range of public debt ratios. The expected return on government debt has a positive and convex relation with public debt ratio in the recent literature on fiscal space summarized above. However, it is stressed that the convex part of this relation occurs in a rather narrow range of debt ratios. See also Bi et al. (2016).

and countercyclical trade balance- in the presence of amplifying financial frictions (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Fernandez and Gulan, 2015).

We extend this core to introduce a rich fiscal block. First, households derive utility from government consumption, government capital is productive and there is distortionary taxation. We specify utility along the lines of Sims and Wolf (2018) to allow complementary private and government consumption. We add government capital in the aggregate production function. Thus, government investment is useful as in Baxter and King (1993), Drautzburg and Uhlig (2015), and Sims and Wolf (2018).

Second, we introduce endogenous sovereign default risk which depends on the level and currency composition of public debt-to-output ratio. Consequently, while shocks affect sovereign default risk, changes in default risk affect debt-to-output ratio by changing government borrowing costs and output, and in turn debt ratio changes default risk. The positive relation between sovereign spreads and government debt is a well-documented empirical fact (for example, Corsetti, et al., 2013; Aizenman et al., 2016). Limited fiscal capacity -high government debt relative to output or tax revenues- is one of the important reasons that prevent countries to pursue countercyclical fiscal policy especially in recessions (for a recent contribution see Aizenman et al., 2019). Note that, one of the shocks that we consider –the spread shock- amounts to a shift in the perception of creditors for an EE despite there is no change in its economic fundamentals. Such perception change stems from exogenous factors as discussed in Neumeyer and Perri (2005) and Uribe and Yue (2006) and can be seen as a sudden capital outflow as in Gertler et al. (2007) (hereafter GGN). Thus, sovereign spreads are driven by both economic fundamentals -i.e. debt-to-output ratio and developments that affect this ratio - and exogenous factors.

Third, the sovereign default risk affects the financial risk premium of entrepreneurs through its impact on the funding cost of banks, the exit rate of entrepreneurs, and the uncertainty of the quality of entrepreneurs' projects. Changes in financial risk premium of entrepreneurs, in turn, influence sovereign spreads through its supply side effects. In the financial accelerator mechanism of our model, we specify the rate at which entrepreneurs leave the market and the uncertainty of the quality of entrepreneurs' projects as functions of the sovereign default probability. Thus, external financial premium of a non-financial firm increases by an increase in the sovereign default risk. This last channel is akin to the risk shock of Christiano et al. (2014). In our model, the sovereign risk changes affect the uncertainty of the quality of entrepreneurs' projects rather than an exogenous shock. Borensztein et al. (2013), Durbin and Ng (2005), and Mascia and Colla (2015) document the strong positive correlation between corporate and sovereign borrowing spreads. Increase in likelihood of government's reliance on tax rate hikes, foreign exchange controls, expropriation of firms' assets, disruptive strikes, social unrest, and general economic turmoil associated with heightened sovereign risk are shown as main underlying factors for this strong correlation (Durbin and Ng, 2005; Corsetti et al., 2013). Another strand of the empirical literature shows that survival rates of firms are affected by sovereign spreads (Aquiar and Gopinath, 2005; Bhattacharjee et al., 2009; Guariglia et al., 2016).

Fourth, the model allows us to analyze the case where certain percentages of public debt and corporate debt are denominated in foreign currency. A negative external financial shock, by causing domestic currency to depreciate, deteriorates balance sheets of the government and firms. This deterioration increases the sovereign default risk and borrowing cost of the government, and the external financial premium of firms. The currency composition of public debt plays a central role in the second generation currency crises model of Obstfeld (1998) while the currency composition of corporate debt is at the core of the third generation currency crises models (Cespedes et al., 2004; Schneider and Tornell, 2004). The link between the currency depreciation and net worth of entrepreneurs is also an important feature of Aoki et al. (2018).

The current study is additionally related to the recent literature that explores the effects of fiscal policy on output when alternative levels of public debt are taken into account. Ilzetski et al. (2013) show that fiscal multipliers are negative in high debt countries. Corsetti et al. (2013) find that when monetary policy is constrained due to a zero lower bound and risk perception is rather high, fiscal multiplier becomes negative, provided that public debt is at very high levels. Çufadar and Özatay (2017) show that high public debt levels coupled with high foreign currency compositions lead to similar results for EEs.[3]

Our main results are as the following. First, we find that *FSDL* is significantly lower than *DL*. That is, if the current level of debt is suggestively below *DL* but exceeds *FSDL*, the fiscal space implied by *DL* cannot be used for additional fiscal stimulus. Second, *FSDL* depends on the type of fiscal instrument employed in implementing fiscal policy. Provided that government capital is productive, the most output friendly fiscal policy is the one that increases government investment, rather than elevates government consumption or decreases tax rates. Increasing government consumption to goods that are complementary to private consumption goods is useful in increasing *FSDL* as well. A countercyclical fiscal policy that relies on tax rates during recessions is counterproductive except at rather low initial debt levels. Third, we show that not considering possible transmission channels of the sovereign risk leads to overestimation of the room for maneuver for a policymaker. Fourth, in the absence of foreign currency denominated debt, *FSDL* rises considerably. Fifth, it is important to emphasize that our *FSDL* concept rests on the importance of the mutual relation between the sovereign risk and the debt ratio. If all public debt were default-free, then *DL* would become the binding constraint. We show that these results are robust to different calibration of the parameters of the model.

The remainder of the paper is organized as follows. Section II presents the model. Section III explores the transmission channels of sovereign risk changes. Section IV documents the calibration of the model. Section V compares the observed business cycle moments with those obtained from the model. Section VI discusses estimation of *DL* and *FSDL*. Section VII presents estimation results for *DL* and *FSDL* and discusses results. Section VIII concludes. Equilibrium conditions and other details of the model are provided on the online appendix to this article.

[3] For a recent discussion of the literature on fiscal multipliers in general, see Alesina et al. (2018).

II Model[4]

II.1 Households

There are a large number of identical households which derive utility from private consumption, government consumption and disutility from labor. Our preference specification follows Sims and Wolf (2018) in permitting government consumption and private consumption to be complements (substitutes). The representative household's lifetime expected utility is:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{v_{pg}}{v_{pg}-1} Ln\widehat{C}_t - \sigma_H \, \frac{H_t^{1+\varrho}}{1+\varrho} \right) \tag{1}$$

where E_t denotes expectations formed at *t*, β is a discount factor, H_t denotes hours of labor, ϱ is the inverse Frisch labor supply elasticity, and $\sigma_H > 0$ is a constant. $\widehat{C}_t$ is a composite of private (C_t) and government $(G_{C,t})$ consumption:

$$\widehat{C}_t = \emptyset_C C_t^{(v_{pg}-1)/v_{pg}} + (1-\emptyset_C) G_{C,t}^{(v_{pg}-1)/v_{pg}}$$

$\emptyset_C$ is the weight of private consumption in $\widehat{C}_t$ and $v_{pg} > 0$ is the elasticity of substitution between C_t and $G_{C,t}$, which are utility complements (substitutes) when $v_{pg} < 1$ $(v_{pg} > 1)$. When $v_{pg} \rightarrow 1$, utility becomes additively separable in C_t and $G_{C,t}$. C_t is composed of domestic (C_t^H) and foreign (C_t^F) final goods, whereas $G_{C,t}$ is composed of domestic goods.[5] The representative households maximizes Eq. (1) subject to the following budget constraint by choosing C_t, H_t, and D_{t+1}(the beginning of period *t*+1 domestic currency deposit stock)[6]:

$$(1+\tau_t^C)C_t = \frac{(1-\tau_t^W)W_t H_t}{P_t} + div_t + div_t^b - \frac{T_t^g}{P_t} - \frac{D_{t+1} - R_{t-1}^D D_t}{P_t} + \frac{T^{fr}}{P_t} \tag{2}$$

[4] With the exception of the household and fiscal blocks, the model mainly follows our earlier study (Çufadar and Özatay, 2017). In the current study, households derive utility from government consumption, government capital is productive, there is distortionary taxation, and sovereign default risk depends not only on the public debt-to-output ratio but also its currency composition. Thus, with the exception of these changes, the exposition of this Section draws on our earlier study.

[5] $C_t^H = (1-\alpha_{mc})(P_t^H/P_t)^{-\rho_c} C_t$ and $C_t^F = \alpha_{mc}(P_t^F/P_t)^{-\rho_c} C_t$ where ρ_c is the intertemporal elasticity of substitution between the home and foreign consumption goods, α_{mc} is the weight of foreign goods in the consumption basket, P_t^H is the home and P_t^F is the foreign consumer price indices.

[6] The first order conditions that are not shown in the text are provided in the online appendix to this article.

W_t is the nominal wage, P_t is the consumer price index, τ_t^C and τ_t^W are consumption and labor income tax rates, respectively. Households own the firms, and div_t denotes real total profits of domestic and imported goods retailers distributed to the households, whereas div_t^b is the banking system profits in real terms. T_t^g is lump-sum taxes – net of transfers – levied by the government, and T^{fr} is remittances from abroad.[7] Households save through domestic currency deposits D_t. R_{t-1}^D is the gross nominal deposit rate.[8]

II.2 Private Capital Producers

Private capital goods are produced by competitive firms owned by households. To produce new private capital (K_{t+1}) capital producers purchase new investment goods and the undepreciated fraction of physical capital at the end of t. Technology for building new private capital is

$$K_{t+1} = (1-\delta)K_t + \left\{1 - \frac{\chi}{2}\left[\frac{I_t}{I_{t-1}} - 1\right]^2\right\} I_t \tag{3}$$

where δ is the rate of capital depreciation and χ is the investment adjustment cost parameter. The second term in the curly brackets denotes the adjustment cost of investment, which is fairly standard in small open economy models to preclude excessive volatility in response to real interest rate changes. This specification follows Christiano et al. (2005). Private capital producers buy new investment goods (I_t) at a real price P_t^I/P_t from final goods producers and undepreciated part of the private capital for real price Q_t from entrepreneurs. I_t is composed of domestic (I_t^H) and foreign (I_t^F) final goods.[9] At the end of period t, they sell new capital stock to entrepreneurs to be used in production at t+1 at a real price Q_t. They choose I_t and K_{t+1}, subject to Eq. (3), to maximize their expected discounted profits

7 Remittances from abroad are equal to the steady state level of total interest payments for foreign debt. This is a technical assumption, which does not affect model dynamics at all. It ensures that foreign trade is in balance in the steady state for each external debt level. Such technical assumptions to ensure balanced foreign trade in the steady state are usual. For example, Guerrieri et al. (2013), to obtain balanced trade in the steady state, force the foreign debt of the core countries of the European Union to be held by periphery banks to match the level of its counterpart.

8 All interest rates shown by capital letters throughout the paper are nominal and gross.

9 $I_t^H = (1-\alpha_{mI})(P_t^H/P_t^I)^{-\rho_I} I_t$ and $I_t^F = \alpha_{mI}(P_t^F/P_t^I)^{-\rho_I} I_t$ where ρ_I is the intertemporal elasticity of substitution between home and foreign investment goods and α_{mI} is the weight of foreign goods in investment goods.

(4) $$E_0 \sum_{t=0}^{\infty} \beta^t \lambda_t \left(Q_t\, K_{t+1} - Q_t(1-\delta)K_t - \frac{P_t^I}{P_t} I_t \right)$$

where λ_t is the marginal utility of consumption.

II.3 Entrepreneurs

Entrepreneurs produce wholesale goods and sell them to retailers in a perfectly competitive market. To purchase private capital from private capital producers, they have to borrow funds from financial intermediaries (banks). Due to agency problems, the cost of borrowing is with a premium. This financial imperfection amplifies interest rate shocks. The financial accelerator mechanism is based on BGG which leads to three important equations: the zero profit condition for the bank, the external finance premium, and the evolution of net worth of entrepreneur. The exposition of the BGG mechanism in this section is standard.

To finance capital purchase, the entrepreneur *j* uses his/her net worth along with borrowed funds from banks. Borrowing is both in domestic and foreign currencies:

(5) $$L_{t+1}^{j} + N_{t+1}^{j} = P_t Q_t K_{t+1}^{j};\ L_{t+1}^{j} = L_{t+1}^{j,DC} + S_t L_{t+1}^{j,FC}$$

where L_{t+1}^{j} is total borrowing banks at the end of period *t*. Domestic currency borrowing is a constant proportion of total loans: $L_{t+1}^{j,DC} = (1-\alpha_{FC})L_{t+1}^{j}$. Similarly, foreign currency borrowing is given by: $S_t L_{t+1}^{j,FC} = \alpha_{FC} L_{t+1}^{j}$. S_t is the exchange rate –domestic currency value of one unit of foreign currency-, and $0 \leq \alpha_{FC} \leq 1$. The net worth of entrepreneur at the end of period *t* is N_{t+1}^{j}.

After purchasing capital, the entrepreneur *j* faces an idiosyncratic productivity shock ω_t^j. This shock is assumed to be distributed log normally with cumulative density function $F(\omega)$ and $E_t \omega_{t+1} = 1$ for all *t*. It is observed by the entrepreneur yet the lender must pay a monitoring cost (μ) to see the shock. There is a cut-off value of this shock $(\overline{\omega}_{t+1}^{j})$, below which the entrepreneur declares bankruptcy and receives nothing:

(6) $$\overline{\omega}_{t+1}^{j} = E_t \left[\frac{R_t^{L,j} L_{t+1}^{j}}{R_{t+1}^{K} P_t Q_t K_{t+1}^{j}} \right]$$

where $\overline{\omega}_{t+1}^{j} R_{t+1}^{K} P_t Q_t K_{t+1}^{j}$ is what the entrepreneur *j*, who purchased one unit of capital at the end of *t*, should at least earn to pay-off his/her debt, R_{t+1}^{K} is the nominal gross rate of return of purchased capital which will be defined shortly, and $R_t^{L,j}$ is the gross risky loan rate charged to the entrepreneur *j* by the bank.

The zero profit condition for banks is as the following:

$$E_t\left\{\left[1-F_t(\overline{\omega}_{t+1}^{j})\right]R_t^{L,j}L_{t+1}^{j}+(1-\mu)\int_0^{\overline{\omega}_{t+1}^{j}}\omega dF_t(\omega)R_{t+1}^{K}P_tQ_tK_{t+1}^{j}\right\}=R_t^{C}L_{t+1}^{j} \tag{7}$$

The first term on the left-hand side denotes the nominal return to financial intermediaries when the entrepreneur *j* does not default whereas the second term is the return to banks net of monitoring cost from the defaulted entrepreneur. The right-hand side of (7) defines the cost of funding to banks while R_t^C is the borrowing rate of banks.[10]

The expected return of the entrepreneur *j* scaled by his/her opportunity cost is:

$$E_t\left\{\int_{\overline{\omega}_{t+1}^{j}}^{\infty}\left[\frac{\left(R_{t+1}^{K}P_tQ_t\omega_{t+1}K_{t+1}^{j}-R_t^{L,j}L_{t+1}^{j}\right)}{R_t^{C}N_{t+1}^{j}}\right]dF_t(\omega)\right\} \tag{8}$$

Given R_{t+1}^{K} and R_t^C, the entrepreneur *j* maximizes Eq. (8) subject to the bank's zero profit condition Eq. (7) by choosing K_{t+1}^{j} and $\overline{\omega}_{t+1}^{j}$. As shown in BGG, in general equilibrium, one can aggregate the first order conditions over the firms. The optimality condition for the entrepreneurial contract is then yields the external finance premium:

$$E_t(R_{t+1}^{K}/R_t^{C})=s(N_{t+1}/P_tQ_tK_{t+1}\,);\ s(.)'<0 \tag{9}$$

Thus, the external finance premium increases as $N_{t+1}/P_tQ_tK_{t+1}$ decreases.

The net worth of entrepreneurs evolves according to:

$$N_{t+1}=(1-\upsilon_t)V_t+(1-\tau_t^{w})W_t^{e} \tag{10}$$

[10] Note that $R_t^C L_{t+1}^j = R_t^{C,DC} L_{t+1}^{j,DC} + R_t^{C,FC} S_{t+1} L_{t+1}^{j,FC}$, where $R_t^{C,DC}$ and $R_t^{C,FC}$ are the domestic and foreign currency borrowing rates of banks, respectively.

where v_t is the rate at which entrepreneurs leave the market, W_t^e is the entrepreneurial wage income, and V_t is the ex-post nominal return of the project to the entrepreneur net of his/her ex-post borrowing cost carried over from the previous period:

(11) $$V_t = R_t^K P_{t-1} Q_{t-1} K_t - R_{t-1}^C L_t - \mu \int_0^{\overline{\omega}_t} \omega dF_{t-1}(\omega) R_t^K P_{t-1} Q_{t-1} K_t$$

The leaving entrepreneurs consume their wealth: $(1+\tau_t^C) C_t^e = v_t V_t / P_t$. The optimal choice of home and foreign goods consumption is similar to the households' choice.

Entrepreneurs real gross output is

(12) $$GY_t = \frac{P_t^W}{P_t} Y_t^H + \left[Q_t - \frac{P_t^I}{P_t} \delta \right] \omega_t K_t$$

The term in the square brackets denotes the real market value of the private capital stock net of repairing worn out equipment and P_t^W is the wholesale price of domestic goods produced. Y_t^H is the wholesale good production and given by

(13) $$Y_t^H = \omega_t A_t K_{G,t}^{\varphi_G} K_t^{\alpha} [(H_t)^{\Omega} (H_t^e)^{1-\Omega}]^{1-\alpha}$$

where, A_t is aggregate productivity shock, $K_{G,t}$ is government capital, $\varphi_G \geq 0$ is a parameter that measures the productivity of $K_{G,t}$, H_t^e is the inelastic labor hours supplied by entrepreneurs as managerial input which is set to unity, α is the share of capital, and Ω is the household labor share in total labor hours.[11]

The entrepreneur maximizes his/her profit by choosing labor. The first order conditions yield:

(14) $$W_t^e / P_t = (P_t^W / P_t)(1-\alpha)(1-\Omega) Y_t^H / H_t^e$$

(15) $$W_t / P_t = (P_t^W / P_t)(1-\alpha) \Omega Y_t^H / H_t$$

The expected gross rate of return of purchased private capital is

$$E_t R_{t+1}^K = E_t \{ \pi_{t+1} [G Y_{t+1}^H - (W_{t+1} H_{t+1} + W_{t+1}^e H_{t+1}^e) / P_{t+1}] / Q_t K_{t+1} \}$$

where $\pi_{t+1} = P_{t+1} / P_t$ is the gross inflation rate. Using (12-15) and $E_t \omega_{t+1} = 1$, this boils down to

[11] Following GGN, we assume that fixed cost is borne by retailers.

(16) $$E_t R^K_{t+1} = E_t \left\{ \pi_{t+1} \left[\frac{P^W_{t+1}}{P_{t+1}} \alpha \frac{Y^H_{t+1}}{K_{t+1}} + Q_{t+1} - \frac{P^I_{t+1}}{P_{t+1}} \delta \right] / Q_t \right\}$$

II.4 Retailers

The retail goods market is as in GGN. Domestic retailers buy goods from entrepreneurs at given wholesale price and then differentiate the product at a fixed cost, fc^H. The differentiated goods are sold in a monopolistically competitive market to households, entrepreneurs, capital producers, exporters, and government. There is a Calvo type staggered nominal price setting. In any period *t*, only a fraction $(1-\theta^H)$ of retailers set their prices independently of the time elapsed since the last adjustment, whereas prices of a fraction θ^H of retailers are kept intact. The gross inflation rate for domestically produced goods is

(17) $$P^H_t / P^H_{t-1} = (\mu^H P^W_t / P^H_t)^{\zeta^H} E_t (P^H_{t+1} / P^H_t)^{\beta};\ \zeta^H = (1-\theta^H)(1-\beta\theta^H)/\theta^H$$

where (μ^H) is the desired mark-up rate of domestic goods retailers over wholesale prices. The imported goods market structure is similar to the domestic goods market.

II.5 Banks

Domestic currency deposits (D_{t+1}) and foreign currency loans from foreign creditors $(B^{B,FC}_{t+1})$ are the sources of banks. Consequently, at the beginning of *t*+1, $L_{t+1} = D_{t+1} + S_t B^{B,FC}_{t+1}$. By making use of the zero profit condition of banks Eq. (7), one can use $R^C_t L_{t+1}$, in place of expected return from loans to entrepreneurs. The expected profits of banks is

$$E_t div^B_{t+1} = R^C_t \left(D_{t+1} + S_t B^{B,FC}_{t+1} \right) - R^D_t D_{t+1} - E_t \left(R^{B,FC}_t S_{t+1} B^{B,FC}_{t+1} \right)$$

where R^D_t is the gross nominal deposit rate which is equal to the central bank policy rate (R^{CB}_t) and $R^{B,FC}_t$ is the foreign currency borrowing rate from foreigners. Optimization leads to[12]:

(18) $$R^C_t = R^D_t = E_t \left(R^{B,FC}_t S_{t+1} / S_t \right)$$

[12] Note that $R^{C,DC}_t = R^C_t$ and $R^{C,FC}_t = R^{B,FC}_t$.

II.6 Foreign Creditors and Exports

The alternative assets available for a foreign investor are risk-free foreign assets, one-period domestic currency ($B_t^{G,DC}$) and foreign currency bonds ($B_t^{G,FC}$) issued by the home country government, and one-period foreign currency loan to home banks ($B_t^{B,FC}$). A risk-neutral investor takes his/her decision based on expected returns of alternative assets, which yields the following optimality conditions:

(19) $$R_t^*(1+s_t^{pr}) = E_t\left[(1-pr_{t+1})R_t^{G,FC} + pr_{t+1}(1-d_{hc})R_t^{G,FC}\right]$$

(20) $$R_t^*(1+s_t^{pr}) = E_t\left[(1-pr_{t+1})R_t^{G,DC}\frac{S_t}{S_{t+1}} + pr_{t+1}(1-d_{hc})R_t^{G,DC}\frac{S_t}{S_{t+1}}\right]$$

(21) $$R_t^{B,FC} = crp_t\left(R_t^{G,FC}\right)^{\psi}\left(R_t^*(1+s_t^{pr})\right)^{1-\psi} = crp_t\, R_t^*(1+s_t^{pr})E_t\left(\frac{1}{1-pr_{t+1}d_{hc}}\right)^{\psi}$$

R_t^* is the risk-free foreign interest rate, $R_t^{G,FC}$ and $R_t^{G,DC}$ are, respectively, the foreign and domestic currency government borrowing rates, and s_t^{pr} is a country spread shock. The probability of sovereign default in the next period is pr_{t+1}.[13] $d_{hc} \in [0,1)$ is the size of the haircut in case of default, which is taken as constant. Given R_t^*, the sovereign default probability, the haircut ratio, and the central bank's policy rate, (18, 19-21) determine $R_t^{G,FC}$, $R_t^{G,DC}$, $R_t^{B,FC}$, and the change in the exchange rate (S_{t+1}/S_t).

A number of studies has presented the high correlation between sovereign spreads and corporate sector spreads (Durbin and Ng, 2005; Fernandez and Gulan, 2015) and so called sovereign risk ceiling policy (Borensztein et al., 2013). The parameter ψ in Eq. (21) shows the degree of pass-through from the sovereign risk to foreign funding costs of banks. If $\psi = 1$, then the borrowing cost of the banking sector from foreign creditors is slightly above that of the government. Consequently, the difference between $R_t^{B,FC}$ and $R_t^{G,FC}$ is determined by $crp_t = exp\left[\emptyset_{crp} SB_{t+1}^{B,FC}/PY\right]$, where $\emptyset_{crp} > 0$ and $exp(.)$ is the exponential function.[14] On the other extreme, when $\psi = 0$, this link ceases to exist.

[13] We discuss how pr_{t+1} is determined in Section II.8.

[14] crp_t ensures the stationarity of the banking sector foreign debt and stability of the open economy model (see, for example, Schmitt-Grohe and Uribe, 2003).

It is assumed that the law of one price holds in the imported goods competitive wholesale market. So, the wholesale domestic currency price of imported goods is

$$P_t^{W,F} = S_t P_t^* \tag{22}$$

where P_t^* is the foreign currency price of imported goods, which is equal to the foreign price level. Exporters operate in a competitive market and purchase exported goods from domestic goods retailers. The foreign demand for home goods is defined as

$$X_t = [P_t^H / S_t P_t^*]^{-\rho_X} Y_t^* \tag{23}$$

where P_t^H is the home consumer price index, ρ_X is the price elasticity of foreign demand for home goods, and Y_t^* is foreign output.

II.7 Monetary Policy

The central bank smoothens interest rate changes ($0 < \rho_{CB} < 1$), responds to the deviations of inflation from the target ($\rho_\pi > 1$), output gap ($\rho_Y > 0$), and nominal depreciation of domestic currency ($\rho_S > 0$):

$$R_t^{CB}/R^{CB} = \left(R_{t-1}^{CB}/R^{CB}\right)^{\rho_{CB}} [(\pi_t/\pi)^{\rho_\pi} (Y_t/Y)^{\rho_Y} (S_t/S_{t-1})^{\rho_S}]^{1-\rho_{CB}} \tag{24}$$

The target for gross inflation is equal to one (its steady state value) and the output gap is defined as the gap between the output and its steady state value. Such a reaction function is one of the possible functions discussed in Svensson (2000) and empirically valid for EEs as shown, among others, in Ortiz et al. (2009).

II.8 Fiscal Policy

Five fiscal policy instruments are available for policymakers: consumption and labor income tax rates, lump-sum taxes, government investment ($G_{I,t}$) and consumption ($G_{C,t}$). The government's total nominal expenditure consists of expenditures on domestically produced consumption goods ($P_t^H G_{C,t}$), composite investment goods ($P_t^I G_{I,t}$), and interest and debt payments.[15] The government capital stock evolves as

(25) $$K_{G,t+1} = G_{I,t} + (1-\delta)K_{G,t}$$

The total nominal tax revenue of the government is the sum of taxes on labor income and consumption expenditures, and lump-sum taxes (T_L^G):

(26) $$T_t^G = T_L^G + \tau_t^W(W_t H_t + W_t^e H_t^e) + \tau_t^C P_t(C_t + C_t^e)$$

The role of the lump-sum taxation in the model is to ensure balanced budget at each initial debt level at the steady state: $T_L^G = [G_C + G_I + (R^G - 1)B^G] - [\tau^w(WH + W^e H^e) + \tau^C(C + C^e)]$. The term in the first square bracket denotes the required total tax revenue at the steady state to ensure balanced budget and the term in the second squared bracket is the sum of income and consumption tax revenues at the steady state.[16]

$G_{C,t}$ and $G_{I,t}$ evolve according to the following process:

(27) $$G_{j,t} - G_j = \rho_{Gj}\left(G_{j,t-1} - G_j\right) + \varepsilon_t^{Gj}; j = C, I$$

where $\rho_{G,j}$ is the autoregressive coefficient. ε_t^{GC} and ε_t^{GI} are shock terms. Fiscal expansion is calibrated as an innovation to the relevant shock term. Otherwise, $G_{j,t}$ stays constant at its steady state level (G_j).

Tax instruments are used for two purposes: for taking fiscal stimulus measures and to prevent explosive debt dynamics. Government debt increases due to fiscal stimulus measures and increased government interest payments following the spread and foreign interest shocks. The j^{th} tax rate is

(28) $$\tau_t^j = \tau^j + \frac{T1_t + T2_t}{W_t H_t + W_t^e H_t^e + P_t(C_t + C_t^e)}; j = c, w$$

The additional tax revenue necessary in preventing explosive debt dynamics is

[15] Note that $P_t^I G_{I,t} = P_t^H G_{I,t}^H + P_t^F G_{I,t}^F$, $G_{I,t}^H = (1-\alpha_{mI})(P_t^H/P_t^I)^{-\rho_I} G_{I,t}$, $G_{I,t}^F = \alpha_{mI}(P_t^F/P_t^I)^{-\rho_I} G_{I,t}$. ρ_I is the intertemporal elasticity of substitution between home ($G_{I,t}^H$) and foreign investment goods ($G_{I,t}^F$), and α_{mI} is the weight of foreign goods in investment goods.

[16] Note that at the steady state $P^H = P^I = P = 1$ and since debt level is constant the only expenditure item other than government investment and consumption is interest payments $(R^G - 1)B^G$.

(29) $$T1_t = \psi_{T1}\left(\frac{B^G_{t+1}}{P_t Y_t} - \frac{B^G}{Y}\right)$$

and the tax revenue reduction process required for fiscal stimulus is given by

(30) $$T2_t = \rho_\tau T2_{t-1} - \varepsilon_t^{T2}$$

where τ^j is the steady-state value of the tax rate j, ψ_{T1} is a parameter that indicates the magnitude of the revenue increasing response to the deviation of debt ratio from its steady-state value, ρ_τ is an autoregressive coefficient, ε_t^{T2} is a shock term.[17] Since we compare the effect of alternative fiscal stimulus measures on *FSDL* we always specify the magnitude of the shock same for the two types of government expenditure and also for the additional tax revenue (Section V).

Any excess expenditure over total revenues is financed by new debt formation. Despite the fact that the government has the option not to honor part of its liabilities, following Corsetti et al. (2013), we assume that a sovereign default is neutral in the sense that it does not affect the government budget deficit identity. This is ensured by assuming that the government makes transfers to foreigners at the amount equal to the value of debt defaulted ($T_t^d = pr_t d_{hc} R^G_{t-1} B^G_t$).[18] The probability of sovereign default still affects the government debt through its effect on the government borrowing cost (R_t^G).[19] The government debt identity is

(31) $$B^G_{t+1} = R^G_{t-1} B^G_t + P^H_t G_{C,t} + P^I_t G_{I,t} - T^G_t$$

where $R^G_{t-1} B^G_t = R^{G,DC}_{t-1}(1-\alpha_{G,FC}) B^G_t + R^{G,FC}_{t-1} \alpha_{G,FC} B^G_t S_t / S_{t-1}$, and $\alpha_{G,FC}$ is the share of foreign currency debt in total debt. Note also that $B^{G,DC}_{t+1} = (1-\alpha_{G,FC}) B^G_{t+1}$ and $S_t B^{G,FC}_{t+1} = \alpha_{G,FC} B^G_{t+1}$.

Corsetti et al. (2013) as well as Çufadar and Özatay (2017) define the ex-ante probability of default at a certain level of sovereign indebtedness in the next period by the cumulative distribution function of the generalized beta distribution. They consider the relation between sovereign spreads and total public debt as

17 Note that the steady-state values of both of the additional tax revenues are equal to zero.

18 For example, these transfers can be considered as lawsuit costs.

19 As stressed by Corsetti et al. (2013), the equilibrium solution of a number of strategic sovereign default models implies that the probability of default increases in the level of debt (for example, Arellano, 2008; Mendoza and Yue, 2012). We do not explicitly model a strategic default decision, and to maintain the tractability of our model we impose such a relationship following Corsetti et al. (2013).

percent of GDP. Plausibly, the effect of one unit of foreign currency government debt on default risk can be more than the effect of the same level of domestic currency government debt, especially when there is an external financial shock that leads domestic currency to depreciate considerably. Based on this consideration, we define the ex-ante probability of default as

(32) $$E_t pr_{t+1} = F_{beta}\left(\frac{(B_{t+1}^{G,DC} + \xi_{FC} S_t B_{t+1}^{G,FC})/(P_t Y_t)}{b_{max}^G};\ \alpha_{B^G}, \beta_{B^G}\right)$$

where ξ_{FC} indicates the importance of foreign currency debt relative to domestic currency debt in determining the probability of default, b_{max}^G is the upper end for $(B_{t+1}^{G,DC} + \xi_{FC} S_t B_{t+1}^{G,FC})/(P_t Y_t)$, and α_{B^G} and β_{B^G} are the parameters of the beta distribution.

II.9 Market Clearing and Equilibrium

The goods market equilibrium for domestically produced goods is

(33) $$Y_t^H = C_t^H + C_t^{e,H} + I_t^H + G_{C,t} + G_{I,t}^H + X_t + fc^H + \mu \Lambda_{t-1}(\overline{\omega}_t) R_t^K Q_{t-1} P_{t-1} K_t / P_t$$

Domestic retailers differentiate the goods that they purchase from entrepreneurs at a fixed cost: $fc^H = (C^H + C^{e,H} + I^H + G_C + G_I^H + X + \mu \Lambda(\overline{\omega}) R^K QK/P)(\mu^H - 1)$. Net output is then given by

(34) $$Y_t = Y_t^H - fc^H$$

Because all government debt is held by foreigners, the total external debt at period *t* is determined by the gross interest payments on the previous period's external debt, foreign trade balance and remittances from abroad to the households (T^{fr}). Consequently,

(35) $$B_{t+1}^G + S_t B_{t+1}^{B,FC} = R_{t-1}^G B_t^G + (S_t P_t^* M_t - P_t^H X_t) + R_{t-1}^{B,FC} S_t B_t^{B,FC} - T^{fr}$$

where M_t is the total volume of imports:

(36) $$M_t = \left(C_t^F + C_t^{e,F} + I_t^F + G_{I,t}^F\right) + (\mu^F - 1)(C^F + C^{e,F} + I^F + G_I^F)$$

Using Eq. (31) for B_{t+1}^G in Eq. (35), banking system external debt is found as

(37) $$S_t B_{t+1}^{B,FC} = R_{t-1}^{B,FC} S_t B_t^{B,FC} + (S_t P_t^* M_t - P_t^H X_t) + \left(T_t^G - P_t^H G_{Ct} - P_t^I G_{I,t}\right) - T^{fr}$$

Finally, the domestic financial market equilibrium is given by

(38) $$D_{t+1} = L_{t+1} - S_t B_{t+1}^{B,FC}$$

III Shocks and Transmission Channels

III.1 Shocks

We consider two exogenous shocks to the economy that follow AR(1) processes. The first one is a shock to the foreign risk free rate:

(39) $$R_t^* - R^* = \rho_{R^*}(R_{t-1}^* - R^*) + \varepsilon_t^{R^*}$$

As emphasized in the introduction, exogenous country spread shocks are important for explaining business cycles in EEs. So, as a second shock we consider the following spread shock:

(40) $$s_t^{pr} - s^{pr} = \rho_{spr}\left(s_{t-1}^{pr} - s^{pr}\right) + \varepsilon_t^{spr}$$

where $\varepsilon_t^{R^*}$ and ε_t^{spr} are shock terms. Their standard deviations are σ_{R^*} and σ_{spr}. The autoregressive coefficients are shown by ρ_{R^*} and ρ_{spr}. From Eq. (19), the sovereign spread is given by $E_t[(1 + s_t^{pr})/(1 - pr_{t+1}d_{hc})]$. Thus, absent the spread shock, sovereign spread is endogenously determined in the model through the probability of sovereign default. This exogenous shock then amounts to a shift in the perception of creditors for an EE despite there is no change in its economic fundamentals. Such shifts can stem, for example, due to a financial crisis in another EE -the contagion effect-, or arise due to unexpected announcements in financial centers -the news effect-.

III.2 Transmission Channels of Shocks

Shocks to R_t^* and s_t^{pr} spill over to the economy through two main channels: upsurge the probability of sovereign default and depreciate the domestic currency (a rise in S_t). These channels are not independent; they reinforce each other.

Following the shocks, the probability of sovereign default (Eq.(32)) increases due to a rise in the government borrowing rates (Eqs. (19-20)) as well as government debt (Eq. (31)), and the depreciation of domestic currency. The elevated probability of sovereign default, in turn, affects the economy through three channels. First, it increases sovereign spreads by raising government borrowing costs and then soars the government debt, which causes a further rise in the sovereign risk, and so on (Eqs. (32, 19-20, 31, and again 32)). This is the only channel in the literature on debt limit summarized in Section I.

Second, an increase in the default risk is transmitted to the rest of the economy through an upsurge in the foreign funding cost of the banking sector (Eq. (21)). A rise in the banking funding costs triggers the financial accelerator mechanism to operate via a rise in the banking sector lending rate (Eqs. (18 and 7)), and the cut-off value of the idiosyncratic productivity shock (Eq. (6)), a reduction in the expected return of the entrepreneur (Eq. (8)) and his/her net worth (Eqs. (10-11)), a further rise in his/her borrowing rate, and so on.

The third transmission channel strengthens the financial accelerator mechanism. As explained in the introduction, the survival rates of firms and the uncertainty of the quality of entrepreneurs' projects are affected by financial distress caused by a rise in the sovereign default risk. Consequently, the model presented in Section II is amended to allow the government default risk to affect the standard deviation of the idiosyncratic shock faced by each entrepreneur:

(41) $$\sigma_t = \sigma * exp[a_\sigma(E_t pr_{t+1} - pr)]$$

and the rate at which entrepreneurs leave the market:

(42) $$v_t = v * exp[a_v(E_t pr_{t+1} - pr)]$$

where $a_\sigma > 0$, $a_v > 0$, σ, and v denote the steady state values of σ_t and v_t. Thus, an increase in the sovereign default risk raises σ_t and v_t, leading to a decline in the net worth of the entrepreneur. This triggers the financial accelerator mechanism to work as explained above.

To clarify the second main channel –the depreciation channel- rewrite Eq. (18) to obtain S_t and use Eqs. (19-21) to substitute-out for $R_t^{B,FC}$: $S_t = E_t\left\{(crp_t R_t^*(1+s_t^{pr})/R_t^{CB})\big(1/(1-pr_{t+1}d_{hc})\big)^{\psi} S_{t+1}\right\}$. On the one hand shocks to R_t^* and s_t^{pr} cause depreciation, on the other hand the central bank responds to the depreciation and inflation by increasing its policy rate (R_t^{CB}). The expected exchange rate for the next period soars as well. Net result is a rise in S_t. These developments trigger a series of effects. First, an increase in R_t^{CB} leads to a rise in the banking sector funding costs and its lending rates (Eqs. (18 and 7)), cut-off value of the idiosyncratic productivity shock (Eq. (6)), and a decline in the net worth of the entrepreneur (Eqs. (10-11)). Second, since entrepreneurs borrow from banks both in domestic and foreign currencies at the same time (Eq. (5)), the depreciation leads to a rise in domestic currency value of the total liabilities of entrepreneurs to the banking sector. This further reduces their net worth. Third, the depreciation of domestic currency increases the wholesale domestic currency price of imported goods (Eq. (22)). This further raises the imported goods retail prices, the consumer price level, the investment price level, wholesale prices. Fourth, all these reactions cause investment and consumption to decline and exports to increase. Net effect is a decline in output. Due to these developments, the sovereign default risk increases.

IV Calibration of Parameters and Shock Processes

We calibrate the parameters of the model following the previous research and using observed values for the Turkish economy to match the fluctuations of the Turkish economy in the 2002Q1-2016Q2 period.[20] Table 1 documents the calibrated parameters.

[20] The Turkish Statistics Institute revised GDP data at the beginning of 2017 and has since then announced GDP data based on the new series. The revision significantly changed the debt-to-GDP ratios of the past. In order to calculate the sample moments of the data, we used the data known at the time and therefore the last observation of our sample is the second quarter of 2016. The first quarter of our sample marks the start of the floating exchange rate regime. The relevant data is provided in the online appendix to this article.

Table 1 Calibrated values

Parameter	Value	Description
v_{pg}	1 (0.7)	elasticity of substitution between private and government consumption
$\emptyset_C$	0.8 (0.7)	weight of private consumption in the composite good
ϱ	1	inverse Frisch labor supply elasticity
H	1/3	steady state labor hours
ρ_x	0.8 (0.5)	price elasticity of export demand
ρ_c	1	consumption intra-temporal substitution
ρ_I	0.25	investment intra-temporal substitution
1-Ω	0.01	share of entrepreneurial labor hours in total labor hours
$\mu^H=\mu^F$	1.15	retailers mark-up rate
$\theta^H=\theta^F$	0.75 (0)	probability of not adjusting prices
δ	0.035	quarterly depreciation rate of private and government capital
α	0.40	capital intensity of domestic goods
χ	3.63 (1)	investment adjustment cost parameter
σ	0.28	steady-state variance of the idiosyncratic shock
μ	0.12	monitoring cost rate
v	0.0272	steady-state exit rate
$a_\sigma=a_v$	2 (0)	sensitivity of BGG parameters to the probability of default
Ψ	1 (0.8)	pass-through from sovereign risk to banking foreign funding cost
ϕ_{crp}	0.00015	elasticity of banks' external borrowing premium with respect to debt ratio
B^{FC}/Y	0.8	foreign-debt-to-output ratio of banks (quarterly)
ρ_{CB}	0 .72	Taylor rule coefficient on lagged interest rate
ρ_π	1.54	Taylor rule coefficient on inflation
ρ_Y	0.02	Taylor rule coefficient on output gap
ρ_S	0.17	Taylor rule coefficient on the rate of currency depreciation
τ^C	0.113	consumption tax rate
τ^W	0.148	labor income tax rate
$G_{C,t}$	0.107	government consumption expenditures-to-output ratio
$G_{I,t}$	0.039	government investment expenditures-to-output ratio
φ_G	0.05 (0.1, 0)	productivity of government capital
ξ_{FC}	2	weight of foreign currency debt in total debt in the beta function
α_{B^G}	2.6	parameter of the beta function
β_{B^G}	2.4	parameter of the beta function
b^G_{max}	11.29	maximum debt-to-output ratio in the beta function (quarterly)
d_{hc}	0.35	haircut ratio (quarterly)
X/Y	0.251	export-to-output ratio
α_{mI}	0.187	the share of imported goods in investment
ρ_{R^*}	0.69	AR(1) coefficient of risk-free rate shock process
$SD(\varepsilon_t^{R^*})$	0.002	standard deviation of risk-free rate shock process
R^*	1.0025	quarterly foreign risk-free gross rate
ρ_s	0.77	AR(1) coefficient of spread shock process
$SD(\varepsilon_t^{sp})$	0.01837	standard deviation of spread shock process

Notes: The numbers in parentheses denote the alternative calibration values

The parameters that are set according to the observed values of the relevant variables in the 2002Q1-2016Q2 period are as follows: At the steady state, we fix the share of government consumption expenditures in GDP (G_C/Y) at 0.107, the share of government investment expenditures in GDP (G_I/Y) at 0.039, the export to GDP ratio X/Y at 0.24, banking sector foreign debt-to-GDP ratio $(SB_{t+1}^{B,FC}/PY)$ at 0.80 (which amounts to 20% of GDP in annual terms), the consumption tax rate τ^C at 0.113, and the labor income tax rate τ^W at 0.148. The share of imported goods in the investment goods composite α_{mI} is set to 0.187. In the same period, the average foreign currency debt share of government in its total debt was 35.6% and the average ratio of the foreign currency liabilities of the non-financial corporate sector in its total liabilities was 45.6%. Consequently, we set $\alpha_{G,FC} = 0.356$ and $\alpha_{FC} = 0.456$. We take the steady state value of the risk-free real foreign interest rate as 1.0025 (quarterly and gross).

A number of the preference and technology parameters are derived from the steady state solution of the model to pin down key steady state ratios. σ_H is derived to set the steady state labor hours H to 1/3. Since the time preference β is the inverse of the steady state value of the gross deposit rate, it is determined by the steady state sovereign default probability, the foreign borrowing premium of banks, and the foreign quarterly foreign discount factor and calculated in the model. Following Sims and Wolf (2018), we choose the steady state value of productivity (A) to be consistent with $AK_G^{\varphi_G} = 1$, given φ_G. The share of imported goods in the consumption goods composite (α_{mC}) and foreign output (Y_t^*) are also derived from the model.

The rest of the preference and technology parameters are taken from the literature on Turkey and other EEs. In their study on Turkey, Alp and Elekdag (2013) fix most of their calibrated parameters as in GGN's study on Korea. They set the inverse Frisch labor supply elasticity ϱ at 1, the intra-temporal elasticity of substitution for the consumption good ρ_C at 1 and that of the investment good ρ_I at 0.25, the share of entrepreneurial labor (1-Ω) in total labor at 0.01, the retailers' mark-up rates for domestic goods μ^H and foreign goods μ^F to 1.15, the capital intensity parameter of domestic goods α to 0.40, and the depreciation rate δ at 0.035. They estimate the investment adjustment cost parameter χ as 3.63 (posterior mode). We use the same values for these parameters. GGN sets the price elasticity of the export demand equation (ρ_X) at unity. Agenor et al. (2014) takes it as 0.7. We set ρ_X to 0.80. Following GGN the Calvo parameters (probability of not adjusting prices for domestic goods θ^H and foreign goods θ^F) are set at 0.75. The parameter that shows the degree of pass-through from sovereign risk to foreign funding costs of banks (ψ)

is set to 1. $\emptyset_{crp}$ (the elasticity parameter of the banking system external borrowing premium with respect to B^{FC}/Y) is taken as 0.00015.

The steady state values of the parameters of the financial accelerator are set to standard values. At the steady state, as evident from Eqs. (41-42), $\sigma_t = \sigma$ and $v_t = v$. Following BGG we fix the steady-state exit rate v at 0.0272 and the steady-state variance of the log-normally distributed idiosyncratic shock faced by entrepreneurs σ at 0.28. Since a_v and a_σ in are introduced in this paper, the literature does not provide guidance for their values. We proceed as follows: the elasticity of v_t is calibrated such that the average life of entrepreneurs declines by approximately 10% at the maximum initial public debt level. Consequently, we set $a_v = 2$. Similarly, we set $a_\sigma = 2$ to ensure that the variance of the idiosyncratic shock does not exceed its steady state value by more than 20%. The monitoring cost rate μ is fixed at 0.12 as in BGG.

The parameters of the monetary policy reaction function are set at estimated values (posterior modes) of Alp and Elekdag (2013). Consequently, $\rho_{CB} = 0.72$, $\rho_\pi = 1.54$, $\rho_Y = 0.02$, and $\rho_S = 0.17$. Note that these values are close to values reported in Ortiz et al. (2009, Table 2.2) for Turkey. To our knowledge, in the literature, for EEs there are no values fixed for $\emptyset_C$ (the weight of private consumption in $\widehat{C_t}$), v_{pg} (the elasticity of substitution between private and government consumption), and φ_G (a measure of the productivity of government capital). Sims and Wolf (2018) calibrate $\emptyset_C$ and φ_G and estimate v_{pg}. Following them, we take $\emptyset_C$ =0.8 and $\varphi_G = 0.05$. We set v_{pg}=1, which is among the alternative values of Sims and Wolf. This amounts to assuming an additively separable utility function. For a number of parameters for which the literature does not provide guidance or alternative values are used for Turkey or EEs we conduct robustness tests (Section VII). These parameters are as follows: ρ_X, θ^H, θ^F, ψ, a_v, a_σ, φ_G, and v_{pg}.

We follow the literature when parametrizing the shock processes. We take the quarterly real gross US 3-month Treasury bill rate as the risk-free foreign interest rate.[21] We then fit Eq. (39) to the Hodrick-Prescott

[21] As in Chang and Fernandez (2013), the real gross rate is the 3-month Treasury bill rate divided by the average gross US inflation over the past four quarters. See the online appendix to this article.

(HP) de-trended data over the 1980Q1-2019Q1 period. The following parameter estimates are obtained: $\rho_{R^*} = 0.69$ and the $\sigma_{R^*} = 0.002$ (standard deviation of $\varepsilon_t^{R^*}$). When Eq. (40) is fitted to the HP de-trended quarterly emerging market bond index (EMBI) spread of Turkey over the 1999Q2-2019Q2 period we obtain the following parameter estimates: $\rho_{spr} = 0.77$ and the $\sigma_{spr} = 0.0184$ (standard deviation of ε_t^{spr}).[22]

Finally, for the parameters of the probability of sovereign default function, we follow Corsetti et al. (2013), and Çufadar and Özatay (2017). Corsetti et al. (2013) use the relation between 5-year sovereign CDS spreads as of May 6, 2011 and forecasts for gross general government debt ratio for end-2011 for a number of EU countries plus the U.S whereas Çufadar and Özatay (2017) specify the link between EMBI spreads as of January 1, 2002 and government debt ratio for end-2002 for a number of EEs.

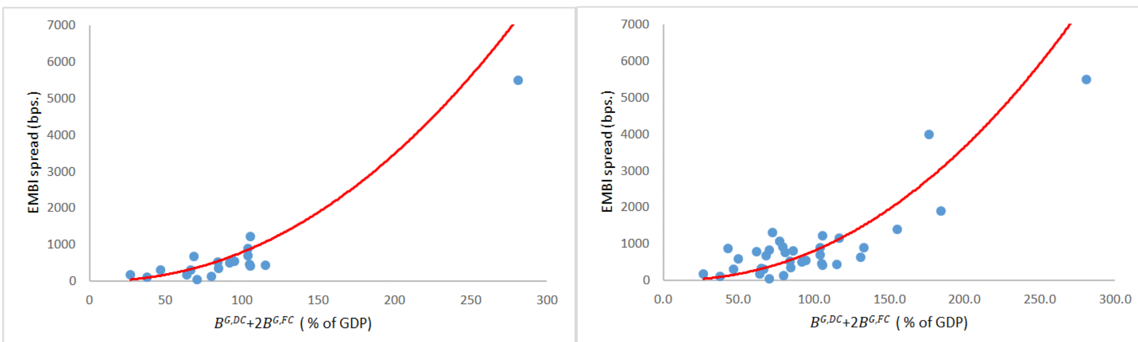

Fig. 1. Sovereign risk premium (EMBI spread in basis points –bps.) and domestic currency plus two times the foreign currency public debt as percent of GDP. Left panel: Argentinean 2001 default episode. Right panel: Argentinean 2001 and Russian 1998 default episodes.
Notes: The curved lines indicate the fitted spreads (projected values are not shown). Left panel: EMBI spreads are as of December 24, 2001, debt as percent of GDP are for end-2002. Countries: Argentina, Brazil, Bulgaria, Chile, Colombia, Ecuador, Egypt, Korea, Mexico, Morocco, Hungary, Panama, Peru, Philippines, Poland, Russia, South Africa, Thailand, and Turkey. Right panel: In addition to the data used in the left panel following data are included: EMBI spreads as of September 2, 1998 and debt as percent of GDP for end-1999 for Argentina, Brazil, Bulgaria, Colombia, Ecuador, Korea, Mexico, Morocco, Panama, Peru, Philippines, Poland, Russia, South Africa, Thailand, and Turkey. EMBI spreads: Bloomberg; Debt-to-GDP ratios: Article IV Consultation Reports of the IMF. Data is provided in the online appendix to this article.

Fig. 1 (left panel) depicts the link between EMBI spreads as of December 24, 2001 -the date when the Argentinean government declared its intention to default- and government debt-to-GDP ratio and its currency composition for end-2002 for EEs. The right panel shows the same relation both for the December 24, 2001 Argentinean and September 2, 1998 Russian default episodes.[23] The solid lines indicate the fitted

[22] EMBI spread data for Turkey starts at 1999Q2. Quarterly spread is calculated as $(EMBI_{TR}/10^4)^{0.25}$, where $EMBI_{TR}$ is the observed sovereign spread for Turkey in basis points. See the online appendix to this article.

[23] Timing of the default episodes is discussed in the online appendix to this article.

spread when the parameters of the generalized beta distribution are as follows: $\xi_{FC} = 2$, $b_{max}^{G} = 11.29$ (end-2002 value for Argentina), $\alpha_{B^G} = 2.6$, and $\beta_{B^G} = 2.4$. The fifth parameter that underlines the plotted projections is the haircut ratio (d_{hc}). The average haircut ratio during the defaults of EEs is reported as 33.6% by Panizza et al. (2009) and 37% by Cruces and Trebesch (2013). We set $d_{hc} = 0.35$.[24]

V Matching Moments

The average government debt-to-GDP ratio over the period 2002Q1-2016Q2 was 50% of GDP and the 35.6% of the total debt was in foreign currency. Using these values, following Corsetti et al. (2013), we solve the non-linear model under perfect foresight, start the economy in the steady state and subject it at the beginning of the first period to shocks. We calibrate the initial innovations to the real foreign interest rate and spread shocks such that each innovation is equal to the standard deviation of the relevant shock and its persistence is as given in Section IV (for the subsequent periods each innovation takes the value of zero).

Table 2 presents the empirical moments for output, private consumption, private investment, trade balance-to-output ratio, and the foreign borrowing rate of government for the Turkish economy over the period 2002Q1-2016Q2 together with the moments obtained from the model. In the data, the volatility of consumption is slightly above the volatility of output. The model matches the observed volatility of consumption, whereas it estimates the volatility of output equal to that of the consumption, and overestimates the volatility of investment. The estimated correlation of investment with output is close to the empirical correlation whereas the model predicts higher correlation between output and consumption. The literature on the business cycles in EEs has stressed the countercyclicality of both the trade balance-to-

[24] We investigate the determinants of spreads through cross-section regressions. Results indicate that the coefficient of foreign currency debt is approximately 2-3 times larger than that of the domestic currency debt, depending on the controls used. The expected total debt of Argentina for the end of 2002 was 164.2% of GDP and its foreign currency share was 71.7%. Based on these values, domestic currency plus two times of the foreign currency debt of Argentina was 281% of its GDP. Because the model is quarterly, in numerical solutions, we set $b_{max}^{G} = 11.2926$. Similarly, for quarterly frequency, $d_{hc} = 0.0875$. The details of the data and estimation results are provided in the online appendix to this article. No doubt that there are other factors that affect spreads as well. For example, Özatay et al. (2009), using daily data for a panel of 18 EEs for the 1997-2006 period, show that the long-run evolution of emerging market bond index (EMBI) spreads depends on global financial conditions, crises contagion and domestic fundamentals. They also demonstrate that short-run spreads respond substantially also to U.S. macroeconomic news and changes in the Federal Reserve's target interest rates. Our spread shock variable aims at capturing contagion and news effects, whereas domestic fundamentals are covered by debt-to-output ratio and its currency composition.

output ratio and the real interest rate (see, for example, Aguiar and Gopinath, 2007; Fernandez and Gulan, 2015). The model captures the countercyclicality of these variables. Consequently, the model's performance is reasonably well in accounting for some of the main business cycle patterns in Turkey.

Table 2. Business cycle moments

	σ (observed)	σ (model)	$\rho_{Y,j}$ (observed)	$\rho_{Y,j}$ (model)
Y_t	2.31 (0.33)	2.65 (0.15)	-	-
C_t	2.62 (0.31)	2.66 (0.26)	0.76 (0.05)	0.96 (0.02)
I_t	7.14 (1.06)	8.61 (2.15)	0.69 (0.06)	0.75 (0.06)
TB_t/Y_t	1.50 (0.15)	1.25 (0.22)	-0.48 (0.13)	-0.87 (0.04)
$R_t^{G,FC}$	0.30 (0.05)	0.49 (0.17)	-0.41 (0.12)	-0.52 (0.10)

Notes: σ denotes standard deviation and $\boldsymbol{\rho_{Y,j}}$ is the correlation coefficient of variable j with *Yt*. Standard deviations are expressed in percent. Values in parentheses are standard errors. Moments and their corresponding standard errors are computed using GMM. The sample for the observed variables is 2002Q1-2016Q2. The same number of observations is used to obtain the model moments. TBt /Yt is the trade balance-to-output ratio. For the definition of the rest of the variables, see the text. For the observed moments, the quarterly rate of changes of Yt, Ct, and It and the first differences of the rest of the variables are used. For the model, the rate of changes and the first differences are calculated with respect to the steady state values.

VI Derivation of Debt Limit and Fiscal Stimulus Debt Limit

VI.1 Debt Limit

Using the government debt accumulation equation -Eq. (31)- the debt-to-output ratio stabilizing primary surplus is given as

(43)
$$PS_{DS,t} = \left(R_{t-1}^{G} - \frac{P_t Y_t}{P_{t-1} Y_{t-1}}\right) B_t^G$$

To derive the debt limit we proceed as follows:

(i) Before the shocks, for each initial (steady state) debt-to-output ratio, we find the debt-to-output stabilizing primary surplus PS_{DS} and check whether this necessitates a primary surplus that exceeds the maximum primary surplus level ($\overline{PS}$). We set $\overline{PS}$ as 5.5% of output based on Escolano et al. (2014).[25] The minimum debt ratio that satisfies this condition gives the steady-state debt limit (DL_{SS}).

[25] In Turkey, in the time period covered in this study, the maximum primary surplus-to-GDP ratio was registered in 2005 as 6%. The 2005-2006 average was 5.7. See the online appendix to this article.

(ii) We subject R_t^* and s_t^{pr} to positive shocks and solve the nonlinear model under perfect foresight as discussed in Section V. If there is no fiscal stimulus $G_{C,t}, G_{I,t}$ and $T2_t$ remain at their steady state levels. However, $T1_t$ increases to prevent explosive debt dynamics and thus tax rates increase (see Section II.8).

(iii) These recessionary shocks create a set of dynamic effects as discussed in Section III. Interest burden of the government rises due to these effects. We calculate the average ($PS_{DS,t}$) for the first four periods (quarters). We check at which initial debt ratio this average value of $PS_{DS,t}$ exceeds $\overline{PS}$. The minimum debt ratio at which this level is exceeded gives the tentative post-shock *DL*.

(iv) We then check whether the average $PS_{DS,t}$ of each four-quarter period follows a declining path for the five consecutive four-quarter periods. If yes, then *DL* is the level found at step iii. If not, we check whether in the previous debt ratio $PS_{DS,t} < \overline{PS}$. If yes, then *DL* is this debt ratio. If not, we continue similarly.[26]

VI.2 Fiscal Stimulus Debt Limit

In the aftermath of the recessionary shocks, there are two alternative fiscal policies. First, the government can keep $G_{C,t}$, $G_{I,t}$, and $T2_t$ at their steady state levels (no action). Second, it can take three alternative fiscal stimulus measures: (i) increase $G_{I,t}$; (ii) increase $G_{C,t}$; (iii) decrease $T2_t$. Fiscal expansion is calibrated as an innovation to the relevant shock term (Eqs. 27 and 30). The magnitude of the shock for all of the alternatives is 1% of output. The persistence coefficient of each shock (the relevant autoregressive coefficient) is fixed to 0.85.[27] This specification amounts to shocks of equal magnitude and equal persistence for each alternative and thus allows us to compare the efficiency of each instrument. For each type of fiscal

26 This way of calculating the debt limit is different from that of the literature on the debt limit that rests on three equations: standard government budget constraint, an arbitrage equation between the expected return on risky government debt and the risk-free rate, and a non-linear fiscal reaction function that reflects the fiscal fatigue concept. One then obtains an equation that reflects the joint endogeneity of the risk premium and the default probability. Solution of this 'fixed point' problem gives the debt limit. See, for example, Ghosh et al. (2013).

27 In the baseline case, which is discussed in the following section, the shock dies at the 34th period when its total impact reaches 1.66% of output. The impact at the end of the second year (8th quarter) is 1.22% and at the end of the third year is 1.43% of output. Horton et al. (2009) provide the fiscal stimulus measures announced by G-20 countries at the beginning of 2009. According to Table 2 of the appendix, the fiscal stimulus measure announced for Turkey was 0.8% of GDP for 2009 (exactly our amount) and 0.3 % of GDP for 2010.

policy and initial steady-state debt level, we calculate the net present value of output losses for the first 20 (and alternatively for the first 8, 12, 16) quarters.[28] The debt level at which the net present values of output losses obtained from the "no action" case and the "fiscal stimulus" case are equal gives *FSDL*. Beyond this level, fiscal stimulus leads to more output losses relative to the no fiscal response case.

VII Results and Discussion

VII.1 Baseline and Alternative Calibration for Fiscal Parameters

The baseline simulation is based on the calibrated parameters and shock processes discussed in Section IV. Fig. 2 depicts the estimated debt-to-output ratio stabilizing primary surpluses both at the steady state (step i of Section VI.1) and after the shocks (step iv of Section VI.1) together with $\overline{PS}$ for the initial debt-to-output ratios in the range of 0 to 67.5%. Notice that, given that the probability of sovereign default and the borrowing rate of the government are convex functions of public debt ratio, as the initial steady state debt ratio increases the debt-stabilizing primary surplus rises at an increasing rate. *DL* is the debt-to-output ratio where the after-shock debt stabilizing primary surplus-to-output ratio (the convex line) intersects the maximum affordable primary surplus-to-output ratio (the horizontal dots indicating 5.5% of output). Consequently, *DL* is 55% of output whereas DL_{SS} is 68% of output. For the purpose of this study, *DL* is the relevant limit which we compare with *FSDL*. [29]

[28] The output loss of each quarter is with respect to the steady state. Output losses are discounted and their sum is calculated to yield the net present value of the output losses. In what follows, to save space, we present results for the shortest and the longest horizons. The online appendix provides the rest.

[29] Pienkowsky (2017), with a different methodology, reports that the debt limit is 58% when the foreign currency denominated debt is half of the public debt and 98% when there is no foreign currency debt. The corresponding debt limits obtained from our model are 48% and 79%, respectively (see Table3).

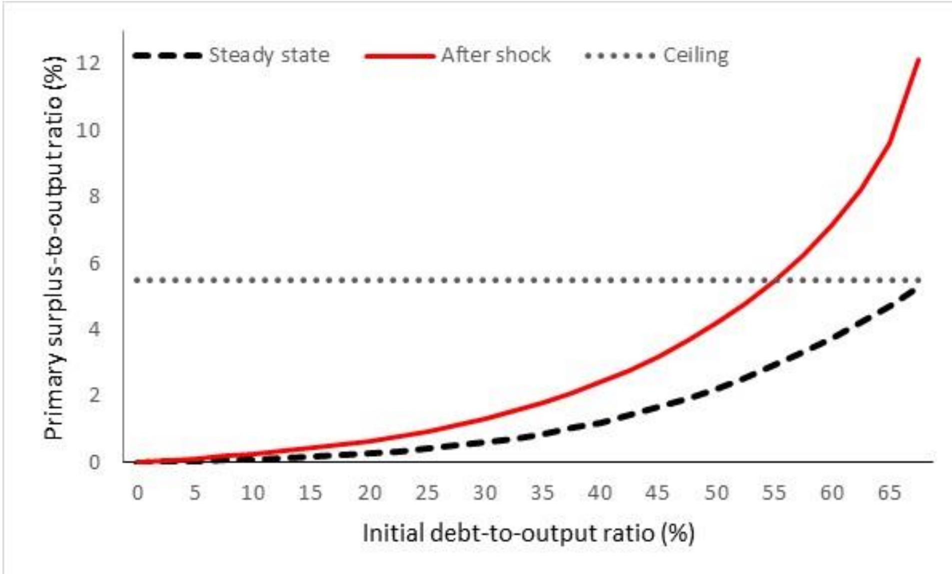

Fig. 2. Debt-to-output ratio stabilizing primary surplus-to output ratio at each initial debt-to-output ratio.

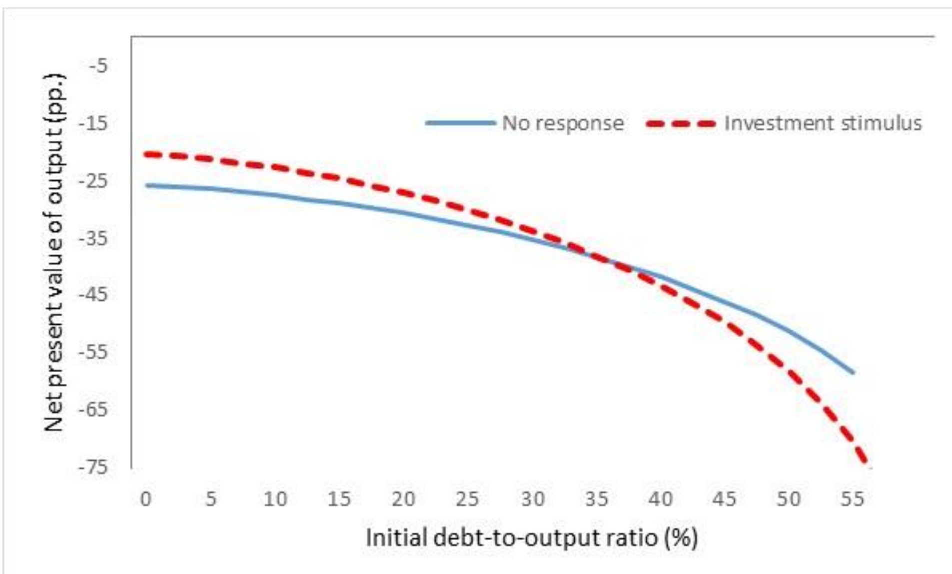

Fig. 3. Net present value of output in percentage points (pp.) for the first 20 quarters for the baseline case.

We now turn to *FSDL* for the baseline case. Fig. 3 shows the net present value of output losses for the first 20 quarters for the "no response" and "investment stimulus" cases for each initial debt level when government investment is used as the fiscal instrument. Increasing government investment decreases output losses relative to the no response case up to 36% initial debt-to-output ratio (the dashed line which shows the fiscal stimulus case remains above the solid line which denotes the no response case). Both curves intersect at the 36% initial debt ratio. According to our definition this is *FSDL*. There is a significant gap of 19 percentage points (pp.) between *DL* and *FSDL*. If one considers only the first 8 quarters –the period in which the bulk of the fiscal stimulus (73% of the total) is given- *DL* is estimated as 44% of output. Still, the gap between *DL* and *FSDL* is high. Table 3 provides both limits for all instruments and two time periods – the first 8 and 20 quarters. Note that there is a unique *DL* for all type of fiscal instruments, which is not the case for *FSDL*. The most output-friendly fiscal instrument is government investment. This is especially evident when one focuses on the 20-quarter period: *FSDL* for the government investment case is 9 pp. and 20 pp. higher than that of the government consumption case and the tax stimulus case, respectively.

Table 3. Fiscal stimulus debt limits (%)

Type of fiscal stimulus:	Investment		Consumption		Tax	
Number of periods for NPV:	8	20	8	20	8	20
S1. Baseline (DL_{SS}=68, *DL*=55)	44	36	43	27	32	16
S2. More productive government capital (DL_{SS}=68, *DL*=56)	50	46	43	27	32	16
S3. Government capital is not in the production function (DL_{SS}=68, *DL*=55)	37	22	43	27	32	16
S4. Non-separable utility in private and government consumption (DL_{SS}=68, *DL*=56)	47	37	52	38	32	15
S5. Higher weight of government consumption in the composite consumption good (DL_{SS}=68, *DL*=55)	44	36	43	27	32	16
S6. Delayed tax increase to prevent explosive debt dynamics (DL_{SS}=68, *DL*=56)	47	35	46	26	36	15
S7. Sovereign spread is not transmitted to entrepreneurs' projects and survival rates (DL_{SS}=68, *DL*=58)	56	47	54	38	44	23
S8. Less pass-through from sovereign spreads to banks (DL_{SS}=68, *DL*=54)	45	37	44	29	34	17
S9. Higher foreign currency share in government debt (50%) (DL_{SS}=64, *DL*=48)	36	29	35	23	26	13
S10. Lower foreign currency share in government debt (10%) (DL_{SS}=79, *DL*=69)	*DL*	54	68	39	49	23
S11. No price rigidity (DL_{SS}=68, *DL*=53)	42	31	40	19	41	21
S12. Less private investment rigidity (DL_{SS}=64, *DL*=51)	36	32	36	26	25	15
S13. Less export price elasticity (DL_{SS}=64, *DL*=56)	42	34	44	28	30	15

Notes: NPV denotes the net present value, DL_{SS} is the steady-state debt limit, and *DL* is the debt limit (after the shocks).

How sensitive are our results to the baseline calibration? To answer this question we conduct a number of exercises. First, we consider a more productive ($\varphi_G = 0.10$) and an unproductive government capital ($\varphi_G = 0$) cases. When government capital is more productive, *FSDL* increases to 50% and 46% of output for the 8 and 20 quarters horizon, respectively. Still, the gap between *DL* and *FSDL* is considerable (Table 3; S2). If government capital is unproductive, increasing government consumption outperforms investment as the most output friendly stimulus measure and the gap between the two limits increase considerably for the 20-quarter horizon (Table 3; S3).

Second, when the utility is not additively separable and government consumption is a complement ($v_{pg} = 0.7$), for the 20-quarter period there is no difference in *FSDL* achieved between expenditure based fiscal stimulus measures. However, for the shorter time horizon government consumption outperforms government investment in yielding a higher *FSDL* (Table 3; S4). Third, a higher government consumption weight in the consumption composite ($1 - \emptyset_C = 0.3$) does not change the baseline results. In all of the cases, the worst performing fiscal stimulus policy is to decrease tax rates. Furthermore, *FSDL* is always lower than *DL*, and significantly so (Table 3; S5).

What if the government delays the tax rate increase? As discussed in Section II.8, following the realization of the exogenous shocks the government increases distortionary tax rates to prevent explosive debt dynamics (Eqs. 28 and 29). In the baseline case, the maximum increase in each of the tax rates is 1.4 pp. (at the end of the 6th quarter) and 2.1. pp (again at the end of the 6th quarter) when no fiscal stimulus measure is taken and government investment is increased, respectively. We consider a delay of 8 quarters in which $\psi_{T1} = 0$ and increases to 0.073 afterwards (in the baseline it is 0.055 for all *t*). This policy slightly increases *FSDL* when the 8-quarter horizon is considered, however, then either lowers it in a limited fashion or leads to the same *FSDL* (Table 3; S6). Nonetheless, the necessary tax rate increase to ensure nonexplosive debt dynamics increases to 2.6 pp. and 4.7 pp. when no fiscal stimulus measure is taken and investment stimulus is taken, respectively (both are the maximum levels observed at the end of the 9th quarter).

VII.2 Restricting Transmission Channels of Shocks

First, we search the effects of eliminating the link between the sovereign risk and the variance of the shock to entrepreneurs' projects and their exit rates: $a_v = 0$ and $a_\sigma = 0$ (Table 3; S7). Now, *DL* increases by 3 pp. to 58% and for the 8-quarter period and for both of the expenditure-based stimulus *FSDL* reaches a level close to, but still remains under it. For the longest horizon (20 quarters) the gap between *DL* and

FSDL is considerable as in the baseline case. Second, we analyze the case when the impact of the sovereign risk on the foreign borrowing cost of the banks is less ($\psi = 0.8$).[30] There is not a significant change compared to the baseline (Table 3; S8).

Third, we investigate how the foreign currency debt of the government affects *DL* and *FSDL*. In the baseline case, the share of foreign currency denominated debt in total government debt is 35.6% which is the average value observed in our sample for Turkey. The maximum and minimum values are 50% and 10%, respectively. When the foreign currency share is increased to 50% and the same shocks are applied, the impact on both of the debt limits is considerable. DL decreases to 48% - 7 pp. reduction relative to the baseline-, whereas FSDL for the government investment case declines to 36% for the 8-quarter period - 8 pp. reduction compared to the baseline. For the longer horizon and other stimulus instruments, declines in both of the limits are similar (Table 3; S9). On the contrary and as expected, a rather limited foreign currency denomination – 10%- increases both of the debt limits significantly. Now, *DL* is 69%. Both for the consumption and investment stimuli, when one considers the 8-quarter horizon, the gap between the two limits ceases to exist. Nevertheless, for the 20-quarter and also for the 16 and 12-quarter horizons (not shown), there is still a considerable gap between *DL* and *FSDL* (Table 3; S10).

VII.3 Further Robustness Checks

Removing the price rigidity and monopolistic competition from the model yields a lower *FSDL* – especially at the 20-quarter horizon- for both of the expenditure instruments (Table 3; S11). For all cases, the gaps between *DL* and *FSDL* are significant. Reducing the cost of investment adjustment parameter (χ =1) lowers *FSDL* (Table 3; S12). Even so, the differences from the baseline case are rather minor. We obtain similar results to the baseline case for a lower price elasticity of export demand ($\rho_X = 0.5$: Table 3; S13).

[30] This is the average correlation between sovereign and corporate spreads given in Durbin and NG (2005). Fernandez and Gulan (2015, Appendix Table 1) report a higher correlation for Turkey (0.88).

VII.4 Discussion

First, as expected, the shocks reduce the steady state debt limit. Second, *FSDL* is significantly lower than *DL* for all types of fiscal instruments considered in this study. As emphasized in the introduction section, the fiscal space -calculated as the difference between *DL* and the current public debt ratio- does not provide any information regarding up to which debt level policymakers can take fiscal stimulus measures. Thus, when faced a recessionary external shock policymakers are clueless regarding their room for maneuver. The *FSDL* concept proposed in this study provides this information. This means that once this lower limit is hit, the remaining fiscal space cannot be used for additional fiscal stimulus. At this point, the only useful information that the conventionally calculated *DL* provides is how close a country is to a collapse.

Third, the composition of fiscal stimulus is important. If fiscal policymakers can design a fiscal stimulus package that consists of productive investment and/or government consumption which is complementary to the private consumption, they can increase *FSDL*. For example, the *FSDL* difference between a fiscal stimulus based on unproductive government investment and productive investment is higher than *FSDL* itself under the unproductive case. Unless the government capital is not productive, an investment stimulus yields the most output-friendly results whereas tax stimulus is the worst performing fiscal instrument.

The fourth result is related with so-called original sin problem of EEs. EEs that have considerable amount of foreign currency denominated debt are infamous for having low debt limit relative to advanced economies. Our study once again confirms this notorious feature of EEs by documenting that when the share of foreign currency denominated public debt is rather low, both *DL* and *FSDL* rise considerably. This mainly stems from the fact that the external shocks lead the domestic currency to depreciate. Nonetheless, in the absence of the external shocks -that is at the steady state- still there is a loss of room for maneuver. The main underlying reason is the close link between foreign currency public debt and the sovereign default risk.

Fifth, when the transmission of the sovereign risk to the rest of the economy is considerably limited, *FSDL* rises. The underlying reason is that the rising debt as percent of output after the fiscal stimulus increases the sovereign risk but falls short of affecting the rest of the economy. Thus, neglecting possible spillover channels of the sovereign risk to the economy can lead to overestimation of the room for maneuver for policymakers.

Sixth, abstracting from the price rigidities or decreasing the investment rigidity lead even a larger gap between *DL* and *FSDL* for the two expenditure instruments. For the tax instruments, the gap is still large. Thus, the main factors effective on our results are the rigidities stemming from the sovereign risk and its spillover channels to the rest of the economy rather than the price rigidity.

Seventh, delaying tax rise to set the stage for fiscal stimulus measures to be more effective on mitigating recessionary forces is fruitless. The underlying reason is that such a policy increases default risk by postponing the necessary measure to prevent the occurrence of explosive debt dynamics.

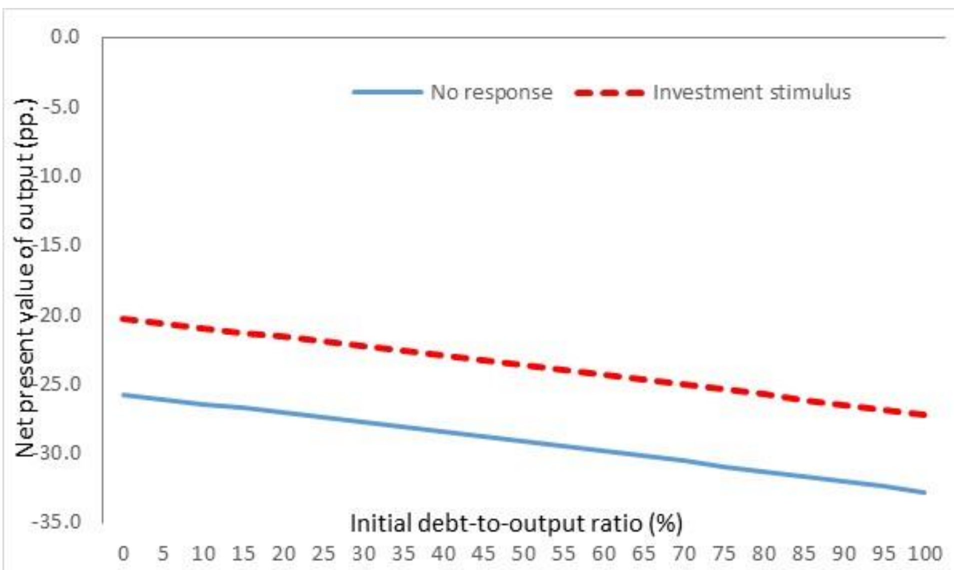

Fig. 4. Government bonds are default free. Net present value of output in percentage points (pp.) for the first 20 quarters.

To clarify further the relative importance of the sovereign default risk, consider an extreme case. Let the government bonds be default free. Fig. 4 depicts the net present value of output changes for the first 20 quarters, for each initial debt-to-output ratio, both when government investment fiscal stimulus measure is taken and not taken. *FSDL* ceases to exist. This brings us to the eighth result. Our *FSDL* concept rests on the importance of the mutual relation between the sovereign default risk and the public debt ratio. If this link does not exist at all, then the debt limit becomes the binding constraint. After the global financial crisis alternative financing mechanisms of public debt to expand fiscal space has intensified. One of the proposals is to issue GDP-linked bonds, which are free of sovereign default risk.[31] Thus, if all the public debt is in the form of GDP-linked bonds, which is not a reasonable case at least for a foreseeable future, the fiscal stimulus debt limit concept will not be operative.

IX Conclusion

The debt limit is defined as the public debt-to-GDP ratio beyond which fiscal solvency is in doubt and thus financial markets stop lending to a sovereign. How far the current level of debt is from this limit, that is how large the fiscal space is, provides important information for the policymakers. However, when a country faces a recessionary shock, this information ceases to be useful regarding up to which point in the fiscal space policymakers can take fiscal stimulus measures. We argue that there is a threshold debt-to-GDP ratio beyond which fiscal stimulus leads to output losses as opposed to a no fiscal response case. We name this level as the fiscal stimulus debt limit.

We apply this concept in a dynamic general equilibrium model. Various fiscal instruments, different currency compositions of debt, and various transmission channels of the sovereign risk to the economy are analyzed. We show that the fiscal stimulus debt limit is significantly lower than the debt limit and the gap between them varies depending upon the composition of the fiscal stimulus, the currency composition of the public debt, and the spillover channels at work. This means that in some cases while the conventionally estimated debt limit can give the impression that a country is far from losing access to the financial markets, in fact it may have no fiscal stimulus space to act and make use of the fiscal space conventionally estimated.

[31] See, for example, Barr et al. (2014) and Kim and Ostry (2018).

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Mind the Gap: Debt Limit and Fiscal Stimulus Debt Limit

Online Appendix

A. Equilibrium Conditions

Households

(A1) $$C_t^H = (1-\alpha_{mc})(P_t^H/P_t)^{-\rho_c}C_t$$

(A2) $$C_t^F = \alpha_{mc}(P_t^F/P_t)^{-\rho_c}C_t$$

(A3) $$\lambda_t(1+\tau_t^C) = \emptyset_C C_t^{-1/v_{pg}}/\widehat{C}_t$$

(A4) $$\lambda_t = \beta E_t(\lambda_{t+1}R_t^D/\pi_{t+1})$$

(A5) $$\lambda_t(1-\tau_t^W)W_t/P_t = \sigma_H H_t^{\varrho}$$

(A6) $$\widehat{C}_t = \emptyset_C C_t^{(v_{pg}-1)/v_{pg}} + (1-\emptyset_C)G_{C,t}^{(v_{pg}-1)/v_{pg}}$$

Capital Producers

(A7) $$I_t^H = (1-\alpha_{mI})(P_t^H/P_t^I)^{-\rho_I}I_t$$

(A8) $$I_t^F = \alpha_{mI}(P_t^F/P_t^I)^{-\rho_I}I_t$$

(A9) $$K_{t+1} = (1-\delta)K_t + \left\{1-\left(\frac{\chi}{2}\right)\left[\left(\frac{I_t}{I_{t-1}}\right)-1\right]^2\right\}I_t$$

(A10) $$\frac{P_t^I}{P_tQ_t} = 1-\frac{\chi}{2}\left(\frac{I_t}{I_{t-1}}-1\right)^2 - \chi\left(\frac{I_t}{I_{t-1}}-1\right)\frac{I_t}{I_{t-1}} + \beta E_t\left[\frac{\lambda_{t+1}Q_{t+1}}{\lambda_tQ_t}\right]\chi\left(\frac{I_{t+1}}{I_t}-1\right)\left(\frac{I_{t+1}}{I_t}\right)^2$$

Entrepreneurs

(A11) $$L_{t+1} + N_{t+1} = P_tQ_tK_{t+1}$$

(A12) $$L_{t+1}^{DC} = (1-\alpha_{FC})L_{t+1}$$

(A13) $$S_tL_{t+1}^{FC} = \alpha_{FC}L_{t+1}$$

(A14) $$E_t\{[\varGamma_t(\overline{\omega}_{t+1}) - \mu\varLambda_t(\overline{\omega}_{t+1})]R_{t+1}^KP_tQ_tK_{t+1}\} = R_t^CL_{t+1}$$

(A15) $$E_t\left\{[1-\varGamma_t(\overline{\omega}_{t+1})]\frac{R_{t+1}^K}{R_t^C} + \frac{\varGamma_t'(\overline{\omega}_{t+1})}{\varGamma_t'(\overline{\omega}_{t+1})-\mu\varLambda_t'(\overline{\omega}_{t+1})}\left[\left(\varGamma_t(\overline{\omega}_{t+1}) - \mu\varLambda_t(\overline{\omega}_{t+1})\right)\frac{R_{t+1}^K}{R_t^C}-1\right]\right\} = 0$$

(A16) $$R_t^CL_{t+1} = R_t^{C,DC}L_{t+1}^{DC} + R_t^{C,FC}S_{t+1}L_{t+1}^{FC}$$

(A17) $$\mu\varLambda(\overline{\omega}) = \mu\int_0^{\overline{\omega}}\omega f(\omega)d\omega;\ f(\omega) \text{ is the pdf of } \omega$$

(A18) $$\mu\varLambda'(\overline{\omega}) = \mu\overline{\omega}f(\overline{\omega})$$

(A19) $$\varGamma(\overline{\omega}) = \int_0^{\overline{\omega}}\omega f(\omega)d\omega + \overline{\omega}\int_{\overline{\omega}}^{\infty}f(\omega)d\omega$$

(A20) $\varGamma'(\overline{\omega}) = 1-F(\overline{\omega})$; $F(x) = Pr[\omega < x]$ is a continuous probability distribution; $F(0) = 0$

(A21) $$N_{t+1} = (1 - v_t)V_t + (1 - \tau_t^w)W_t^e$$

(A22) $$V_t = R_t^K P_{t-1} Q_{t-1} K_t - R_{t-1}^C L_t - \mu \Lambda_{t-1}(\overline{\omega}_t) R_t^K P_{t-1} Q_{t-1} K_t$$

(A23) $$\sigma_t = \sigma * exp[a_\sigma(E_t pr_{t+1} - pr)]$$

(A24) $$v_t = v * exp[a_v(E_t pr_{t+1} - pr)]$$

(A25) $$(1 + \tau_t^C) C_t^e = v_t V_t / P_t$$

(A26) $$C_t^{e,H} = (1 - \alpha_{mc})(P_t^H / P_t)^{-\rho_c} C_t^e$$

(A27) $$C_t^{e,F} = \alpha_{mc}(P_t^F / P_t)^{-\rho_c} C_t^e$$

(A28) $$Y_t^H = \omega_t A_t K_{G,t}^{\varphi_G} K_t^\alpha [(H_t)^\Omega (H_t^e)^{1-\Omega}]^{1-\alpha}$$

(A29) $$H_t^e = 1$$

(A30) $$E_t R_{t+1}^K = E_t \left\{ \pi_{t+1} \left[\frac{P_{t+1}^W}{P_{t+1}} \alpha \frac{Y_{t+1}^H}{K_{t+1}} + Q_{t+1} - \frac{P_{t+1}^I}{P_{t+1}} \delta \right] / Q_t \right\}$$

(A31) $$\frac{W_t^e}{P_t} = \frac{P_t^W}{P_t} (1 - \alpha)(1 - \Omega) \frac{Y_t^H}{H_t^e}$$

(A32) $$\frac{W_t}{P_t} = \frac{P_t^W}{P_t} (1 - \alpha) \Omega \frac{Y_t^H}{H_t}$$

Retailers and Price Equations

(A33) $$\frac{P_t^H}{P_{t-1}^H} = \left(\mu^H \frac{P_t^W}{P_t^H} \right)^{\zeta^H} E_t \left(\frac{P_{t+1}^H}{P_t^H} \right)^\beta ; \zeta^H = \frac{(1-\theta^H)(1-\beta\theta^H)}{\theta^H}$$

(A34) $$\frac{P_t^F}{P_{t-1}^F} = \left(\mu^F \frac{P_t^{W,F}}{P_t^F} \right)^{\zeta^F} E_t \left(\frac{P_{t+1}^F}{P_t^F} \right)^\beta ; \zeta^F = \frac{(1-\theta^F)(1-\beta\theta^F)}{\theta^F}$$

(A35) $$P_t = [(1 - \alpha_{mc})(P_t^H)^{1-\rho_c} + \alpha_{mc}(P_t^F)^{1-\rho_c}]^{\frac{1}{1-\rho_c}}$$

(A36) $$P_t^I = [(1 - \alpha_{mI})(P_t^H)^{1-\rho_I} + \alpha_{mI}(P_t^F)^{1-\rho_I}]^{\frac{1}{1-\rho_I}}$$

(A37) $$\pi_{t+1} = P_{t+1} / P_t$$

Banks

(A38) $$R_t^C = E_t\left(R_t^{B,FC} S_{t+1} / S_t\right)$$

(A39) $$R_t^D = R_t^{CB}$$

(A40) $$R_t^C = R_t^D$$

(A41) $$R_t^{C,DC} = R_t^D$$

(A42) $$R_t^{C,FC} = R_t^{B,FC}$$

Foreign Creditors

(A43) $$R_t^*(1 + s_t^{pr}) = E_t\left[(1 - pr_{t+1}) R_t^{G,FC} + pr_{t+1}(1 - d_{hc}) R_t^{G,FC}\right]$$

(A44) $$R_t^*(1 + s_t^{pr}) = E_t \left[(1 - pr_{t+1}) R_t^{G,DC} \frac{S_t}{S_{t+1}} + pr_{t+1}(1 - d_{hc}) R_t^{G,DC} \frac{S_t}{S_{t+1}} \right]$$

(A45) $$R_t^{B,FC} = crp_t\left(R_t^{G,FC}\right)^{\psi}\left(R_t^*(1+s_t^{pr})\right)^{1-\psi} = crp_t\, R_t^*(1+s_t^{pr})E_t\left(\frac{1}{1-pr_{t+1}d_{hc}}\right)^{\psi}$$

(A46) $$crp_t = exp\left[\emptyset_{crp}SB_{t+1}^{B,FC}/PY\right]$$

(A47) $$P_t^{W,F} = S_t P_t^*$$

(A48) $$X_t = \left[\frac{P_t^H}{S_t P_t^*}\right]^{-\rho_X} Y_t^*$$

Fiscal Policy

(A49) $$K_{G,t+1} = G_{I,t} + (1-\delta)K_{G,t}$$

(A50) $$T_t^G = T_L^G + \tau_t^W(W_t H_t + W_t^e H_t^e) + \tau_t^C P_t(C_t + C_t^e)$$

(A51) $$T_L^G = [G_C + G_I + (R^G - 1)B^G] - [\tau^W(WH + W^e H^e) + \tau^C(C + C^e)]$$

(A52) $$G_{j,t} - G_j = \rho_{Gj}\left(G_{j,t-1} - G_j\right) + \varepsilon_t^{Gj}; j = C, I$$

(A53) $$\tau_t^j = \tau^j + \frac{T1_t + T2_t}{W_t H_t + W_t^e H_t^e + P_t(C_t + C_t^e)}; j = c, w$$

(A54) $$T1_t = \psi_{T1}\left(\frac{B_{t+1}^G}{P_t Y_t} - \frac{B^G}{Y}\right)$$

(A55) $$T2_t = \rho_\tau T2_{t-1} - \varepsilon_t^{T2}$$

(A56) $$B_{t+1}^G = R_{t-1}^G B_t^G + P_t^H G_{C,t} + P_t^I G_{I,t} - T_t^G$$

(A57) $$B_{t+1}^{G,DC} = \left(1 - \alpha_{G,FC}\right)B_{t+1}^G$$

(A58) $$S_t B_{t+1}^{G,FC} = \alpha_{G,FC} B_{t+1}^G$$

(A59) $$P_t^I G_{I,t} = P_t^H G_{I,t}^H + P_t^F G_{I,t}^F$$

(A60) $$G_{I,t}^H = (1 - \alpha_{mI})(P_t^H/P_t^I)^{-\rho_I} G_{I,t}$$

(A61) $$G_{I,t}^F = \alpha_{mI}(P_t^F/P_t^I)^{-\rho_I} G_{I,t}$$

(A62) $$E_t pr_{t+1} = F_{beta}\left(\frac{(B_{t+1}^{G,DC} + \xi_{FC} S_t B_{t+1}^{G,FC})/(P_t Y_t)}{b_{max}^G};\ \alpha_{B^G}, \beta_{B^G}\right)$$

(A63) $$PS_t = \left(T_t^G - P_t^H G_{Ct} - P_t^I G_{I,t}\right)$$

(A64) $$PS_{DS,t} = \left(R_{t-1}^G - \frac{P_t Y_t}{P_{t-1} Y_{t-1}}\right) B_t^G$$

(A65) $$R_{t-1}^G = \left(1 - \alpha_{G,FC}\right)R_{t-1}^{G,DC} + \alpha_{G,FC}(S_t/S_{t-1})R_{t-1}^{G,FC}$$

Monetary Policy

(A66) $$R_t^{CB}/R^{CB} = \left(R_{t-1}^{CB}/R^{CB}\right)^{\rho_{CB}}\left[(\pi_t/\pi)^{\rho_\pi}(Y_t/Y)^{\rho_Y}(S_t/S_{t-1})^{\rho_S}\right]^{1-\rho_{CB}}$$

Market clearing and equilibrium

(A67) $$Y_t^H = C_t^H + C_t^{e,H} + I_t^H + G_{C,t} + G_{I,t}^H + X_t + fc^H + \mu\Lambda_{t-1}(\overline{\omega}_t)R_t^K Q_{t-1}P_{t-1}K_t/P_t$$

(A68) $$fc^H = (C^H + C^{e,H} + I^H + G_C + G_I^H + X + \mu\Lambda(\bar{\omega})R^K QK/P)(\mu^H - 1)$$

(A69) $$Y_t = Y_t^H - fc^H$$

(A70) $$M_t = \left(C_t^F + C_t^{e,F} + I_t^F + G_{I,t}^F\right) + (\mu^F - 1)(C^F + C^{e,F} + I^F + G_I^F)$$

(A71) $$S_t B_{t+1}^{B,FC} = R_{t-1}^{B,FC} S_t B_t^{B,FC} + (S_t P_t^* M_t - P_t^H X_t) + \left(T_t^G - P_t^H G_{Ct} - P_t^I G_{I,t}\right) - T^{fr}$$

(A72) $$T^{fr} = (R^{B,FC} - 1)B^{FC} + (R^{G,DC} - 1)B^{G,DC} + (R^{G,FC} - 1)B^{G,FC}$$

(A73) $$D_{t+1} = L_{t+1} - S_t B_{t+1}^{B,FC}$$

Shocks

(A74) $$R_t^* - R^* = \rho_{R^*}(R_{t-1}^* - R^*) + \varepsilon_t^{R^*}$$

(A75) $$s_t^{pr} - s^{pr} = \rho_{spr}\left(s_{t-1}^{pr} - s^{pr}\right) + \varepsilon_t^{spr}$$

B. Steady State Equations

Households

(B1) $$C^H = (1 - \alpha_{mc})C$$

(B2) $$C^F = \alpha_{mc} C$$

(B3) $$\lambda(1 + \tau^C) = \emptyset_C C^{-\frac{1}{v_{pg}}} / (\emptyset_C C^{\frac{v_{pg}-1}{v_{pg}}} + (1 - \emptyset_C) G_C^{\frac{v_{pg}-1}{v_{pg}}})$$

(B4) $$1/\beta = R^D$$

(B5) $$(1 - \tau^W)W/P = \sigma_H H^{\varrho}$$

Capital Producers

(B6) $$I^H = (1 - \alpha_{mI})I$$

(B7) $$I^F = \alpha_{mI} I$$

(B8) $$\delta K = I$$

(B9) $$Q = 1$$

Entrepreneurs

(B10) $$L + N = K$$

(B11) $$L^{DC} = (1 - \alpha_{FC})L$$

(B12) $$L^{FC} = \alpha_{FC} L$$

(B13) $$[\Gamma(\bar{\omega}) - \mu\Lambda(\bar{\omega})]R^K K = R^C L$$

(B14) $$[1 - \Gamma(\bar{\omega})]R^K/R^C + \frac{\Gamma'(\bar{\omega})}{\Gamma'(\bar{\omega}) - \mu\Lambda'(\bar{\omega})}([\Gamma(\bar{\omega}) - \mu\Lambda(\bar{\omega})]R^K/R^C - 1) = 0$$

(B15) $$R^C L = R^{C,DC} L^{DC} + R^{C,FC} L^{FC}$$

(B16) $\mu\Lambda(\bar{\omega}) = \mu\int_0^{\bar{\omega}} \omega f(\omega) d\omega$; $f(\omega)$ is the pdf of ω

(B17) $$\mu\Lambda'(\bar{\omega}) = \mu\bar{\omega}f(\bar{\omega})$$

(B18) $$\Gamma(\bar{\omega}) = \int_0^{\bar{\omega}} \omega f(\omega) d\omega + \bar{\omega}\int_{\bar{\omega}}^{\infty} f(\omega) d\omega$$

(B19) $\Gamma'(\bar{\omega}) = 1 - F(\bar{\omega})$; $F(x) = Pr[\omega < x]$ is a continuous probability distribution; $F(0) = 0$

(B20) $$N = (1 - v)V + W^e(1 - \tau^W)$$

(B21) $$V = R^K K - R^C L - \mu\Lambda(\bar{\omega})R^K K$$

(B22) $$(1 + \tau^C)C^e = vV$$

(B23) $$C^{e,H} = (1 - \alpha_{mc})C^e$$

(B24) $$C^{e,F} = \alpha_{mc}C^e$$

(B25) $$Y^H = K^\alpha H^{\Omega(1-\alpha)}$$

(B26) $$AK_G^{\varphi_G} = 1$$

(B27) $$H^e = 1$$

(B28) $$R^K = \frac{\alpha Y^H}{\mu^H K} + 1 - \delta$$

(B29) $$W^e = (1 - \alpha)(1 - \Omega)\frac{Y^H}{\mu^H}$$

(B30) $$W = (1 - \alpha)\Omega\frac{Y^H}{H}$$

Retailers and Price Equations

(B31) $$P^H = 1$$

(B32) $$P^F = 1$$

(B33) $$P = 1$$

(B34) $$P^I = 1$$

(B35) $$\pi = 1$$

Banks

(B36) $$R^C = R^{B,FC}$$

(B37) $$R^D = R^{CB}$$

(B38) $$R^C = R^D$$

(B39) $$R^{C,DC} = R^C = R^D$$

(B40) $$R^{C,FC} = R^{B,FC}$$

Foreign Creditors

(B41) $$R^* = (1 - pr * d_{hc})R^{G,FC}$$

(B42) $$R^* = (1 - pr * d_{hc})R^{G,DC}$$

(B43) $$R^{B,FC} = crp * (R^{G,FC})^{\psi}(R^*)^{(1-\psi)}$$

(B44) $$crp = exp\left[\emptyset_{crp}B^{B,FC}/Y\right]$$

(B45) $$P^{W,F} = 1/\mu^F$$

(B46) $$X = [1/\mu^F]^{-\rho_X}Y^*$$

Fiscal Policy

(B47) $$B^G = R^G B^G + G_C + G_I - T^G$$

(B48) $$G_I^H = (1-\alpha_{mI})G_I$$

(B49) $$G_I^F = \alpha_{mI}G_I$$

(B50) $$R^G = R^{G,DC}\left(1-\alpha_{G,FC}\right) + R^{G,FC}\alpha_{G,FC}$$

(B51) $$B^{G,DC} = \left(1-\alpha_{G,FC}\right)B^G$$

(B52) $$B^{G,FC} = \alpha_{G,FC}B^G$$

(B53) $$T_L^G = [G_C + G_I + (R^G - 1)B^G] - [\tau^w(WH + W^e H^e) + \tau^C(C + C^e)]$$

(B54) $$T^G = [G_C + G_I + (R^G - 1)B^G]$$

(B55) $$T1 = 0$$

(B56) $$T2 = 0$$

(B57) $$\delta K_G = G_I$$

(B58) $$PS = T^G - (G_C + G_I)$$

(B59) $$PS_{DS} = (R^G - 1)B^G$$

(B60) $$pr = F_{beta}\left(\frac{(B^{G,DC} + \xi_{FC}B^{G,FC})/Y}{b_{max}^G};\ \alpha_{B^G}, \beta_{B^G}\right)$$

Market clearing and equilibrium

(B61) $$Y^H = C^H + C^{e,H} + I^H + G_C + G_I + X + \mu\Lambda(\overline{\omega})R^K K + f_c^H$$

(B62) $$f_c^H = (C^H + C^{e,H} + I^H + G_C + G_I + X + \mu\Lambda(\overline{\omega})R^K K)(\mu^H - 1)$$

(B63) $$Y = Y^H - f_c^H$$

(B64) $$M = \mu^F(C^F + C^{e,F} + I^F + G_I^F)$$

(B65) $$B^{B,FC} = R^{B,FC}B^{B,FC} + (M/\mu^F - X) + (T^G - G_C + G_I) - T^{fr}$$

(B66) $$D = L - B^{B,FC}$$

where, α_{mc}, τ, β, Y^*, b are find from the steady state solution of the model and $S = 1; P^* = 1$

C. Algorithm for Finding Steady State Values

(C1) The model is solved for different initial values of government debt-to-output ratio and its foreign currency share. Thus B^G/Y and $\alpha_{G,FC}$ as well as $B^{G,DC}/Y$ and $B^{G,FC}/Y$ are given (S =1).

(C2) One obtains pr from (B60).

(C3) Taking $R^* = 1.0025$ (quarterly), (B41-B42) yields $R^{G,FC}$ and $R^{G,DC}$. (B50) gives R^G.

(C4) Since $B^{B,FC}/Y$ is calibrated one obtains $R^{B,FC}$ from (B43-B44).

(C5) This yields R^C, $R^{C,DC}$, and $R^{C,FC}$ (B36, B39-B40) and also R^D and R^{CB} (B38, B37).

(C6) One obtains β from (B4).

(C7) Numerical derivation of the optimal cut-off value $\overline{\omega}$:

a. Derive R^K/R^C from (B14), which is a function of $\overline{\omega}$.

b. Divide both sides of (B10) and (B13) by N and find K/N as a function of R^K/R^C and $\overline{\omega}$, thus only a function of $\overline{\omega}$. Name this as $(K/N)_1$.

c. Divide both sides of (B20) by K and derive K/N as a function of V/K and W^e/K. Call this as $(K/N)_2$.

d. Divide both sides of (B29) by K and find W^e/K as a function of Y^H/K. Use (B28) to derive Y^H/K as a function of R^K. Substitute these in $(K/N)_2$. Thus now one has $(K/N)_2$ as a function of V/K and R^K. We have to derive V/K as a function of R^K.

e. Use (B13) in (B21) which gives V/K as a function of R^K/R^C as well as a function of R^K since we know R^C. Use this in $(K/N)_2$.

f. So far we obtained two equations for K/N only a function of $\overline{\omega}$.

g. Use an initial value for $\overline{\omega}$ to initiate an iterative process that ends when $(K/N)_1 = (K/N)_2$. This yields the optimal value for $\overline{\omega}$.

(C8) Using $\overline{\omega}$ in (B16, B17, B18, and B19) yields $\Lambda(\overline{\omega})$, $\Lambda'(\overline{\omega})$, $\Gamma(\overline{\omega})$, and $\Gamma'(\overline{\omega})$.

(C9) R^K/R^C and thus R^K are derived from (B14). Using this in step b of (C7) yields K/N.

(C10) One now has Y^H/K from (B28).

(C11) One now has monitoring cost divided by Y^H : $\mu\Lambda(\overline{\omega})R^K K/Y^H$.

(C12) I/Y^H is obtained from (B8), which gives I^H/Y^H and I^F/Y^H from (B6, B7)

(C13) $N/K * K/Y^H$ gives N/Y^H.

(C14) Equations (B10, B11, and B12) yields L/Y^H, L^{DC}/Y^H, and L^{FC}/Y^H.

(C15) Obtain W^e/Y^H from (B29).

(C16) Use step (C11), $/Y^H$, L/Y^H, R^K, and R^C in (B21) for V/Y^H.

(C17) Find D/Y^H from (B66).

(C18) Foreign trade is balanced at the steady state: $M/\mu^F = X$. Since X/Y is given one obtains M/Y.

(C19) H =1/3. Step (C10) provides one equation for Y^H/K. The second one is (B25). These two equations give Y^H and K.

(C20) Use these values in steps given above to obtain the monitoring cost, $I^H, I, I^F, N, L, L^{DC}, L^{FC}, W^e, V, W^e, D, M, X$.

(C21) Derive C^e from (B22).

(C22) Add (B61, B62) and (B64). This will yield $C + C^e$ and since C^e is known, one obtains C.

(C23) Use (B2) for C^F and (B24) for $C^{e,F}$ in imports equation (B64) to obtain α_{mc}. Using this value in (B1) gives C^H and in (B2) yields C^F. Similarly (B23) gives $C^{e,H}$and (B24) $C^{e,F}$.

(C24) Find W from (B30).

(C25) Since X is known, Y^* is derived from (B46).

(C26) Obtain Y from (B63).

(C27) Since G_C/Y and G_I/Y are given obtain G_C and G_I. (B48) and (B49) give $G_I^H$and G_I^F. Find K_G from (B57). Use (B26) to derive A.

(C28) Using initial values for various debt ratios derive $B^{B,FC}, B^{G,DC}, B^{G,FC}, B^G$.

(C29) Find T_L^G from (B53) and T^G from (B54). Use this value in (B58) to obtain PS. Find PS_{DS} from (B59).

(C30) Find T^{fr} from (B65).

(C31) Using W in (B5), find σ_H. Derive λ from (B3).

D. Probability of Default, Spread, and Debt-to-GDP Ratio

Data used for drawing Panel A of Fig. 1 is given in Table A1, whereas Panel B of Fig. 1 is based on the data of Panel A and also the EMBI data as of September 2, 1998 -when the founder of the Long-Term Capital Management (LTCM) announced that LTCM lost 52% of its value following the Russian debt moratorium - and end-1999 debt data. Table A2 provides the data for this second episode. Table A3 shows results of some simple cross section regression to show the relation between sovereign spreads as measured by JP Morgan’s EMBI+ and debt-to-output ratio.

E. GDP and its Components, Tax Rates, Share of Imported Investment Goods, Government and Banking Sector Debt

The Turkish Statistics Institute revised GDP data at the beginning of 2017 and has since then announced GDP data based on the new series. The revision significantly changed the debt-to-GDP ratios of the past.

In order to calculate the sample moments of the data we used the data known at the time and therefore the last observation of our sample is the second quarter of 2016. The first quarter of our sample marks the start of the floating exchange rate regime. Relevant data are provided in the following tables.

Table A4: Source: Turkey Data Monitor. Original source: Turkish Statistical Institute.

Table A5: Source: Turkey Data Monitor. Original source: Turkish Statistical Institute.

Table A6: Source: Turkey Data Monitor. Original source: Ministry of Treasury and Finance and Turkish Statistical Institute.

Table A7: Source:

EMBI: Bloomberg.

Nominal US 3-month Treasury bill rate: Federal Reserve Bank of St. Louis (FRED) database; code: TB3MS. Quarterly average, not seasonally adjusted. It is converted to gross nominal rate. Annual consumer price inflation: FRED database; code: CPALTT01USQ659N. It is converted to gross inflation rate. Gross nominal interest rate divided by the gross inflation rate gives the real US 3-month bill rate (annual). This annual rate then converted to the quarterly real rate.

Government foreign currency borrowing rate: As in Uribe and Yue (2006) and Fernandez and Gulan (2015) it is obtained as the product between EMBI spread for Turkey and the 3-month real US Treasury bill rate.

Tables A8 and A9: Source: Turkey Data Monitor. Original source: Ministry of Treasury and Finance and Turkish Statistical Institute.

Table A1. Data of Figure 1 (Panel A)

	B^G/Y (%) End 2002	$\alpha_{G,FC}$ (%) End 2002	Source	EMBI December 24, 2001
Argentina	164.2	71.1	July 2005 AIV, T11, IMF CRP No 05/236	5501
Brazil	79.3	31.1	March 24, 2003 IMF PIN; debt-to-GDP: WEO April 2014	907
Bulgaria	61.3	88.3	June 2004 AIV, T9, IMF CRP No 04/176	439
Chile	15.7	70.7	September 2004 AIV, T1, IMF CRP No 04/291	174
Colombia	60.2	53	May 2005 AIV, T1, IMF CRP No 05/154	500
Ecuador	59.6	77.4	April 2003 AIV, T1, IMF CRP No 03/90	1232
Egypt	65.9	28.4	June 2005 AIV, T1, IMF CRP No 05/177; debt: net debt	353
Hungary	57.1	23.6	May 2004 AIV, T5, IMF CRP No 04/145	50
Korea	33.5	12.2	February 2005 AIV, T7, IMF CRP No 05/49	118
Mexico	49.7	34	December 2004 AIV; Annex IV T1&T2, IMF CRP No 04/149	306
Morocco	71.5	32.6	June 2004 AIV, T1 IMF CRP No 04/162	542
Panama	69.4	52	January 2006 AIV, T8, IMF CRP No 06/7	413
Peru	47.1	78.1	May 2004 AIV, T3, IMF CRP No 04/155	521
Philippines	63.3	65.8	March 2005 AIV, T2 and Annex 1 TA1, , IMF CRP No 05/105; debt-to-GDP: WEO April 2004	465
Poland	45.1	41.5	July 2004 AIV, T10, IMF CRP No 04/271	188
Russia	35.6	91.9	May 2003 AIV, T8, IMF CRP No 03/144	685
South Africa	38.9	20.1	June 2004 AIV, T3, IMF CRP No 04/178	315
Thailand	57.1	40.1	December 1, 2004 IMF PIN	129
Turkey	74	40.7	May 2005 AIV, Appendix T2, IMF CRP 05/163; debt-to-GDP: WEO April 2004	692

Notes: B^G/Y is public debt-to-GDP ratio, $\alpha_{G,FC}$ is foreign currency share of public debt. 'AIV' stands for Article IV, 'Txx' denotes Table xx, IMF is the International Monetary Fund, 'CRP' denotes Country Report, 'PIN' is Public Information Notice, 'WEO' stands for World Economic Outlook database. Source of EMBI is Bloomberg; it is EMBI+.

Table A2. Data of Figure 1 (Panel B)

	B^G/Y (%) End 1999	$\alpha_{G,FC}$ (%) End 1999	Source	EMBI September 2, 1998
Argentina	47.3	63.4	December 2000 AIV, T13, IMF CRP No 00/164	1064
Brazil	53	36.4	Public debt and its determinants in market access countries, World Bank Report, March 2005	1309
Bulgaria	86.7	78.8	June 2004 AIV, T1, IMF CRP No 04/176	1408
Colombia	38.2	62.3	April 2001 AIV, T9, IMF CRP No 01/04	793
Ecuador	101.6	81.5	April 2003 AIV, T1, IMF CRP No 03/90	1910
Korea	35.6	20.5	March 2003 AIV, T6, IMF CRP No 03/79	882
Mexico	50.9	37.7	October 2001 AIV, T5, IMF CRP No 01/190	841
Morocco	81.3	43.9	July 2004 AIV, T1, IMF CRP No 04/162	1167
Panama	72.8	80.1	February 2001 AIV, T3, IMF CRP No 01/39	645
Peru	40.8	94.9	March 2001 AIV, T8, IMF CRP No 01/48	926
Philippines	87.4	52.3	Public debt and its determinants in market access countries, World Bank Report, March 2005	895
Poland	44.5	46.5	April 2001 AIV, T1, IMF CRP No 01/56	336
Russia	94.3	87.0	April 2002 AIV, p.29, IMF CRP No 02/74	3989
South Africa	46.5	6.7	January 2003 AIV, T1, IMF CRP No 03/17	596
Thailand	56.6	52.1	August 29, 2002 IMF PIN	804
Turkey	61	33.0	July 2002 AIV, T1, IMF CRP No 02/1137	774

Notes: B^G/Y is public debt-to-GDP ratio, $\alpha_{G,FC}$ is foreign currency share of public debt. 'AIV' stands for Article IV, 'Txx' denotes Table xx, IMF is the International Monetary Fund, 'CRP' denotes Country Report, 'PIN' is Public Information Notice. Source of EMBI is Bloomberg; it is EMBI+.

Table A3 EMBI-Debt regressions

	I	II	III	IV	V	VI
$B^{G,DC}/Y$	-5.1 (0.5)					
$(B^{G,DC}/Y)^2$	0.27 (1.2)	0.14 (3.1)	0.22 (3.3)			0.15 (3.2)
$B^{G,FC}/Y$	-1.1 (0.2)					
$(B^{G,FC}/Y)^2$	0.38 (7.6)	0.37 (19.0)	0.37 (13.4)			0.36 (16.2)
$(B^{G,DC}/Y$+2*$B^{G,FC}/Y)^2$				0.07 (23.9)	0.07 (15.7)	
Current account balance / Y						15.58 (0.8)
$\bar{R}^2$	0.95	0.96	0.81	0.96	0.79	0.95
Number of observations	19	19	35	19	35	19

Notes: Dependent variable is EMBI+. $B^{G,DC}/Y$ is domestic currency public debt-to-GDP ratio, $B^{G,FC}/Y$ is foreign currency public debt-to-GDP ratio. Data for debt ratios and EMBI+ are provided in Tables A1 and A2. Values in parentheses are t-ratios. Colums III and IV are for the Argentinian and Russian default episodes, whereas the rest of the columns are for the Argentinian default episode.

Table A4. Share of imported capital goods in total investment (GDP and its components are seasonally adjusted)

	Imports A (10^6 \$)	Capital goods imports B (10^6 \$)	B/A (%)	Imports in GDP C	GDP D	C/D (%)	Investment in GDP E	E/D	α_{mI} (%) (B/A)*(C/D)/(E/D)
2002-03	10409	1378	13.2	3681	17583	20.9	3056	17.4	15.9
2002-06	12454	2082	16.7	3481	18001	19.3	3038	16.9	19.2
2002-09	13529	2129	15.7	3867	18273	21.2	3179	17.4	19.1
2002-12	15162	2811	18.5	4075	18663	21.8	3412	18.3	22.1
2003-03	14367	1827	12.7	4255	18853	22.6	3264	17.3	16.6
2003-06	16470	2672	16.2	4277	18624	23.0	3295	17.7	21.1
2003-09	18448	2913	15.8	4953	19237	25.7	3716	19.3	21.1
2003-12	20055	3914	19.5	5172	19624	26.4	4207	21.4	24.0
2004-03	20921	3609	17.2	5384	20403	26.4	4526	22.2	20.5
2004-06	24390	4551	18.7	5667	20770	27.3	4711	22.7	22.4
2004-09	25098	4350	17.3	5680	21081	26.9	4670	22.2	21.1
2004-12	27130	4888	18.0	5815	21231	27.4	4682	22.1	22.4
2005-03	25740	4033	15.7	5863	22198	26.4	5051	22.8	18.2
2005-06	29355	5248	17.9	6176	22278	27.7	5405	24.3	20.4
2005-09	30234	5220	17.3	6502	22717	28.6	5615	24.7	20.0
2005-12	31446	5863	18.6	6748	23307	29.0	5751	24.7	21.9
2006-03	29547	4884	16.5	6496	23419	27.7	5953	25.4	18.0
2006-06	36747	6069	16.5	6955	24321	28.6	6182	25.4	18.6
2006-09	36138	5960	16.5	6721	24340	27.6	6316	25.9	17.6
2006-12	37144	6434	17.3	6860	24659	27.8	6264	25.4	19.0
2007-03	35209	5133	14.6	6994	24879	28.1	6087	24.5	16.8
2007-06	42120	6558	15.6	7297	25106	29.1	6299	25.1	18.0
2007-09	44355	6977	15.7	7670	25365	30.2	6459	25.5	18.7
2007-12	48378	8386	17.3	7954	25905	30.7	6636	25.6	20.8
2008-03	49177	6981	14.2	7923	26258	30.2	6519	24.8	17.3
2008-06	56672	7332	12.9	7446	25795	28.9	6179	24.0	15.6
2008-09	57693	7437	12.9	7371	25694	28.7	5910	23.0	16.1
2008-12	38421	6270	16.3	5939	24175	24.6	5305	21.9	18.3
2009-03	28878	4363	15.1	5581	22820	24.5	4825	21.1	17.5
2009-06	33489	5190	15.5	5890	23920	24.6	4585	19.2	19.9
2009-09	38152	5716	15.0	6498	24990	26.0	4832	19.3	20.1
2009-12	40410	6194	15.3	6609	25273	26.2	5116	20.2	19.8
2010-03	38495	5426	14.1	6728	25412	26.5	5536	21.8	17.1
2010-06	44903	6485	14.4	7041	26212	26.9	5965	22.8	17.0
2010-09	47156	7022	14.9	7574	26523	28.6	6390	24.1	17.6
2010-12	54990	9885	18.0	8324	27739	30.0	7379	26.6	20.3
2011-03	56069	8207	14.6	8772	28440	30.8	7475	26.3	17.2
2011-06	63666	10623	16.7	8371	28599	29.3	7676	26.8	18.2
2011-09	61944	9111	14.7	8081	28951	27.9	7338	25.3	16.2
2011-12	59162	9329	15.8	7610	29185	26.1	7338	25.1	16.4
2012-03	55934	8265	14.8	8056	29088	27.7	7416	25.5	16.1
2012-06	61461	8591	14.0	8208	29439	27.9	7326	24.9	15.7
2012-09	59588	7950	13.3	8358	29493	28.3	7181	24.3	15.5
2012-12	59562	9119	15.3	8081	29605	27.3	7099	24.0	17.4
2013-03	58757	8316	14.2	8645	30052	28.8	7540	25.1	16.2
2013-06	67083	9656	14.4	9256	30753	30.1	7591	24.7	17.6
2013-09	61785	8950	14.5	8794	30804	28.5	7526	24.4	16.9
2013-12	64036	9849	15.4	8954	30947	28.9	7634	24.7	18.0
2014-03	57458	8266	14.4	8692	31442	27.6	7523	23.9	16.6
2014-06	62327	9483	15.2	8841	31429	28.1	7326	23.3	18.4
2014-09	60035	8589	14.3	8646	31511	27.4	7520	23.9	16.4
2014-12	62357	9657	15.5	9372	31875	29.4	7518	23.6	19.3
2015-03	52313	7807	14.9	8995	32210	27.9	7597	23.6	17.7
2015-06	54441	9856	18.1	8965	32677	27.4	8107	24.8	20.0
2015-09	49598	8340	16.8	8538	33004	25.9	7618	23.1	18.8
2015-12	50883	8902	17.5	9127	33382	27.3	7748	23.2	20.6
2016-03	46797	8345	17.8	9623	33601	28.6	7617	22.7	22.5
2016-06	52861	10224	19.3	9668	33702	28.7	8028	23.8	23.3

Table A5. Real GDP and some of its components (seasonally adjusted)

	Y	G_C	G_I	X	M	C	I	X/Y %	G_C/Y %	G_I/Y %	Trade Balance / Y %
2002-03	17583	2032	881	4127	3681	11753	2175	23.5	11.6	5.0	2.5
2002-06	18001	2063	700	4208	3481	12010	2338	23.4	11.5	3.9	4.0
2002-09	18273	2103	838	4359	3867	12352	2341	23.9	11.5	4.6	2.7
2002-12	18663	2085	684	4546	4075	12259	2728	24.4	11.2	3.7	2.5
2003-03	18853	1988	641	4517	4255	13171	2623	24.0	10.5	3.4	1.4
2003-06	18624	2034	651	4375	4277	12957	2644	23.5	10.9	3.5	0.5
2003-09	19237	2048	665	4763	4953	13334	3051	24.8	10.6	3.5	-1.0
2003-12	19624	1997	676	4767	5172	13833	3530	24.3	10.2	3.4	-2.1
2004-03	20403	2102	604	4841	5384	14600	3922	23.7	10.3	3.0	-2.7
2004-06	20770	2093	586	5171	5667	14989	4125	24.9	10.1	2.8	-2.4
2004-09	21081	2113	604	5161	5680	14877	4066	24.5	10.0	2.9	-2.5
2004-12	21231	2246	667	5306	5815	14678	4016	25.0	10.6	3.1	-2.4
2005-03	22198	2174	754	5369	5863	15477	4297	24.2	9.8	3.4	-2.2
2005-06	22278	2125	744	5430	6176	15672	4661	24.4	9.5	3.3	-3.3
2005-09	22717	2191	796	5606	6502	16118	4819	24.7	9.6	3.5	-3.9
2005-12	23307	2276	780	5690	6748	16520	4971	24.4	9.8	3.3	-4.5
2006-03	23419	2350	777	5681	6496	16464	5176	24.3	10.0	3.3	-3.5
2006-06	24321	2355	750	5785	6955	17046	5432	23.8	9.7	3.1	-4.8
2006-09	24340	2422	777	5927	6721	16518	5539	24.4	10.0	3.2	-3.3
2006-12	24659	2379	851	6171	6860	16722	5413	25.0	9.6	3.5	-2.8
2007-03	24879	2465	796	6228	6994	17102	5291	25.0	9.9	3.2	-3.1
2007-06	25106	2640	825	6312	7297	17433	5474	25.1	10.5	3.3	-3.9
2007-09	25365	2521	894	6301	7670	17662	5565	24.8	9.9	3.5	-5.4
2007-12	25905	2501	839	6433	7954	18225	5798	24.8	9.7	3.2	-5.9
2008-03	26258	2542	929	6749	7923	17905	5590	25.7	9.7	3.5	-4.5
2008-06	25795	2565	964	6590	7446	17676	5215	25.5	9.9	3.7	-3.3
2008-09	25694	2609	939	6430	7371	17649	4971	25.0	10.2	3.7	-3.7
2008-12	24175	2588	949	6199	5939	16969	4356	25.6	10.7	3.9	1.1
2009-03	22820	2755	949	6175	5581	16217	3876	27.1	12.1	4.2	2.6
2009-06	23920	2681	900	5990	5890	17436	3685	25.0	11.2	3.8	0.4
2009-09	24990	2790	930	6259	6498	17391	3901	25.0	11.2	3.7	-1.0
2009-12	25273	2880	976	6237	6609	17554	4140	24.7	11.4	3.9	-1.5
2010-03	25412	2757	1033	6098	6728	17474	4503	24.0	10.8	4.1	-2.5
2010-06	26212	2799	1087	6501	7041	18042	4878	24.8	10.7	4.1	-2.1
2010-09	26523	2787	1120	6225	7574	18504	5271	23.5	10.5	4.2	-5.1
2010-12	27739	2982	1179	6677	8324	19155	6199	24.1	10.8	4.3	-5.9
2011-03	28440	2926	1026	6741	8772	19650	6449	23.7	10.3	3.6	-7.1
2011-06	28599	2973	1100	6567	8371	19589	6576	23.0	10.4	3.8	-6.3
2011-09	28951	3023	1123	7076	8081	19785	6215	24.4	10.4	3.9	-3.5
2011-12	29185	2933	1071	7126	7610	19773	6266	24.4	10.0	3.7	-1.7
2012-03	29088	3034	1057	7545	8056	19617	6359	25.9	10.4	3.6	-1.8
2012-06	29439	3126	1192	8166	8208	19406	6134	27.7	10.6	4.0	-0.1
2012-09	29493	3224	1258	8112	8358	19722	5923	27.5	10.9	4.3	-0.8
2012-12	29605	3199	1261	8174	8081	19680	5838	27.6	10.8	4.3	0.3
2013-03	30052	3263	1512	7796	8645	20149	6028	25.9	10.9	5.0	-2.8
2013-06	30753	3367	1479	8073	9256	20559	6112	26.3	10.9	4.8	-3.8
2013-09	30804	3310	1440	7846	8794	20864	6086	25.5	10.7	4.7	-3.1
2013-12	30947	3461	1484	8215	8954	20875	6149	26.5	11.2	4.8	-2.4
2014-03	31442	3519	1428	8651	8692	20584	6095	27.5	11.2	4.5	-0.1
2014-06	31429	3431	1311	8674	8841	20665	6015	27.6	10.9	4.2	-0.5
2014-09	31511	3527	1323	8539	8646	21003	6197	27.1	11.2	4.2	-0.3
2014-12	31875	3556	1370	8442	9372	21375	6148	26.5	11.2	4.3	-2.9
2015-03	32210	3604	1417	8516	8995	21462	6179	26.4	11.2	4.4	-1.5
2015-06	32677	3654	1458	8482	8965	21687	6649	26.0	11.2	4.5	-1.5
2015-09	33004	3815	1463	8570	8538	22141	6155	26.0	11.6	4.4	0.1
2015-12	33382	3899	1511	8438	9127	22323	6237	25.3	11.7	4.5	-2.1
2016-03	33601	4085	1461	8629	9623	22876	6156	25.7	12.2	4.3	-3.0
2016-06	33702	4240	1500	8386	9668	22752	6528	24.9	12.6	4.5	-3.8

Table A6. Public debt and its currency composition (10^6 TL)

	Public debt	Domestic currency	Foreign currency	Nominal GDP	A/D	C/A
	A	B	C	D (last 4-quarter)	%	%
2002-03	183044			265269	69.0	
2002-06	198139			289131	68.5	
2002-09	225703			320062	70.5	
2002-12	236874			350476	67.6	
2003-03	255173	109665	145508	379055	67.3	57.0
2003-06	261117	124726	136391	405779	64.3	52.2
2003-09	262963	133391	129572	432316	60.8	49.3
2003-12	276367	143838	132529	454781	60.8	48.0
2004-03	286019	161447	124572	476243	60.1	43.6
2004-06	301382	169755	131627	501532	60.1	43.7
2004-09	310651	175150	135501	530710	58.5	43.6
2004-12	321218	183401	137817	559033	57.5	42.9
2005-03	323276	192462	130814	580617	55.7	40.5
2005-06	326859	196946	129914	603382	54.2	39.7
2005-09	327732	201064	126668	627264	52.2	38.6
2005-12	330214	205089	125124	648932	50.9	37.9
2006-03	333187	208742	124445	667918	49.9	37.3
2006-06	345539	210578	134961	697807	49.5	39.1
2006-09	348843	215043	133800	729530	47.8	38.4
2006-12	347209	216846	130363	758391	45.8	37.5
2007-03	356645	224614	132030	786269	45.4	37.0
2007-06	347777	226483	121294	805896	43.2	34.9
2007-09	344726	226945	117782	824858	41.8	34.2
2007-12	335726	229452	106274	843178	39.8	31.7
2008-03	344213	235875	108338	870833	39.5	31.5
2008-06	350245	240306	109939	906917	38.6	31.4
2008-09	348925	244427	104498	937053	37.2	29.9
2008-12	378279	250527	127752	950534	39.8	33.8
2009-03	401407	261980	139427	942855	42.6	34.7
2009-06	410472	280677	129795	932063	44.0	31.6
2009-09	424094	295732	128362	931381	45.5	30.3
2009-12	440706	311016	129690	952559	46.3	29.4
2010-03	452203	324350	127853	985659	45.9	28.3
2010-06	458234	328410	129824	1023084	44.8	28.3
2010-09	461354	334762	126592	1057369	43.6	27.4
2010-12	466894	345206	121687	1098799	42.5	26.1
2011-03	483029	351285	131743	1147678	42.1	27.3
2011-06	492451	357441	135010	1199074	41.1	27.4
2011-09	509116	361378	147739	1254251	40.6	29.0
2011-12	515144	363802	151342	1297713	39.7	29.4
2012-03	518510	374764	143746	1332992	38.9	27.7
2012-06	521259	376112	145147	1365761	38.2	27.8
2012-09	529327	384897	144430	1391630	38.0	27.3
2012-12	534114	388547	145567	1416798	37.7	27.3
2013-03	536361	390862	145499	1447427	37.1	27.1
2013-06	546556	394855	151702	1484394	36.8	27.8
2013-09	569609	404429	165180	1525201	37.3	29.0
2013-12	579954	405091	174864	1567289	37.0	30.2
2014-03	600733	407439	193294	1622684	37.0	32.2
2014-06	595102	410054	185048	1663369	35.8	31.1
2014-09	596265	407960	188305	1708395	34.9	31.6
2014-12	606106	413087	193018	1748168	34.7	31.8
2015-03	629790	420441	209350	1780802	35.4	33.2
2015-06	649697	429366	220331	1835372	35.4	33.9
2015-09	677097	435846	241251	1891940	35.8	35.6
2015-12	678112	439262	238850	1952638	34.7	35.2
2016-03	684874	445132	239742	2006641	34.1	35.0
2016-06	695140	451654	243486	2050190	33.9	35.0

Table A7. EMBI Turkey and real government borrowing rate

	EMBI Turkey average (bps)	EMBI Turkey A (gross quarterly)	Real US-3 month bill rate B (gross quarterly)	Real government borrowing rate A*B (gross quarterly)
1999-09	530.1	1.0130	1.0056	1.0187
1999-12	494.3	1.0121	1.0058	1.0181
2000-03	398.0	1.0098	1.0055	1.0153
2000-06	414.9	1.0102	1.0057	1.0160
2000-09	439.9	1.0108	1.0060	1.0169
2000-12	682.0	1.0166	1.0062	1.0229
2001-03	830.0	1.0201	1.0034	1.0236
2001-06	892.4	1.0216	1.0007	1.0223
2001-09	1006.8	1.0243	1.0012	1.0255
2001-12	826.6	1.0201	1.0001	1.0202
2002-03	655.3	1.0160	1.0012	1.0172
2002-06	662.3	1.0162	1.0010	1.0172
2002-09	955.2	1.0231	1.0001	1.0232
2002-12	784.8	1.0191	0.9979	1.0169
2003-03	756.0	1.0184	0.9958	1.0141
2003-06	773.1	1.0188	0.9973	1.0161
2003-09	614.2	1.0150	0.9969	1.0119
2003-12	383.1	1.0094	0.9976	1.0070
2004-03	325.5	1.0080	0.9979	1.0059
2004-06	430.2	1.0106	0.9956	1.0062
2004-09	362.9	1.0090	0.9970	1.0059
2004-12	301.8	1.0075	0.9968	1.0042
2005-03	267.2	1.0066	0.9988	1.0054
2005-06	313.3	1.0077	0.9998	1.0075
2005-09	270.1	1.0067	0.9989	1.0055
2005-12	230.4	1.0057	1.0002	1.0059
2006-03	197.8	1.0049	1.0018	1.0067
2006-06	214.2	1.0053	1.0017	1.0070
2006-09	244.9	1.0061	1.0038	1.0099
2006-12	231.0	1.0057	1.0072	1.0130
2007-03	214.3	1.0053	1.0062	1.0115
2007-06	193.6	1.0048	1.0050	1.0099
2007-09	217.9	1.0054	1.0047	1.0101
2007-12	227.5	1.0056	0.9986	1.0042
2008-03	291.4	1.0072	0.9950	1.0022
2008-06	311.1	1.0077	0.9933	1.0010
2008-09	333.5	1.0082	0.9908	0.9990
2008-12	503.7	1.0124	0.9968	1.0091
2009-03	550.2	1.0135	1.0006	1.0141
2009-06	466.7	1.0115	1.0033	1.0148
2009-09	312.0	1.0077	1.0045	1.0122
2009-12	211.0	1.0052	0.9966	1.0018
2010-03	226.6	1.0056	0.9944	1.0000
2010-06	225.7	1.0056	0.9960	1.0016
2010-09	251.5	1.0062	0.9975	1.0037
2010-12	201.8	1.0050	0.9972	1.0022
2011-03	186.4	1.0046	0.9950	0.9996
2011-06	207.6	1.0052	0.9917	0.9968
2011-09	242.6	1.0060	0.9909	0.9968
2011-12	331.9	1.0082	0.9920	1.0001
2012-03	375.9	1.0093	0.9932	1.0025
2012-06	316.6	1.0078	0.9955	1.0033
2012-09	288.2	1.0071	0.9961	1.0032
2012-12	211.2	1.0052	0.9955	1.0008
2013-03	180.6	1.0045	0.9961	1.0005
2013-06	200.3	1.0050	0.9967	1.0016
2013-09	256.3	1.0063	0.9962	1.0026
2013-12	274.8	1.0068	0.9971	1.0039
2014-03	302.5	1.0075	0.9966	1.0041
2014-06	263.2	1.0065	0.9950	1.0015
2014-09	220.4	1.0055	0.9957	1.0011
2014-12	226.8	1.0056	0.9970	1.0026
2015-03	232.5	1.0058	1.0002	1.0060
2015-06	248.4	1.0062	1.0001	1.0063
2015-09	267.3	1.0066	0.9998	1.0064
2015-12	296.9	1.0073	0.9991	1.0065
2016-03	313.9	1.0078	0.9980	1.0058
2016-06	296.9	1.0073	0.9980	1.0054
2016-09	306.9	1.0076	0.9980	1.0055
2016-12	311.9	1.0077	0.9966	1.0043
2017-03	361.5	1.0089	0.9952	1.0041
2017-06	319.1	1.0079	0.9975	1.0054
2017-09	292.0	1.0072	0.9977	1.0049
2017-12	281.8	1.0070	0.9978	1.0047
2018-03	299.3	1.0074	0.9984	1.0058
2018-06	304.5	1.0075	0.9979	1.0054
2018-09	402.0	1.0099	0.9985	1.0084
2018-12	476.3	1.0117	1.0003	1.0120
2019-03	434.8	1.0107	1.0018	1.0125

Table A8. Tax revenue (10^6 TL) and effective tax rates

	Tax revenue Income	Tax revenue Consumption	GDP Wage income	GDP Private consumption	Tax rate (%) Labor income	Tax rate (%) Consumption
2006	28983	59408	189193	534849	15.3	11.1
2007	34447	63590	217214	601239	15.9	10.6
2008	38030	67258	245633	663944	15.5	10.1
2009	38446	73136	256441	680768	15.0	10.7
2010	40392	91736	297649	787753	13.6	11.6
2011	48807	103381	345711	923836	14.1	11.2
2012	56494	113837	395864	994396	14.3	11.4
2013	63761	134855	438528	1109722	14.5	12.2
2014	73902	142111	504970	1204364	14.6	11.8
2015	85756	167092	570875	1348767	15.0	12.4

Table A9. Primary balance (% GDP)

	Primary balance / GDP (%)
2002	3.3
2003	4.0
2004	4.9
2005	6.0
2006	5.4
2007	4.2
2008	3.5
2009	0.0
2010	0.7
2011	1.9
2012	1.3
2013	2.0
2014	1.5
2015	1.5