Fiscal Austerity in Emerging Market Economies*

Chetan Dave[†] Chetan Ghate[‡] Pawan Gopalakrishnan[§]
Suchismita Tarafdar[¶]

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Abstract

We build a small open economy RBC model with financial frictions to analyze the incidence of expansionary fiscal consolidations in emerging market economies (EMEs). We calibrate the model to India, a proto-typical EME. We show that a spending based fiscal consolidation has an expansionary effect on output. In contrast, tax based consolidations are always contractionary. Either measure of consolidation, however, tends to increase the fiscal deficit and therefore the sovereign risk premia in our framework. Our findings support the results in the IMF WEO (2010), that tax based consolidation measures are more costly (in terms of GDP losses) than spending based consolidations in the short run. We identify new mechanisms that gird the dynamics of fiscal reforms and their implications for successful fiscal consolidations.

Keywords : Expansionary Fiscal Consolidations, Fiscal Policy in Small Open Economies, Emerging Market Business Cycles, Financial Frictions.

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[†]Corresponding Author: Department of Economics, University of Alberta. 9-18 Tory Building, Edmonton, Alberta Canada T6G 2H4. Tel: (1)-780-492 7645. E-mail: cdave@ualberta.ca.

[‡]Economics and Planning Unit, Indian Statistical Institute, New Delhi – 110016, India. Tel: (91)-11-4149-3938. Fax: 91-11-4149-3981. E-mail: cghate@isid.ac.in.

[§]Strategic Research Unit, Reserve Bank of India, Mumbai – 400001, India. Tel: (91)-22-2260-2206. E-mail: pawangopalakrishnan@rbi.org.in.

[¶]Department of Economics, Shiv Nadar University, Gautam Buddha Nagar, Uttar Pradesh - 201314, India. Tel: (91)-120-266-3801. E-mail: suchismita.tarafdar@gmail.com.

1. Introduction

While many countries undertake fiscal consolidations to reduce their fiscal deficits, there is little consensus on the short and long term effects of fiscal austerity on public debt and potential economic growth. The 2010 IMF World Economic Outlook (WEO) finds that domestic demand falls by about 1 percent in response to a fiscal consolidation. It also finds that fiscal contractions that rely on spending cuts tend to have smaller contractionary effects than tax based adjustments (IMF WEO, page 95). However, another branch of the literature, building on the seminal work of Giavazzi and Pagano (1990), shows that fiscal retrenchments can stimulate growth in the short run, a phenomenon referred to as the "expansionary fiscal contraction" hypothesis.[1] Such expansions happen if the consolidation is structured in a way that increases confidence.

Most of the quantitative macroeconomic literature on fiscal contractions - whether driven by expenditure reductions or tax increases - is in the context of advanced economies.[2] What is missing is an understanding of the mechanisms behind fiscal consolidations in emerging market economies (EMEs). To fill this gap, we build a small open economy real business cycle (SOE RBC) model with financial frictions and fiscal policy that is more suited to analyzing fiscal contractions in EMEs. Our model builds on the work of Neumeyer and Perri (2005), Ghate et al. (2016), and Hansen and Imrohoroglu (2016). We calibrate the model to India, which we view as a prototypical small open economy, to understand the effects of fiscal contractions from the standpoint of declines in government spending, and increases in tax rates.[3] The novel aspect of our framework is that we build a unified framework for

[1] See Alesina and Ardagna (2010).

[2] An important exception is Diniz (2018) who studies the effects of fiscal contractions in Latin American Economies (LAEs). He shows that a spending based consolidation has higher expansionary effects on consumption compared to investments, especially under high debt levels. A consolidation due to a tax increase on the other hand is driven by a bigger fall in investment as compared to consumption. In the context of advanced economices, a large literature on fiscal consolidation on economic activity finds that with infinitely lived Ricardian households, an increase in (non-productive) government spending purchases (financed by current or future lump sum taxes) lowers the present value of after tax income and generates a negative wealth effect on consumption. The empirical literature on the effects of fiscal policy (Blanchard and Perotti (2002), Romer and Romer (2010)) also finds similar results. See Aiyagari et al. (1992); Baxter and King (1993); Christiano and Eichenbaum (1992); Gali, Lopez-Salido, and Valles (2007).

[3] Neumeyer and Perri (2005), Aguiar and Gopinath (2007), and Chang and Fernandez (2013) provide important frameworks for understanding the impact of interest rate shocks in small open economy RBC models.

emerging market economies that identifies conditions under which fiscal contractions are, (i) contractionary, and (ii) expansionary when both spending reductions and tax increases are used to consolidate.

Our results are explained by two key channels. *First*, a spending based government consolidation, modeled as a negative shock to utility enhancing government spending, alters "effective consumption" and therefore the labor-leisure choice. *Second,* a tax based consolidation, modeled as a positive shock to factor income tax rates alters disposable incomes, and therefore household demand for consumption of the final good and bonds, and supply of factors of final good production, i.e., labor and capital. We also show that under both measures of consolidation, the sovereign risk premia increases, because public debt/GDP rises in transition to the steady state. This increases the domestic interest rate which has further contractionary macroeconomic outcomes.

Broadly, expenditure based consolidations, i.e., a contractionary fiscal shock, has an *expansionary* effect on GDP. The quantitative effects, however, crucially depends on the weight of government spending in effective consumption. That is, if the weight of government spending in effective consumption is small, the effects may be less expansionary or mildly contractionary. On the contrary, with respect to tax based consolidations we show that tax shocks always yield contractionary outcomes. This is consistent with the findings in the IMF WEO (2010), that tax based consolidation are more costly (in terms of higher GDP losses) than spending based consolidation in the short run. This is also consistent with the literature which provides evidence for *expansionary austerity* for spending cuts, whereas *recessions* for tax increases in a sample of OECD economies (see Alesina and Ardagna 2010).

We also show that the effect of government spending contractions on output crucially depends on parameters such as that governing habit persistence on private consumption and that governing the working capital constraint faced by firms. A higher degree of habit persistence makes private consumption more sluggish and less responsive to a contraction in government spending, thereby causing labor supply to increase more, which in turn increases output by more. On the other hand, as the working capital constraint of firms increases, labor demand contracts and therefore output contracts for a given increase in borrowing rates due to a fiscal consolidation measure. This channel is similar to Neumeyer and Perri

(2005) although they do not model fiscal policy.

Our analysis is policy relevant since in recent years many emerging market economies have undergone fiscal consolidations to reduce their fiscal deficits and public debt/GDP ratios. The left panel of Figure 1, which plots the fiscal deficit/GDP ratio of Malaysia since 2009, depicts a fairly large 3.7% reduction in the fiscal deficit/GDP ratio.

{Insert Figure 1}

The right panel in Figure 1 depicts the Indian case and also shows a reduction in the central government fiscal deficit/GDP reduction of a similar order of magnitude. The 2018 IMF Fiscal Monitor notes that many emerging market countries have already (Brazil, Saudi Arabia) or are in the process of implementing (Russia, China) fiscal consolidation plans. In the context of EMDEs, Diniz (2018) shows that spending based consolidation is less recessionary as compared to tax increases for Latin American Economies (LAEs). Since our framework identifies conditions under which fiscal contractions may be contractionary, or expansionary with both spending reductions and tax increases used for consolidation, we provide more general insights into whether spending reductions and tax increases would be more expansionary in any EME, and how they affect the fiscal deficit in the short run and the long run.

1.1. Model Description

Our model builds on that of Neumeyer and Perri (2005), Ghate et al. (2016), and Hansen and Imrohoroglu (2016).

The economy consists of firms, a government, and households. Firm wage payments are subject to working capital constraints, as in Neumeyer and Perri (2005) and Ghate et al. (2016). Working capital constraints are the key financial friction in the model. To meet the working capital constraint, firms borrows from households domestically and abroad by issuing corporate debt which is priced at the international interest rate, R^*.

Infinitely lived households derive utility over private consumption (C_t) and government consumption (G_t) which are assumed to be perfect substitutes but with different weights; leisure ($1 - H_t$); government bonds (D_t), as in Hansen and Imrohoroglu (2015); and private bonds (B_t). We assume that households value holding government bonds relatively more than private bonds since private bonds are assumed to be relatively riskier compared to the risk free asset. Holding bonds also proxies for the level of financial participation in the economy.[4] Consumers form habits in their expenditure formation with utility depending on current consumption, C_t, relative to a habit reference level, $C_{t-1.}$ Effective consumption is given by $C_t^* = C_t + \zeta G_t$, where $\zeta > 0$ is the relative weight of government consumption in utility.[5]

The government collects tax revenue by imposing time invariant distortionary taxes on wage and capital incomes, does not balance its budget, and borrows by issuing debt at a rate $R_t^G > 1$. The government allocates G_t of it's total revenue towards government consumption. The residual is transferred to households in the form of a lump-sum transfer (T_t). The sovereign risk premium on public debt depends on the deviation of the period t debt to GDP (d_t) ratio relative to its steady state value ($\bar{d}$). If the debt to GDP ratio is higher than its steady state, then the rate at which the government borrows is higher. Thus, the sovereign risk premia required to borrow in international capital markets depends on domestic fundamentals in the economy. Finally, the interest rate on corporate debt, $R_t^p > 1$, is priced off of R_t^G as in many emerging market economies, which implies that $R_t^P > R_t^G$ (see Caballero, Fernandez, and Park (2016)). Hence, $R_t^P > R_t^G > R^*$.

We calibrate the model using a broad set of parameters representative of the Indian economy. Using Sims (2002), the solution to the log-linearized system is the state equation of the model in the form of a VAR (1). We discuss the intuition behind the impulse response functions generated by shocks to three main variables in the model: government spending, the foreign interest rate, and total factor productivity.

[4]For instance, from the 2017 round of the Consumer Pyramids Survey for India we see that on the extensive margin, the probability that a household participates in purchasing financial assets is more than 60%.

[5]The presence of habits ensures that fiscal shocks lead to sluggish adjustments in effective consumption which ensures that steady state consumption, $\overline{C} > 0$.

1.2. Intuition Behind Main Results

Our main insight is with respect to the mechanisms and conditions under which fiscal contractions can be contractionary or expansionary in the short run, and how they can affect the fiscal deficit. We also compare these results with the propagation mechanism from foreign interest rate shocks, and TFP shocks.

1.2.1. Expenditure based consolidations

In our baseline specification, a reduction in government consumption leads to a rise in private consumption, but a decline in effective consumption, since government consumption and private consumption are perfect substitutes in utility. A decline in effective consumption increases the marginal utility from effective consumption, which induces the household to work more. Equilibrium labor (hours worked) therefore increases due to an increase in labor supply. With capital remaining unchanged, higher hours worked leads to higher GDP. Disposable income increases because of an increase in both wage income and the marginal productivity of capital. An increase in disposable income increases the demand for private and government bonds, and private investment. An increase in government bonds increases the fiscal deficit on impact which increases the sovereign risk premium. An increase in the sovereign risk premium causes an increase in the domestic interest rates on government and private bonds, which makes firm-level borrowing costly. This causes a subsequent contraction of output in transition to the steady state. In sum, on impact, a contractionary fiscal shock is expansionary. As we will discuss in the robustness section, the impact of a government spending shock on output crucially depends on the habit persistence parameter.[6]

1.2.2. Tax based consolidations

Positive shocks to factor income tax rates, in our model are contractionary, unlike the case of an expenditure based consolidation. A one period shock to labor income tax instantaneously causes disposable incomes to fall. This reduces a household's private consumption,

[6] We compare these results with the propagation mechanism from foreign interest rate shocks, and TFP shocks. A positive interest rate shock reduces GDP because of a rise in the foreign interest rate, as in Neumeyer and Perri (2005). A single period TFP shock on the other hand is expansionary.

effective consumption, and their demand for private and public bonds. Households also reduce their supply of hours worked, since the opportunity cost of working falls, and leisure increases. This reduces output on impact. This also reduces the marginal productivity of capital, and therefore, households invest less on capital, which results in a persistent contractionary effect on output in transition to the steady state. A one period shock to capital income tax τ_{k_t} reduces after-tax returns from capital income, pushing households to invest more on government and private bonds. Because the marginal utility of private consumption must fall to maintain the marginal rate of substitution between financial assets and effective consumption, private consumption rises, and hours worked falls. This depresses output. The sovereign risk premium also rises in both cases because output falls by more than the fall in demand for government bonds, which results in an increase in the fiscal deficit. On the whole, a one period positive shock to factor income taxes is contractionary in nature, even though the overall magnitude is lower compared to a spending based consolidations.

2. The Model

2.1. Firms

The economy consists of firms, a government, and households. At any given time t a representative firm produces final output using labor employed at time t and capital carried forward from time period $t-1$. However, prior to actual production, the firm needs to pay a portion $\theta \in [0,1]$ of its total wage bill. To meet this working capital constraint, the firm borrows from households by issuing debt. The firm issues corporate bonds (B_t) to households to whom they promise a return of R^P_{t-1} which is considered to be a markup over the domestic government bond interest rate, R^G_{t-1}.

The firm hires labor (H_t) and uses capital (K_{t-1}) accumulated in time period $t-1$ to produce final output Y_t such that

$$\max_{\{K_t,H_t\}} Y_t - R_t K_{t-1} - (1-\theta) W_t H_t - \theta W_t H_t R^P_{t-1}, \tag{1}$$

where,

$$Y_t = A_t K_{t-1}^{\alpha} H_t^{1-\alpha} \tag{2}$$

and A_t denotes exogenous total factor productivity (TFP). This yields the following first order conditions for firms.

$$\frac{(1-\alpha)Y_t}{H_t} = W_t \left[1 - \theta + \theta R_{t-1}^{P}\right] \tag{3}$$

$$\frac{\alpha Y_t}{K_{t-1}} = R_t \tag{4}$$

The timing of events and decisions is identical to Neumeyer and Perri (2005) and Ghate et al. (2016). In the beginning of period t, which we denote as t^{-}, firms borrow $\theta W_t H_t$ to make advance payments to labor prior to actual production (which occurs at t). Firms then produce output and repay the loan borrowed at the end of time period (t^{+}), with workers receiving the rest of their wage bill $(1-\theta)W_t H_t$ at time t^{+}. Since the time gap between t^{-} and t, and between t and t^{+} is very small, we drop these superscripts and consider the entire period as time period t (see Neumeyer and Perri 2005).

2.2. Households

The economy is populated by infinitely lived households with a mass normalized to 1. The representative household consumes and invests a homogenous good and supplies labor and capital to firms. As in the literature on habit formation, we assume that consumers form habits in their expenditure formation with utility, U, depending on current consumption, C_t, relative to a habit reference level, C_{t-1}. The representative household has the following expected discounted lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t^*, H_t, B_t, D_t), \tag{5}$$

where $\beta \in (0,1)$ denotes the households subjective discount factor. We assume that

$$C_t^* = C_t + \zeta G_t, \tag{6}$$

where household consumption (C_t) is augmented by government consumption (G_t). The parameter ζ captures the weight of public consumption in household utility, where $\zeta > 0$. Given our specification in equation (6), C_t and G_t are assumed to be perfect substitutes.[7] We assume that agents treat G_t as a given covariance stationary stochastic process (CSSP). Finally, households also derive utility from holding private and government debt (B_t and D_t respectively). This assumption is consistent with the evidence reported in a new database on Indian households called the "CMIE Households Consumer Pyramids" that examines asset allocation of a panel of Indian households for the period 2014-18.[8] While this survey only contains information on participation in asset purchases – i.e., on the extensive margin, and not the volume of asset purchases along the intensive margin – out of those households that invest, a majority (around 60%) choose to save only in financial assets across the entire time horizon of the data.[9] Our specification of the household deriving utility over public debt follows Hansen and Imrohoroglu (2016).[10] In the calibration exercise below, we assume that the preference for holding public debt is higher than private debt since public debt is the risk free asset.

We adopt a unitary elasticity of substitution specification for instantaneous utility

$$\begin{aligned} U(C_t^*, H_t, B_t, D_t) = {} & \mu \ln(C_t - \chi C_{t-1} + \zeta G_t) + (1 - \mu - \varphi_1 - \varphi_2)\ln(1 - H_t) \\ & + \varphi_1 \ln(D_t) + \varphi_2 \ln(B_t). \end{aligned} \tag{7}$$

The household faces the budget constraint

$$\begin{aligned} & C_t + X_t + B_t + \kappa_1(B_t) + D_t + \kappa_2(D_t) \\ & = (1 - \tau_w) W_t H_t + (1 - \tau_k) R_t K_{t-1} + R_{t-1}^P B_{t-1} + R_{t-1}^G D_{t-1} + T_t \end{aligned} \tag{8}$$

[7] In an emerging markets context, an example of G_t can be public health or public transportation services whose quality is typically seen as being superior to private alternatives. See Barro (1981), Christiano and Eichenbaum (1992), Ambler and Paquet (1996), and Ghate et al. (2016).

[8] See Consumer Pyramids Survey, CMIE, 2018. "https://consumerpyramidsdx.cmie.com/"

[9] These calculations are available from the authors on request.

[10] Blanchard (1983) includes dis-utility of debt function in the household's utility function to capture the non-monetary costs of foreign debt in the given framework. However, in our framework, we include debt to proxy for high savings in the economy.

where X_t denotes investment, $\tau_w \in [0, 1]$ is the tax on labor income, and $\tau_k \in [0, 1]$ is the tax on capital income. Agents take the competitive wage rate (W_t) and return to capital (R_t) as given in deciding optimal choices. For private bond holdings the term $\kappa(B_t)$ in (8) is the bond holding cost,

$$\kappa_1(B_t) = \frac{\kappa_1}{2} Y_t \left[\frac{B_t}{Y_t} - \frac{\bar{B}}{\bar{Y}} \right]^2. \tag{9}$$

Households also invest in government bonds (D_t) and holding these involves an analogous cost,

$$\kappa_2(D_t) = \frac{\kappa_2}{2} Y_t \left[\frac{D_t}{Y_t} - \frac{\overline{D}}{\bar{Y}} \right]^2. \tag{10}$$

The term X_t in (8) is the level of private investment

$$X_t = K_t - (1 - \delta)K_{t-1} + \Phi(K_t, K_{t-1}), \tag{11}$$

where $\Phi(K_t, K_{t-1})$ is the capital adjustment costs[11]

$$\Phi(K_t, K_{t-1}) = \frac{\phi}{2} K_{t-1} \left[\left(\frac{K_t}{K_{t-1}} \right) - 1 \right]^2. \tag{12}$$

Therefore,

$$X_t = K_t - (1 - \delta)K_{t-1} + \frac{\phi}{2} K_{t-1} \left[\frac{K_t}{K_{t-1}} - 1 \right]^2 \tag{13}$$

is the law of motion governing capital accumulation.

2.3. The Government Budget Constraint

The government in our model follows a non-discretionary fiscal policy. It collects tax revenues by imposing time invariant distortionary taxes on wage and capital incomes, does not balance its budget, and borrows by issuing debt at a rate R_t^G. The government allocates G_t of it's total revenue towards government consumption. The residual is transferred to households in the form of a lump-sum transfer (T_t). The following is the government budget

[11] An investment adjustment cost is required to make the volatility of private investments relative to output match empirically observed values. This is also a standard practice in RBC models.

constraint, in every time period t.

$$G_t + T_t = \tau_w W_t H_t + \tau_k R_t K_t + D_t - R^G_{t-1} D_{t-1}, \tag{14}$$

where

$$R^G_t = \xi_t R^*_t \tag{15}$$

R^G_t is assumed to be a mark-up over the international interest rate R^*_t.[12] The mark-up is the spread over the international interest rate, to capture sovereign risk, modelled as deviations from the steady state debt to GDP levels, i.e.,

$$\xi_t = \xi \exp\left(\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right), \text{ where } \xi > 0. \tag{16}$$

We further assume that the interest rate on private bonds is equal to the interest rate on government bonds with an additional mark-up, i.e.,

$$R^P_t = \Gamma_t R^G_t. \tag{17}$$

This reflects the fact that there is a risk premium in corporate bonds over government bonds, as in most EMEs where corporate debt is priced off the risk-free asset. Hence, there are two mark-ups in the model: ξ_t, which is determined by macroeconomic fundamentals (public debt) and is endogenous, and Γ_t (which is exogenous).

In light of the above environment, given $\{A_t, R^*_t, G_t\}_{t=0}^{\infty}$, a vector of fiscal policy parameters $\{\tau_k, \tau_w, \zeta\}$, and initial conditions K_{-1}, B_{-1}, D_{-1}, R^P_{-1}, R^G_{-1}, a competitive equilibrium for our model is a vector of allocations of $\{C_t, K_t, D_t, B_t,$ and $H_t\}_{t=0}^{\infty}$ and factor prices $\{W_t$ and $R_t\}_{t=0}^{\infty}$ such that, for the given sequence of factor prices, (i) $\{K_t$ and $H_t\}_{t=0}^{\infty}$ solves the firm's profit maximization problem (1), and first order conditions (3-4), (ii) $\{C_t, K_t, B_t, D_t, H_t\}_{t=0}^{\infty}$ maximizes the utility of the representative agent (5) subject to (2), (8), (6), (9), (10), (12), and (13) together with $C_t, K_t \geqslant 0$, (iii) T_t satisfies (14), (iv) a no-Ponzi associated with the initial conditions K_{-1}, B_{-1}, and D_{-1} holds for the representative

[12] We assume R^*_t to be an exogenous process. Typically in the literature, the international interest rate R^*_t is assumed to be the US 91 day T-Bill rates (see Neumeyer and Perri (2005), Ghate et al. (2016)).

agent, and finally, (v) all markets clear for all time periods. .

Collecting the decision rules and constraints across all economic actors, this definition of a competitive equilibrium results in the following system of nonlinear expectational difference equations that describe our "cycles only" model[13]:

$$\Lambda_t = \frac{\mu}{C_t - \chi C_{t-1} + \zeta G_t} - \frac{\chi\mu}{C_{t+1} - \chi C_t + \zeta G_{t+1}} \tag{N1}$$

$$(1-\tau_w)\Lambda_t W_t = \frac{1-\mu-\varphi_1-\varphi_2}{1-H_t} \tag{N2}$$

$$E_t \left\{ \begin{array}{c} \beta\Lambda_{t+1}\left[1-\delta-\frac{\phi}{2}\left[\frac{K_{t+1}}{K_t}-1\right]^2+\frac{\phi K_{t+1}}{K_t}\left[\frac{K_{t+1}}{K_t}-1\right]+(1-\tau_k)R_{t+1}\right] \\ = \Lambda_t\left[1+\phi\left[\frac{K_t}{K_{t-1}}-1\right]\right] \end{array} \right\} \tag{N3}$$

$$E_t\left\{\beta\Lambda_{t+1}R_t^P = \Lambda_t\left[1+\kappa_1\left[\frac{B_t}{Y_t}-\frac{\bar{B}}{\bar{Y}}\right]\right]-\frac{\varphi_2}{B_t}\right\} \tag{N4}$$

$$E_t\left\{\beta\Lambda_{t+1}R_t^G = \Lambda_t\left[1+\kappa_2\left[\frac{D_t}{Y_t}-\frac{\bar{D}}{\bar{Y}}\right]\right]-\frac{\varphi_1}{D_t}\right\} \tag{N5}$$

$$\begin{aligned} C_t + K_t - (1-\delta)K_{t-1} + \frac{\phi}{2}K_{t-1}\left[\frac{K_t}{K_{t-1}}-1\right]^2 + B_t + \frac{\kappa_1}{2}Y_t\left[\frac{B_t}{Y_t}-\frac{\bar{B}}{\bar{Y}}\right]^2 + D_t \\ + \frac{\kappa_2}{2}Y_t\left[\frac{D_t}{Y_t}-\frac{\bar{D}}{\bar{Y}}\right]^2 = (1-\tau_w)W_tH_t + (1-\tau_k)R_tK_{t-1} + R_{t-1}^P B_{t-1} + R_{t-1}^G D_{t-1} + T_t \end{aligned} \tag{N6}$$

$$\frac{(1-\alpha)Y_t}{H_t} = W_t\left[(1-\theta)+\theta R_{t-1}^P\right] \tag{N7}$$

$$\frac{\alpha Y_t}{K_{t-1}} = R_t \tag{N8}$$

$$Y_t = A_t K_{t-1}^{\alpha} H_t^{1-\alpha} \tag{N9}$$

$$G_t + T_t = \tau_w W_t H_t + \tau_k R_t K_t + D_t - R_{t-1}^G D_{t-1} \tag{N10}$$

$$R_t^G = \xi R_t^* \exp\left(\frac{D_t}{Y_t}-\frac{\bar{D}}{\bar{Y}}\right) \tag{N11}$$

$$R_t^P = \Gamma R_t^G \tag{N12}$$

$$G_t \sim CSSP(\bar{G}, \rho_G, \sigma_G) \tag{N13}$$

$$A_t \sim CSSP(\bar{A}, \rho_A, \sigma_A) \tag{N14}$$

$$R_t^* \sim CSSP(\bar{R}^*, \rho_{R^*}, \sigma_{R^*}) \tag{N15}$$

[13] We note that there is no source of deterministic growth in this model and so the log-linearized version we analyze next is to be interpreted in terms of Hodrick-Prescott filtered data analogs.

where $CSSP$ denotes (an exogenous) covariance stationary stochastic process. The assumption that government debt has utility value following Hansen and Imrohoroglu (2016) asserts itself in the system above. The Euler equations governing private and public debt (equations (N4) and (N5) respectively) are distinct from each other and distinct from that governing the determination of physical capital (equation (N3)). The working capital friction clearly introduces a wedge into the equation governing the determination of wages from the firms' side (equation (N2)). The remaining equations are standard relative to a baseline RBC model with real frictions.

3. Calibration

We analyze the log-linearized version of the model, which, following Sims (2001), can be written as a system of 15 equations in 15 variables:

$$\Gamma_0 X_{t+1} = \Gamma_1 X_t + \Psi \varepsilon_t + \Pi \eta_t$$
$$\text{where, } X_t = \{C_t, H_t, D_t, K_t, B_t, Y_t, W_t, R_t, R_t^P, R_t^G, T_t, \Lambda_t, G_t, A_t, R_t^*\}$$

and the matrices Γ_0, Γ_1, Ψ and Π are functions of 25 model parameters:

$$\beta, \chi, \mu, \zeta, \varphi_1, \varphi_2, \delta, \phi, \kappa_1, \kappa_2, \tau_w, \tau_k, \theta, \alpha, \Gamma, \xi, \bar{G}, \bar{A}, \bar{R}^*, \rho_G, \rho_A, \rho_{R^*}, \sigma_G, \sigma_A, \sigma_{R^*},$$

with $\bar{G} = \bar{A} = 1$, and three new variables reflecting idiosyncratic rational expectations errors (η_t) have been subsumed in the notation (see DeJong and Dave (2011)). Given the above representation, any linear solution method including that of Sims (2001) solves a system of linear expectational difference equations under rational expectations as

$$X_{t+1} = F X_t + G \varepsilon_t,\ E(\varepsilon_t \varepsilon_t') = \begin{bmatrix} \sigma_G^2 & 0 & 0 \\ 0 & \sigma_A^2 & 0 \\ 0 & 0 & \sigma_{R^*}^2 \end{bmatrix},$$

which is the state equation of the model in the form of a VAR (1).[14]

We calibrate the model to India, a prototypical small open emerging market economy. Our baseline calibration proceeds as follows. We chose the value of $\overline{R}^*$ to equal 1.01755 so that it is close to the long run quarterly averaged real interest rate on 10 year G-Sec bonds (with $\{\rho_{R^*}, \sigma_{R^*}\}$ being (0.7100, 0.0070)).[15] We calculate the tax on capital income, $\tau_k = 0.031$, by averaging the gross annual corporate tax revenue as a percentage of GDP for the period 2000-2018 for India. We similarly calculate the tax on labor income, $\tau_w = 0.018$, by averaging the gross income tax revenue as a percentage of GDP for the same period.[16] We assume R_t^G as a constant markup over R_t^*, and therefore, using the long run quarterly averaged real interest rate on 10 year G-Sec bonds for India, we calculate $\xi = 1.0093$.[17] We similarly assume R_t^P to be a constant markup over R_t^G. Since agents derive utility from both private and public bonds, we restrict the magnitude of $\Gamma > 1 = 1.003$ such that in the steady state, $\overline{B} > 0$, and $\overline{R}^P \simeq 1.02$, which is close to the long run average real corporate bond rates in India during the fiscal period 1997:Q4-2019:Q4.[18] Since we have included bond holding costs in our household constraint not just for realism in the EME context but also to ensure that the corresponding first order conditions do not follow a random walk, we assume them to be small ($\kappa_1 = \kappa_2 = 0.0062$). We similarly fix ϕ to be 8.8591 and θ to be 0.5[19].

[14] We analyze the model using DYNARE v. 4.5.0.

[15] We take daily 10 Year US G-Sec bond yields, obtain montly averages, and adjust for monthly US CPI inflation to derive real rates. We then take quarterly averages of the monthly series. The long run average $\overline{R}^*$ is calculated for the fiscal period 1997Q04-2019Q04 so as to match the availability of quarterly data in India. The AR(1) coefficient and the standard error of the shocks are calculated for $\widehat{R}_t^*$, i.e., HP-Filtered log-deviations from R_t^*.

[16] Our calculations are consistent with Poirson (2006) who estimated the average effective tax rates in india to be $\tau = 0.01$, given that India has a very narrow income tax base and depends more on generating revenue from indirect taxation.

[17] We take daily 10 Year Indian G-Sec bond yields, obtain montly averages, and adjust for monthly India CPI inflation for industrial workers, to derive real rates. We then take quarterly averages of the monthly series.

[18] It can be shown that as long as $\frac{1}{\beta} > \overline{R}^P$, $\overline{B} > 0$. Using the long run averaged real commercial paper rates, the actual markup over R_t^G is equal to 1.009.

[19] Our choice of κ_1, κ_2, ϕ, and θ are consistent with a log-likelihood minimzation exercise we undertook using our model and the Indian data.

Parameters	Values	Source	Parameters	Values	Source
μ	0.65	Arbitrary	$\kappa_1 = \kappa_2$	0.006	Estimated
ζ	$= 1$	Ghate et al. (2016)	ρ_G	0.59	Anand and Prasad (2010)
χ	0.4	Ghate and Kletzer (2016)	ρ_A	0.82	Basu et al. (2018)
ϑ_1	0.02	Arbitrary	ρ_{R^*}	0.71	Authors' Calculation
ϑ_2	0.015	Arbitrary	σ_G	0.026	Anand and Prasad (2010)
α	0.36	Ghate et al. (2016)	σ_A	0.016	Anand and Prasad (2010)
β	0.98	Gabriel et al. (2012)	σ_{R^*}	0.007	Authors' Calculation
δ	0.025	Banerjee and Basu (2017)	$\overline{R}^*$	1.01755	Authors' Calculation
τ_w	0.018	Authors' Calculation	ξ	1.0093	Authors' Calculation
τ_k	0.031	Authors' Calculation	Γ	1.003	Arbitrary
ϕ	8.8591	Estimated	$\overline{G} = \overline{A}$	1	Arbitrary
θ	0.5	Estimated			

Table 1: Baseline Parameters

Our choices for preference parameter values reflect the following intuition. Given the lack of estimates for these parameters, we set μ to be 0.65 to give the highest weight to consumption and φ_1 and φ_2 equal to 0.02 and 0.015 respectively to reflect that due to risk considerations households would give less (but positive) weight to private bonds than government bonds. These parameter values then imply a weight of approximately a third on leisure which says that households spend approximately that amount of time on non-employment activity.[20] Table 1 above summarizes our choice of parameters in our model.

In the sections that follow, we discuss the impact of exogenous shock processes, G_t, R_t^* and A_t (all in logarithmic deviations from steady state), to our baseline system. We analyze the HP filtered model equivalent impulse responses for these shocks. Later on, we discuss in a separate section some of our robustness results with respect to the parameters ζ, χ and θ.[21]

[20] This implies hours worked in the steady state is $\overline{H} = 0.51$, which is slightly higher than $\frac{1}{3}$ assumed in a standard RBC model.

[21] We choose $\zeta = 1$ for our baseline case as in Ghate et al. (2016). The evidence on the magnitude of ζ in the literature is however mixed. We do robustness around $\zeta \in (0, 1)$, i.e., we assume that private and government consumption expenditures are substitutes.

4. Expenditure based consolidations

We consider the following specification for $\widehat{G}_t$, the log deviation of government spending from its steady state:

$$\widehat{G}_t = \rho_G \widehat{G}_{t-1} + \varepsilon_{Gt},$$

where $\rho_G = 0.59$, and the standard error on ε_{Gt}, i.e., $\sigma\left(\varepsilon_{G_t}\right) = 0.026$ as discussed in Table 1 (see Anand and Prasad 2010). Figure 2 depicts the impulse response due to a negative government spending shock (government consumption falls).

{Insert Figure 2 here}

A reduction in government consumption leads to a rise in private consumption, but a decline in effective consumption CS_t (i.e. C_t^*), since government consumption and private consumption are substitutes in utility. A decline in effective consumption increases the marginal utility from effective consumption, which induces the household to work more. Equilibrium labor (H_t) therefore increases due to an increase in labor supply. This causes wage (W_t) to fall. Since the capital stock (K_t) is given in time period t, higher hours worked leads to higher GDP, which directly increases the return on capital, $R_t \left(= \frac{\alpha Y_t}{K_{t-1}}\right)$. A higher labor supply increases the marginal productivity of private capital increasing investment and K_t overall. However, given that an increase in R would depress demand for capital in the next time period, K_{t+1} contracts in the next time period, which causes overall output to fall in the subsequent time periods before returning to the steady state. Further, an increase in output, and in increase in factor incomes results in an increase in the proportional tax revenue (TR_t) which is equal to $\tau_{w_t} W_t H_t + \tau_{k_t} R_t K_{t-1}$.

Despite an increase in the tax revenues, disposable income (YD_t) increases on impact and does not contract as much as output does in the subsequent time periods. This is because, disposable income is defined as

$$YD_t = \left(1 - \tau_{w_t}\right) W_t H_t + \left(1 - \tau_{k_t}\right) R_t K_{t-1} + R_{t-1}^P B_{t-1} + R_{t-1}^G D_{t-1} - T_t,$$

where T_t is the lump-sum tax, which is negative or positive in the steady state for the given set of parameters, causing T_t to fall in the steady state. Disposable income increases on impact because the increase in H_t is more than the the decline in W_t. R_t increases for the given level of capital, K_{t-1}. And lump-sum transfers increase on impact. An increase in disposable income results in an increase in demand for private bonds (B_t), government bonds (D_t), and private investment (X_t). Because the increase in government bonds increases by more than the increase in output, the debt to GDP ratio $d_t = \frac{D_t}{Y_t}$ rises on impact. Since d_t in our model is equivalent to the gross fiscal deficit as a percentage of GDP, this implies *an increase* in the fiscal deficit. In this scenario, however, an increase in the fiscal deficit purely occurs on account of an increase in the household demand for government bonds due to rising disposable incomes, and therefore, on impact, this is not a negative outcome. The increase in the debt to GDP ratio relative to its steady state value, further increases the sovereign risk premium, which increases R_t^G. Finally, since private sector debt R_t^P is priced off of R_t^G, the interest on working capital loans, R_t^P, also rises. This contributes to an increase in interest income from bonds in the next time period, adding to future disposable incomes.

In sum, on impact, a contractionary fiscal shock is expansionary, and higher output and disposable incomes induces households to buy more government and private bonds, since these enhance utility. This also increases hours worked, GDP, investment and capital accumulation. In terms of magnitudes, however, the expansion in output occurs mainly due to private consumption and not private investments. This is because the main channel of transmission is through substitution between private consumption and government expenditure.[22]

5. Tax based consolidations

We now consider the effects of a tax based consolidation on the economy. We attempt to understand how positive shocks to both tax rates, i.e., τ_{w_t} and τ_{k_t} – by making them CSSP processes – transmit through the model, and how do they compare with government spending contractions. We consider the following AR(1) data generating process for $\widehat{\tau}_{wt}$,

[22] For Latin American Countries, however, Diniz (2018) shows that spending based consolidation causes output expansions, largely due to increase in investments and not consumption. On the other hand, our framework is relevant for India since India is predominantly a consumption-driven economy, with government consumption and private consumption approximately 70% of GDP.

which is the log deviation of the gross income tax revenue as a percentage of GDP on from its long run average:

$$\widehat{\tau}_{wt} = \rho_{\tau_w}\widehat{\tau}_{wt-1} + \varepsilon_{\tau_{wt}},$$

where we estimate $\rho_{\tau_w} = 0.98$, and the standard error on $\varepsilon_{\tau_{wt}}$, i.e., $\sigma\left(\varepsilon_{\tau_{wt}}\right) = 0.12$. We similarly estimate an AR(1) data generating process for $\widehat{\tau}_{kt}$, which is the log deviation of the gross corporate tax revenue as a percentage of GDP from its long run average:

$$\widehat{\tau}_{kt} = \rho_{\tau_k}\widehat{\tau}_{kt-1} + \varepsilon_{\tau_{kt}},$$

where we estimate $\rho_{\tau_k} = 0.85$, and the standard error on $\varepsilon_{\tau_{kt}}$, i.e., $\sigma\left(\varepsilon_{\tau_{kt}}\right) = 0.21$.

Figure 3 depicts the impulse response due to a one period positive shock to $\widehat{\tau}_{wt}$.

{Insert Figure 3 here}

A one period shock to labor income tax τ_{w_t} instantaneously causes after-tax labor income and disposable income to fall. Tax revenues, TR_t, rise on impact.[23] A positive τ_w shock induces households to reduce their supply of labor (thereby increasing the equilibrium wage) which reduces output for a given level of capital, K_{t-1}.[24] This in turn reduces their incomes and therefore private consumption, effective consumption, and their demand for B_t and D_t. A fall in output also lowers the marginal product of capital R_t, which, together with lower disposable incomes results in lower demand for private investments X_t. This causes capital in future time periods to remain depressed. Since output falls by more than the fall in demand for D_t, d_t rises, which implies an increase in the fiscal deficit. Unlike a spending based contraction, the increase in fiscal deficit due to a positive shock to the tax on wage income is a negative outcome as output falls more than the fall in the demand for government bonds. A rise in d_t also increases the sovereign risk premium, which results in a higher R^G and R^P. On the whole, a one period positive shock to τ_w is contractionary in nature. As in the case of spending consolidations, the magnitude of contraction in private consumption is higher, compared to the contraction in private investments.

[23] Lumpsum taxes T continue to fall since in the steady state, $\overline{T}$ is negative.

[24] This is because, with a higher tax, the price of leisure is lower, consequently to equate the marginal rate of substitution between leisure, and consumption, leisure increases the labor supply decreases.

Figure 4 depicts the impulse response due to a one period positive shock to $\widehat{\tau}_{kt}$.

{Insert Figure 4 here}

A one period shock to the capital income tax, τ_{k_t} reduces after-tax returns from capital income. As a result, households substitute away from capital investment – by lowering X and therefore K_t – towards bond and debt holdings. Through the marginal rate of substitution condition between debt/bonds and consumption, a lower marginal utility from B and D due to increased holdings of both results in a lower marginal utility of effective consumption. Since G is exogenous, households respond by increasing C, i.e., private consumption. With an increase in effective consumption, and from the marginal rate of substitution between consumption and leisure, labor supply falls (wages rise), which causes output to fall. Since the fall in output is more than the fall in capital, the returns to capital, $R_t\left(=\frac{\alpha Y_t}{K_{t-1}}\right)$, also falls on impact. Therefore, in terms of the demand components of output, a single period $\widehat{\tau}_k$ shock increases private consumption but decreases private investments, thereby differing in impact from the responses from a single period $\widehat{\tau}_w$ shock.[25] Finally, as in the case of a one period shock to $\widehat{\tau}_{wt}$, a fall in output coupled with an increase in D, results in higher d_t, i.e., the fiscal deficit rises. This results in a higher R^G and therefore R^P. Finally, as in the case of a single period shock in τ_w a single period shock in τ_k increases tax revenues (TR_t), and decreases disposable income (YD_t). Lump-sum taxes T, on the other hand, continue to fall since in the steady state, $\overline{T}$ is negative.

Overall, our baseline results suggest that compared to the absolute magnitude of expansion in output for a spending based consolidation, the absolute magnitude of contraction in output for a tax based consolidation (both τ_w and τ_k shocks) is lower. Our results differ from the IMF WEO (2010) which shows that both ways of consolidation are contractionary; here, our baseline model suggests that a spending based consolidation is expansionary. This is because a shock to government expenditure, which has a significant weight in effective consumption, instantaneously transmits through the labor market from the supply side.

[25] This is identical to the Latin American experience (see Diniz 2018).

6. Other shocks

Figure 5 depicts the case of a positive TFP ($\widehat{A}$ shock). We consider the following specification for $\widehat{A}_t$, the log deviation of TFP from its steady state:

$$\widehat{A}_t = \rho_A \widehat{A}_{t-1} + \varepsilon_{At},$$

where $\rho_A = 0.82$ (see Basu et al. 2018), and the standard error on ε_{At}, i.e., $\sigma\left(\varepsilon_{A_t}\right) = 0.026$ (see Anand and Prasad 2010), as discussed in Table 1. With a TFP shock, both factor prices, wages, and the marginal product of capital, rise. Households work more, which increases GDP, tax revenues, and disposable incomes. Lump-sum taxes fall, as in other impulse responses because $\overline{T}$, i.e., steady lump-sum taxes are negative. More employment raises the marginal product of capital which increases investment and the capital stock in the next period. Higher GDP raises consumption and effective consumption. The demand for public and private debt also rises but not as much as the increase in output, which in turn reduces the fiscal deficit and therefore the risk premium. A reduction in the risk premium reduces R^P and R^G.

{Insert Figure 5 here}

Figure 6 below depicts the case of a positive foreign interest rate, R^*, shock. We consider the following specification for $\widehat{R}^*_t$, the log deviation of the international real interest rate from its steady state:

$$\widehat{R}^*_t = \rho_{R^*} \widehat{R}^*_{t-1} + \varepsilon_{R^*t},$$

where $\rho_{R^*} = 0.71$, and the standard error on ε_{R^*t}, i.e., $\sigma\left(\varepsilon_{R^*t}\right) = 0.006$, as discussed in Table 1. A foreign interest rate shock on R^* raises R^P and R^G on impact. This reduces private consumption and effective consumption, and increases the demand for public and private debt since these now give higher returns. The reduction in effective consumption raises the supply of hours worked, but in the net, hours worked fall, since falling lump sum and proportional taxes induce households to enjoy more leisure, as this raises disposable incomes. This pushes hours worked down, and GDP falls. Given the increase in demand for

D_t and a fall in Y_t, the fiscal deficit, d_t, increases. This reinforces the increase in R_t^P and R_t^G. The increase in disposable income also induces households to increase their allocation towards physical investments X_t, which increases K_t. However, since Y_t falls on impact, R_t falls.

The reduction in GDP is similar to the adverse effect on GDP of a rise in foreign interest rates in Neumeyer and Perri (2005). In Neumeyer and Perri however, there is no role of fiscal policy. The reduction in GDP in our model obtains because of a fiscal policy channel where higher lump sum taxes are required to balance the government budget constraint. As we will discuss in the robustness section, the effect of an interest rate shock crucially depends on χ and θ.

{Insert Figure 6 here}

7. Robustness

The main point of departure from the IMF WEO (2010) is that in our baseline simulations, unlike in the case of a tax based consolidation, a spending based consolidation is expansionary. This is because with a high ζ (equals to 1 in our baseline case), a negative shock to government expenditure reduces effective consumption significantly which results in an increase in labor supply. As a robustness exercise, Figure 7 below depicts the impulse responses for a single period government spending shock when $\zeta < 1$. For illustration, we arbitrarily assume $\zeta = 0.5$.

{Insert Figure 7 here}

A reduction in government consumption leads to a rise in private consumption. Unlike in the baseline case where $\zeta = 1$, effective consumption CS_t (i.e. C_t^*) now increases and is driven by an increase in C_t, since the weight of government consumption in utility is now lower. An increase in effective consumption decreases the marginal utility from effective consumption, which induces the household to enjoy more leisure, and therefore work less. Equilibrium labor (H_t) therefore falls due to a fall in labor supply. Since output is a function of H_t and $K_{t-1,}$ output falls on impact. This directly increases the return on capital, R_t.

Therefore, demand for private investment (X_t) increases which increases capital, K_t, which however does not sustain for very long. W_t now rises on impact because of a fall in labor supply. Disposable income (YD_t) on the other hand, increases on impact. This is because, a fall in hours worked and a fall in income from private capital decreases tax revenues, and because lump-sum taxes are negative and therefore falling on impact. Together, this causes disposable incomes to rise. As a result, with an increase in disposable income and a fall in private consumption the demand for private bonds (B_t) and government bonds (D_t) goes up. $d_t = \frac{D_t}{Y_t}$, the debt to GDP ratio, also the sovereign risk premium, rises on impact. The risk premium, however, increases not just on account of a rise in the demand for D_t but also because of a decrease in Y_t. This increases both R_t^G and R_t^P, just as before. In sum, unlike the baseline case where $\zeta = 1$, on impact, *a contractionary fiscal shock is contractionary when* $\zeta < 1$, i.e., it decreases output, hours worked, and consumption, and increases the demand for bonds because of an increase in disposable income. However, the magnitude of contraction in output for a spending based consolidation is lesser as compared to the tax based consolidation.[26]

Our results are also sensitive to the choice of the parameters χ and θ. If the habit persistence parameter, χ, is increased (from 0.4), it makes responses of private consumption more sluggish to interest rate or government spending shocks. Therefore, for higher χ, a negative government spending shock may be expansionary even when $\zeta < 1$. This is because changes to effective consumption, which affects the labor leisure choice moves more closely with respect to G compared to C. On the contrary, a positive interest rate shock may tend to be more contractionary and along the lines of Neumeyer and Perri (2005) for higher χ since more sluggish movements in private consumption makes effective consumption more sluggish, and this in turn dampens the outward movements of labor supply (see Ghate et al. 2016).

The working capital constraint parameter, θ, i.e., the working capital constraint parameter, plays a crucial role with respect to interest rate shocks, especially from the point of view of labor demand. Higher θ strengthens the working capital constraint which dampens

[26] Further, unlike the case of government spending consolidations, results of tax based consolidations remain qualitatively unchanged for changes in ξ. These results are available from the autors on request.

the demand for labor. Since R^P_{t-1} determines the working capital constraint at time period t, a positive shock to the interest rate reduces the demand for labor (and therefore overall equilibrium labor) only in the next period, i.e. $t+1$. Therefore, higher θ causes a stronger contraction in output at time $t+1$.

We summarize our main results for the baseline and the robustness case in Table 2.

Shock	C	C^*	X	H	Y	R^G	$d = \frac{D_t}{Y_t}$
G shock ($\zeta = 1$)	↑	↓	↑	↑	↑	↑	↑
G shock ($\zeta < 1$)	↑	↑	↑	↓	↓	↑	↑
τ_w shock	↓	↓	↓	↓	↓	↑	↑
τ_k shock	↑	↑	↓	↓	↓	↑	↑
R^* shock	↓	↓	↑	↓	↓	↑	↑
A shock	↑	↑	↑	↑	↑	↓	↓

Table 2: Summary of Main Results

Broadly, our model – calibrated to Indian data – suggests that a tax based consolidation increases the fiscal deficit and therefore hardens domestic interest rates, thereby not just resulting in contractionary effects on output on impact, but also in transition to the steady state. Further, contractionary shocks to government spending increase both consumption and investment, although when $\zeta < 1$, hours worked falls. A government spending contraction, however, has expansionary outcomes for high values of ζ since hours work rises. Unlike in Diniz (2018), the effects of a consolidation shock on output is however largely driven by changes in private consumption and not private investments. These results corroborate with the fact that India and many EMEs are consumption-driven economies, and therefore fiscal consolidations are likely to affect the consumption channel more relative to the investment channel.

8. Conclusion

To model fiscal consolidations in EMEs, we develop a tractable small open economy real business cycle model with fiscal policy and financial frictions. We identify some novel mechanisms under which fiscal contractions are expansionary. We analyze two cases of fiscal consolidation – an expenditure based fiscal consolidation and a tax based fiscal consolidation as in the IMF WEO (2010). We show that a spending based fiscal consolidation is expansionary when private consumption is sluggish or when the weight on government expenditure vis-à-vis private consumption in the household's utility is sufficiently high. When the weight on government expenditure in the household's utility is low, both ways of fiscal consolidation are contractionary although the tax based consolidation is more contractionary than the spending based consolidation. We also show under both cases of consolidation the fiscal deficit as a percentage of output increases. In case of a spending based consolidations the fiscal deficit increases because the demand for government bonds increases, whereas, in the case of a tax based consolidation the fiscal deficit increases because output falls. When the habit parameter is not very high, government expenditure needs to be valued at least as much as private consumption for expansionary fiscal contractions. If the habit persistence parameter is sufficiently high, our model can generate expansionary effects on output for even lower weight on government expenditure in the household's utility. We also show that a positive foreign interest rate shock reduces output in the short run, but via a channel that does not require assuming that households have GHH preferences as in Neumeyer and Perri (2005). We also show that tax based consolidations are always costly, since they reduce output, although the magnitudes of these losses are smaller in comparison to expenditure based fiscal consolidations.

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Technical Appendix (for online publication)

This appendix provides the derivation of the linear system comprising the model we analyze. We note that this model is built for use with HP-filtered data and as such does not feature deterministic trends.

A.1 The Household's Problem

A representative household maximizes utility:

$$\max_{\{C_t,H_t,B_t,D_t,K_t\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{c} \mu \ln\left(C_t - \chi C_{t-1} + \zeta G_t\right) + (1-\mu-\varphi_1-\varphi_2)\ln\left(1-H_t\right) \\ +\varphi_1 \ln\left(D_t\right) + \varphi_2 \ln\left(B_t\right) \end{array} \right],$$

where $\beta \in (0,1)$, $G_t \sim CSSP(\bar{G}, \rho_G, \sigma_G)$ and subject to,

$$C_t + K_t - (1-\delta)K_{t-1} + \frac{\phi}{2}K_{t-1}\left[\frac{K_t}{K_{t-1}} - 1\right]^2 + B_t + \frac{\kappa_1}{2}Y_t\left[\frac{B_t}{Y_t} - \frac{\bar{B}}{\bar{Y}}\right]^2 + D_t + \frac{\kappa_2}{2}Y_t\left[\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right]^2$$
$$= (1-\tau_w)W_t H_t + (1-\tau_k)R_t K_{t-1} + R^P_{t-1}B_{t-1} + R^G_{t-1}D_{t-1} + T_t$$

where $CSSP$ denotes a covariance stationary stochastic process. The Lagrangian of the problem, where Λ_t is the multiplier on the household budget constraint, is

$$\max_{\{C_t,H_t,B_t,D_t,K_t\}} L = \left[\sum_{t=0}^{\infty} \beta^t \left[\mu \ln\left(C_t - \chi C_{t-1} + \zeta G_t\right) + (1-\mu-\varphi)\ln\left(1-H_t\right) + \varphi \ln\left(D_t\right)\right]\right]$$
$$- \left[\sum_{t=0}^{\infty} \beta^t \Lambda_t \left[\begin{array}{c} C_t + K_t - (1-\delta)K_{t-1} + \frac{\phi}{2}K_{t-1}\left[\frac{K_t}{K_{t-1}} - 1\right]^2 + B_t \\ +\frac{\kappa_1}{2}Y_t\left[\frac{B_t}{Y_t} - \frac{\bar{B}}{\bar{Y}}\right]^2 + D_t + \frac{\kappa_2}{2}Y_t\left[\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right]^2 \\ -\left[(1-\tau_w)W_t H_t + (1-\tau_k)R_t K_{t-1} + R^P_{t-1}B_{t-1} + R^G_{t-1}D_{t-1} + T_t\right] \end{array} \right]\right]$$

and the FONC are, for C_t, H_t, K_t, B_t and D_t respectively,

$$\Lambda_t = \frac{\mu}{C_t - \chi C_{t-1} + \zeta G_t} - \frac{\chi\mu}{C_{t+1} - \chi C_t + \zeta G_{t+1}}$$
$$(1-\tau_w)\Lambda_t W_t = \frac{1-\mu-\varphi_1-\varphi_2}{1-H_t}$$
$$E_t \left\{ \begin{array}{c} \beta\Lambda_{t+1}\left[(1-\delta) - \frac{\phi}{2}\left[\frac{K_{t+1}}{K_t} - 1\right]^2 + \frac{\phi K_{t+1}}{K_t}\left[\frac{K_{t+1}}{K_t} - 1\right] + (1-\tau_k)R_{t+1}\right] \\ = \Lambda_t\left[1+\phi\left[\frac{K_t}{K_{t-1}} - 1\right]\right] \end{array} \right\}$$
$$E_t\left\{\beta\Lambda_{t+1}R_t^P = \Lambda_t\left[1+\kappa_1\left[\frac{B_t}{Y_t} - \frac{\bar{B}}{\bar{Y}}\right]\right] - \frac{\varphi_2}{B_t}\right\}$$
$$E_t\left\{\beta\Lambda_{t+1}R_t^G = \Lambda_t\left[1+\kappa_2\left[\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right]\right] - \frac{\varphi_1}{D_t}\right\}.$$

The household problem therefore delivers the following system of 7 equations:

$$\Lambda_t = \frac{\mu}{C_t - \chi C_{t-1} + \zeta G_t} - \frac{\chi\mu}{C_{t+1} - \chi C_t + \zeta G_{t+1}}$$
$$(1-\tau_w)\Lambda_t W_t = \frac{1-\mu-\varphi_1-\varphi_2}{1-H_t}$$
$$E_t\left\{\beta\Lambda_{t+1}\left[(1-\delta) - \frac{\phi}{2}\left[\frac{K_t}{K_{t-1}} - 1\right]^2 + \phi\frac{K_{t+1}}{K_t}\left[\frac{K_t}{K_{t-1}} - 1\right] + (1-\tau_k)R_{t+1}\right] = \Lambda_t\left[1+\phi\left[\frac{K_t}{K_{t-1}} - 1\right]\right]\right\}$$
$$E_t\left\{\beta\Lambda_{t+1}R_t^P = \Lambda_t\left[1+\kappa_1\left[\frac{B_t}{Y_t} - \frac{\bar{B}}{\bar{Y}}\right]\right] - \frac{\varphi_2}{B_t}\right\}$$
$$E_t\left\{\beta\Lambda_{t+1}R_t^G = \Lambda_t\left[1+\kappa_2\left[\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right]\right] - \frac{\varphi_1}{D_t}\right\}$$
$$C_t + K_t - (1-\delta)K_{t-1} + \frac{\phi}{2}K_{t-1}\left[\frac{K_t}{K_{t-1}} - 1\right]^2 + B_t + \frac{\kappa_1}{2}Y_t\left[\frac{B_t}{Y_t} - \frac{\bar{B}}{\bar{Y}}\right]^2 + D_t + \frac{\kappa_2}{2}Y_t\left[\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right]^2$$
$$= (1-\tau_w)W_t H_t + (1-\tau_k)R_t K_{t-1} + R_{t-1}^P B_{t-1} + R_{t-1}^G D_{t-1} + T_t$$
$$\text{where } G_t \sim CSSP(\bar{G}, \rho_G, \sigma_G)$$

in 15 parameters

$$\{\beta, \chi, \mu, \zeta, \varphi_1, \varphi_2, \delta, \phi, \kappa_1, \kappa_2, \tau_w, \tau_k, \bar{G}, \rho_G, \sigma_G\}$$

and 13 variables

$$\{C_t, G_t, H_t, D_t, K_t, B_t, Y_t, W_t, R_t, R_t^P, R_t^G, T_t, \Lambda_t\}.$$

A2. The Firm's Problem

The firm seeks to maximize it's profits given by,

$$\max_{\{K_{t-1},H_t\}} \; Y_t - R_t K_{t-1} - (1-\theta) W_t H_t - \theta W_t H_t R^P_{t-1},$$

subject to

$$Y_t = A_t K_{t-1}^{\alpha} H_t^{1-\alpha}$$
$$A_t \sim CSSP(\bar{A}, \rho_A, \sigma_A)$$

This optimization yields 2 First order conditions,

$$\frac{(1-\alpha)Y_t}{H_t} = W_t \left[(1-\theta) + \theta R^P_{t-1}\right]$$
$$\frac{\alpha Y_t}{K_{t-1}} = R_t$$

The firm problem therefore delivers the following system of 4 equations:

$$\frac{(1-\alpha)Y_t}{H_t} = W_t \left[(1-\theta) + \theta R^P_{t-1}\right]$$
$$\frac{\alpha Y_t}{K_{t-1}} = R_t$$
$$Y_t = A_t K_{t-1}^{\alpha} H_t^{1-\alpha}$$
$$A_t \sim CSSP(\bar{A}, \rho_A, \sigma_A)$$

with the addition of 5 parameters $\{\theta, \alpha, \bar{A}, \rho_A, \sigma_A\}$ and 1 variable (A_t) to the household system.

A.3 Government Budget Constraint

The government budget constraint is given by

$$G_t + T_t = \tau_w W_t H_t + \tau_k R_t K_t + D_t - R^G_{t-1} D_{t-1},$$

where

$$
\begin{aligned}
R_t^G &= \xi R_t^* \exp\left(\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right) \\
R_t^P &= \Gamma R_t^G \\
R_t^* &\sim CSSP(\bar{R}^*, \rho_{R^*}, \sigma_{R^*})
\end{aligned}
$$

The specification for government behavior therefore delivers 4 additional equations to the system so far:

$$
\begin{aligned}
G_t + T_t = \tau_w W_t H_t + \tau_k R_t K_t + D_t - R_{t-1}^G D_{t-1} \\
R_t^G = \xi R_t^* \exp\left(\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right) \\
R_t^P = \Gamma R_t^G \\
R_t^* \sim CSSP(\bar{R}^*, \rho_{R^*}, \sigma_{R^*})
\end{aligned}
$$

with the addition of 5 parameters $\{\xi, \Gamma, \bar{R}^*, \rho_{R^*}, \sigma_{R^*}\}$ and 1 variable (R_t^*) to the system given by the household and firm problems.

A.4 The Nonlinear System

Collecting across economic actors, the system of expectational difference equations is

$$\Lambda_t = \frac{\mu}{C_t - \chi C_{t-1} + \zeta G_t} - \frac{\chi\mu}{C_{t+1} - \chi C_t + \zeta G_{t+1}} \tag{N1}$$

$$(1-\tau_w)\Lambda_t W_t = \frac{1-\mu-\varphi_1-\varphi_2}{1-H_t} \tag{N2}$$

$$E_t\left\{\beta\Lambda_{t+1}\left[1-\delta-\frac{\phi}{2}\left[\frac{K_{t+1}}{K_t}-1\right]^2+\frac{\phi K_{t+1}}{K_t}\left[\frac{K_{t+1}}{K_t}-1\right]+(1-\tau_k)R_{t+1}\right] = \Lambda_t\left[1+\phi\left[\frac{K_t}{K_{t-1}}-1\right]\right]\right\} \tag{N3}$$

$$E_t\left\{\beta\Lambda_{t+1}R_t^P = \Lambda_t\left[1+\kappa_1\left[\frac{B_t}{Y_t}-\frac{\bar{B}}{\bar{Y}}\right]\right]-\frac{\varphi_2}{B_t}\right\} \tag{N4}$$

$$E_t\left\{\beta\Lambda_{t+1}R_t^G = \Lambda_t\left[1+\kappa_2\left[\frac{D_t}{Y_t}-\frac{\bar{D}}{\bar{Y}}\right]\right]-\frac{\varphi_1}{D_t}\right\} \tag{N5}$$

$$C_t + K_t - (1-\delta)K_{t-1} + \frac{\phi}{2}K_{t-1}\left[\frac{K_t}{K_{t-1}}-1\right]^2 + B_t + \frac{\kappa_1}{2}Y_t\left[\frac{B_t}{Y_t}-\frac{\bar{B}}{\bar{Y}}\right]^2 + D_t + \frac{\kappa_2}{2}Y_t\left[\frac{D_t}{Y_t}-\frac{\bar{D}}{\bar{Y}}\right]^2 \tag{N6}$$

$$= (1-\tau_w)W_tH_t + (1-\tau_k)R_tK_{t-1} + R_{t-1}^P B_{t-1} + R_{t-1}^G D_{t-1} + T_t$$

$$\frac{(1-\alpha)Y_t}{H_t} = W_t\left[(1-\theta)+\theta R_{t-1}^P\right] \tag{N7}$$

$$\frac{\alpha Y_t}{K_{t-1}} = R_t \tag{N8}$$

$$Y_t = A_t K_{t-1}^{\alpha} H_t^{1-\alpha} \tag{N9}$$

$$G_t + T_t = \tau_w W_t H_t + \tau_k R_t K_t + D_t - R_{t-1}^G D_{t-1} \tag{N10}$$

$$R_t^G = \xi R_t^* \exp\left(\frac{D_t}{Y_t}-\frac{\bar{D}}{\bar{Y}}\right) \tag{N11}$$

$$R_t^P = \Gamma R_t^G \tag{N12}$$

$$G_t \sim CSSP(\bar{G}, \rho_G, \sigma_G) \tag{N13}$$

$$A_t \sim CSSP(\bar{A}, \rho_A, \sigma_A) \tag{N14}$$

$$R_t^* \sim CSSP(\bar{R}^*, \rho_{R^*}, \sigma_{R^*}) \tag{N15}$$

which is a nonlinear system of 15 equations in:

- 25 parameters $\{\beta, \chi, \mu, \zeta, \varphi_1, \varphi_2, \delta, \phi, \kappa_1, \kappa_2, \tau_w, \tau_k, \theta, \alpha, \Gamma, \xi, \bar{G}, \bar{A}, \bar{R}^*, \rho_G, \rho_A, \rho_{R^*}, \sigma_G, \sigma_A, \sigma_{R^*}\}$

and,

- 15 variables $\{C_t, H_t, D_t, K_t, B_t, Y_t, W_t, R_t, R_t^P, R_t^G, T_t, \Lambda_t, G_t, A_t, R_t^*\}$.

A.5 The Nonstochastic Steady State

Assume that the steady state values $\bar{A}$, $\bar{G}$ and $\bar{R}^*$ are in hand, then $\bar{R}^G$ is in hand from equation 11 above:

$$R_t^G = \xi R_t^* \exp\left(\frac{D_t}{Y_t} - \frac{\bar{D}}{\bar{Y}}\right) \rightarrow \bar{R}^G = \xi \bar{R}^*.$$

Equation (3) above yields the expression for $\bar{R}$:

$$E_t \left\{ \begin{array}{c} \beta\Lambda_{t+1}\left[1-\delta-\frac{\phi}{2}\left[\frac{K_{t+1}}{K_t}-1\right]^2+\frac{\phi K_{t+1}}{K_t}\left[\frac{K_{t+1}}{K_t}-1\right]+(1-\tau_k)R_{t+1}\right] \\ =\Lambda_t\left[1+\phi\left[\frac{K_t}{K_{t-1}}-1\right]\right] \end{array} \right\} \rightarrow \bar{R} = \frac{1-\beta(1-\delta)}{\beta(1-\tau_k)},$$

and finally equation (12) above yields the expression for $\bar{R}^P$:

$$R_t^P = \Gamma R_t^G \rightarrow \bar{R}^P = \Gamma \bar{R}^G$$

The remaining (9) equation system in the steady state is

$$\bar{\Lambda} = \frac{\mu(1-\chi)}{(1-\chi)\bar{C} + \zeta\bar{G}}$$
$$(1-\tau_w)\bar{\Lambda}\bar{W} = \frac{1-\mu-\varphi_1-\varphi_2}{1-\bar{H}}$$
$$\beta\bar{\Lambda}\bar{R}^P = \bar{\Lambda} - \frac{\varphi_2}{\bar{B}}$$
$$\beta\bar{\Lambda}\bar{R}^G = \bar{\Lambda} - \frac{\varphi_1}{\bar{D}}$$
$$\bar{C} + \delta\bar{K} + \bar{B} + (1-\bar{R}^G)\bar{D} = (1-\tau_w)\bar{W}\bar{H} + (1-\tau_k)\bar{R}\bar{K} + \bar{R}^P\bar{B} + \bar{T}$$
$$\frac{(1-\alpha)\bar{Y}}{(1-\theta+\theta\bar{R}^P)\bar{H}} = \bar{W} \leftrightarrow \frac{\bar{W}\bar{H}}{\bar{Y}} = \frac{1-\alpha}{1-\theta+\theta\bar{R}^P}$$
$$\frac{\alpha\bar{Y}}{\bar{K}} = \bar{R}$$
$$\bar{Y} = \bar{A}\bar{K}^\alpha\bar{H}^{1-\alpha}$$
$$\bar{G} + \bar{T} = \tau_w\bar{W}\bar{H} + \tau_k\bar{R}\bar{K} + \bar{D} - \bar{R}^G\bar{D}$$

from which we need to determine the steady state values for C_t, H_t, D_t, K_t, Y_t, W_t, T_t, B_t and Λ_t. Combining the 5^{th} and 9^{th} equations in the above system eliminates

$$\bar{T} = \tau_w \bar{W}\bar{H} + \tau_k \bar{R}\bar{K} + \bar{D} - \bar{R}^G \bar{D} - \bar{G}$$

and yields

$$\begin{aligned}
\bar{\Lambda} &= \frac{\mu(1-\chi)}{(1-\chi)\bar{C} + \zeta\bar{G}} \\
(1-\tau_w)\bar{\Lambda}\bar{W} &= \frac{1-\mu-\varphi_1-\varphi_2}{1-\bar{H}} \\
\bar{\Lambda} &= \frac{\varphi_2}{\bar{B}(1-\beta\bar{R}^P)} \\
\bar{D} &= \frac{\varphi_1}{(\bar{\Lambda}-\beta\bar{\Lambda}\bar{R}^G)} \\
\bar{G} + (1-\bar{R}^P)\bar{B} &= \bar{W}\bar{H} + (\bar{R}-\delta)\bar{K} - \bar{C} \\
\bar{W} &= \frac{(1-\alpha)\bar{Y}}{(1-\theta+\theta\bar{R}^P)\bar{H}} \\
\frac{\alpha\bar{Y}}{\bar{K}} &= \bar{R} \\
\bar{Y} &= \bar{A}\bar{K}^\alpha \bar{H}^{1-\alpha}
\end{aligned}$$

Next, we can eliminate $\bar{K} = \alpha\frac{\bar{Y}}{\bar{R}}$

$$\bar{Y} = \bar{A}\left(\alpha\frac{\bar{Y}}{\bar{R}}\right)^\alpha \bar{H}^{1-\alpha} \tag{18}$$

$$\bar{Y} = \left(\bar{A}\left(\frac{\alpha}{\bar{R}}\right)^\alpha\right)^{\frac{1}{1-\alpha}} \bar{H} \tag{19}$$

$$\bar{Y} = \vartheta_1\bar{H},\ \vartheta_1 = \left(\bar{A}\left(\frac{\alpha}{\bar{R}}\right)^\alpha\right)^{\frac{1}{1-\alpha}} \tag{20}$$

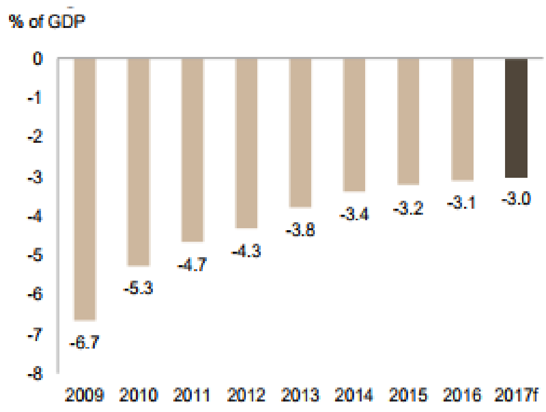
yielding

$$
\begin{aligned}
\bar{\Lambda} &= \frac{\mu(1-\chi)}{(1-\chi)\bar{C}+\zeta\bar{G}} \\
(1-\tau_w)\bar{\Lambda}\bar{W} &= \frac{1-\mu-\varphi_1-\varphi_2}{1-\bar{H}} \\
\bar{\Lambda} &= \frac{\varphi_2}{\bar{B}(1-\beta\bar{R}^P)} \\
\bar{D} &= \frac{\varphi_1}{(\bar{\Lambda}-\beta\bar{\Lambda}\bar{R}^G)} \\
\bar{G}+(1-\bar{R}^P)\bar{B} &= \bar{W}\bar{H}+(\bar{R}-\delta)\bar{K}-\bar{C} \\
\bar{W} &= \frac{(1-\alpha)\vartheta_1}{(1-\theta+\theta\bar{R}^P)} = \vartheta_2
\end{aligned}
$$

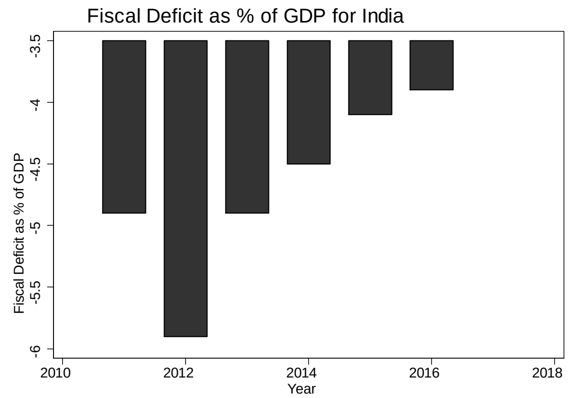
Then letting $\vartheta_3 = 1-\mu-\varphi_1-\varphi_2$

$$
\begin{aligned}
\bar{C} &= \frac{\mu}{\bar{\Lambda}} - \frac{\zeta\bar{G}}{1-\chi} \\
\bar{H} &= \frac{(1-\tau_w)\vartheta_2\bar{\Lambda}-\vartheta_3}{(1-\tau_w)\vartheta_2\bar{\Lambda}} \\
\bar{B} &= \frac{(1-\beta\bar{R}^P)}{\varphi_2}\bar{\Lambda} \\
\bar{D} &= \frac{(1-\beta\bar{R}^G)}{\varphi_1}\bar{\Lambda} \\
\vartheta_6\bar{\Lambda}^2 - \vartheta_5\bar{\Lambda}+\vartheta_4 &= 0 \\
\bar{\Lambda} &= \frac{\vartheta_5 \pm \sqrt{\vartheta_5^2-4\vartheta_4\vartheta_6}}{2\vartheta_6} \\
\vartheta_4 &= \bar{R}\vartheta_2(1-\chi)\varphi_2\vartheta_3 + (1-\chi)\varphi_2(\bar{R}-\delta)\alpha\vartheta_1\vartheta_3 + \bar{R}\vartheta_2\mu(1-\tau_w)(1-\chi)\varphi_2 \\
\vartheta_5 &= \left[\begin{array}{c} \bar{R}\vartheta_2(1-\chi)\varphi_2\vartheta_2(1-\tau_w) + (1-\chi)\varphi_2(\bar{R}-\delta)\alpha\vartheta_1(1-\tau_w)\vartheta_2 \\ +\bar{R}\vartheta_2(1-\tau_w)\varphi_2\zeta\bar{G} - \bar{R}\vartheta_2(1-\tau_w)(1-\chi)\varphi_2\bar{G} \end{array}\right] \\
\vartheta_6 &= \bar{R}\vartheta_2(1-\tau_w)(1-\chi)(1-\bar{R}^P)(1-\beta\bar{R}^P).
\end{aligned}
$$

Figures



Recent trends in Fiscal Deficit (% of GDP) in Malaysia.



Recent trends in Fiscal Deficit (% of GDP) in India.

Figure 1: Recent trends in Fiscal Deficit in Malaysia and India

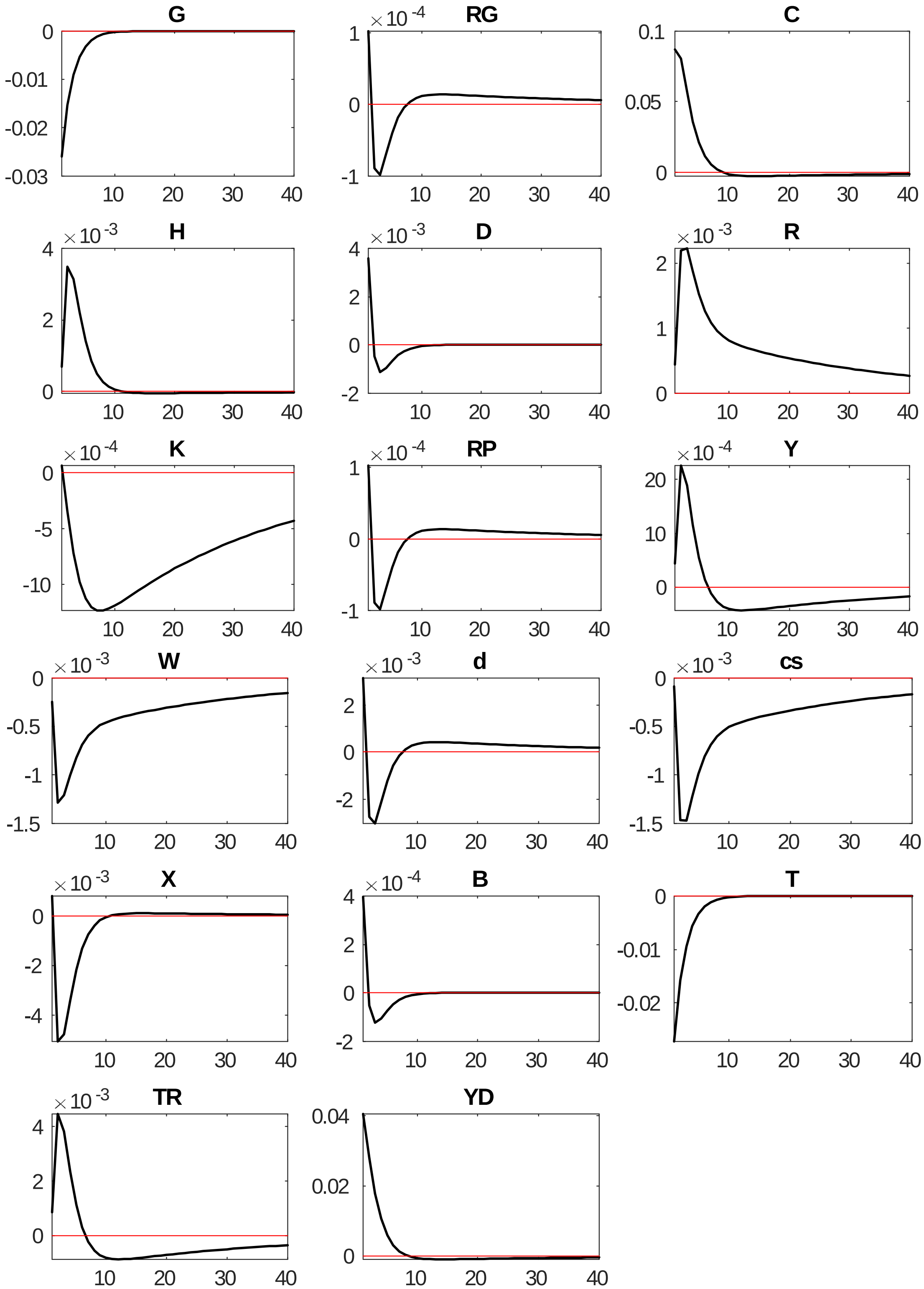


Figure 2: Impulse responses for a single period $\widehat{G}$ shock

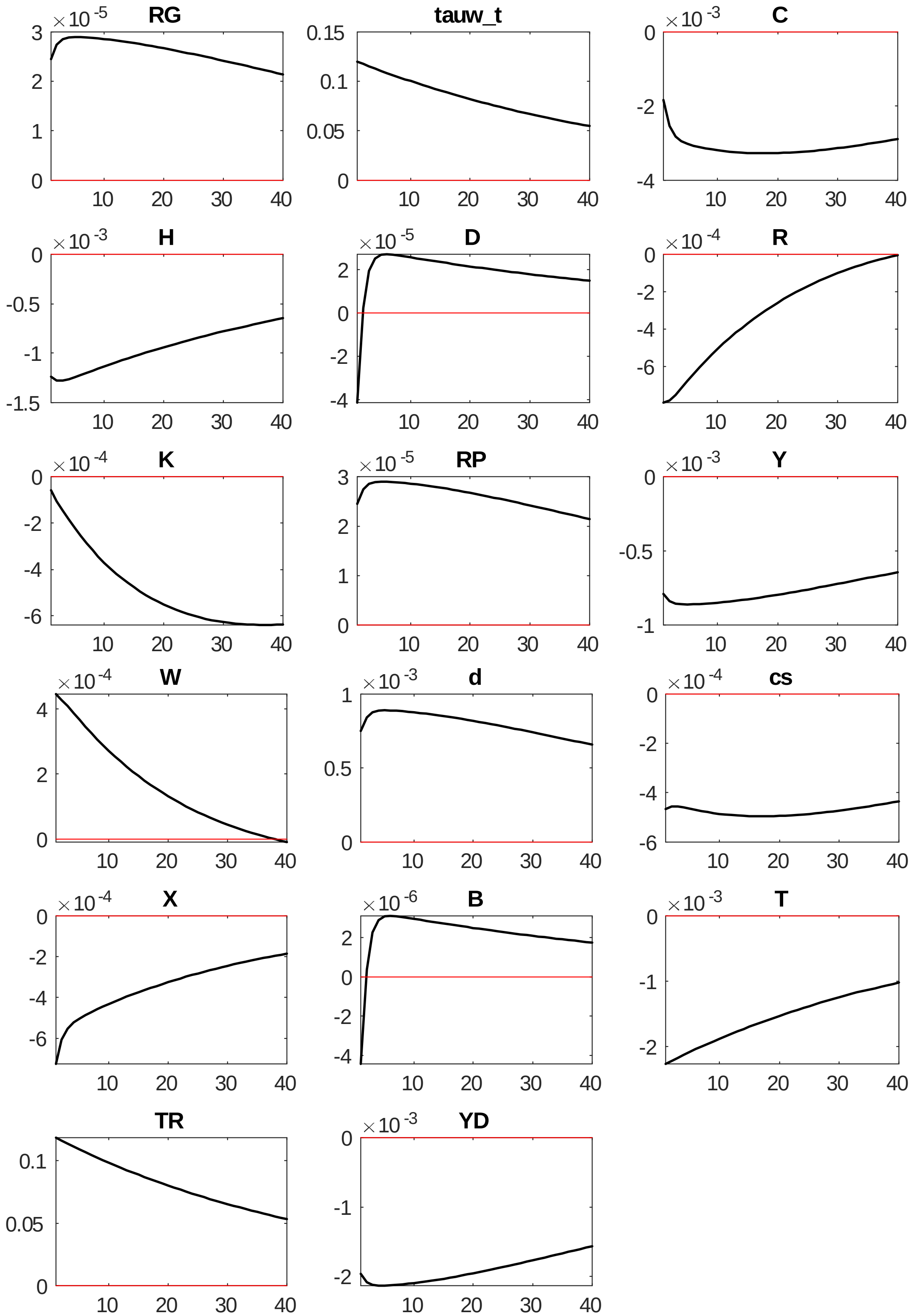


Figure 3: Impulse responses for a single period $\widehat{\tau}_w$ shock

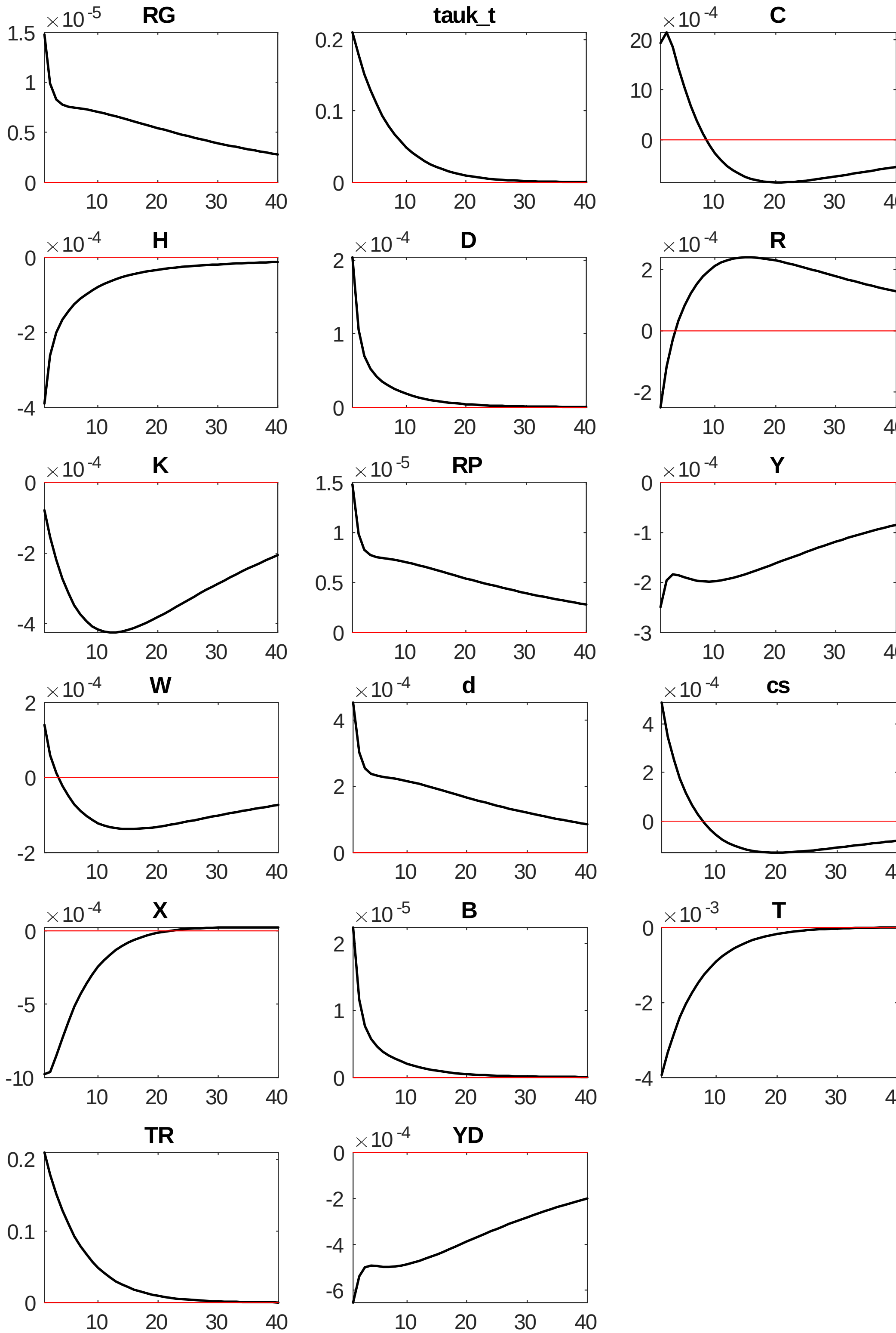


Figure 4: Impulse responses for a single period $\widehat{\tau}_k$ shock

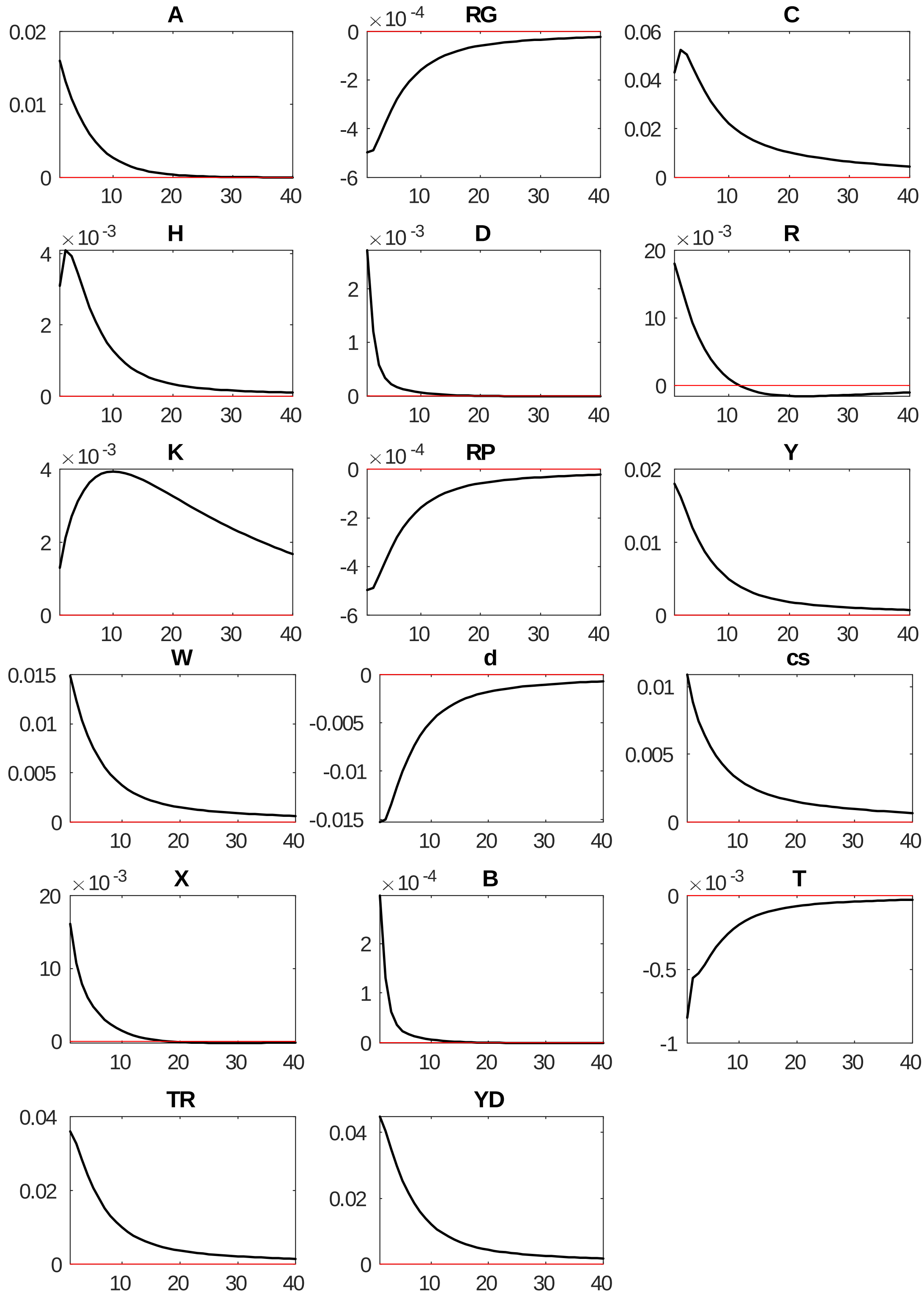


Figure 5: Impulse responses for a single period $\widehat{A}$ shock

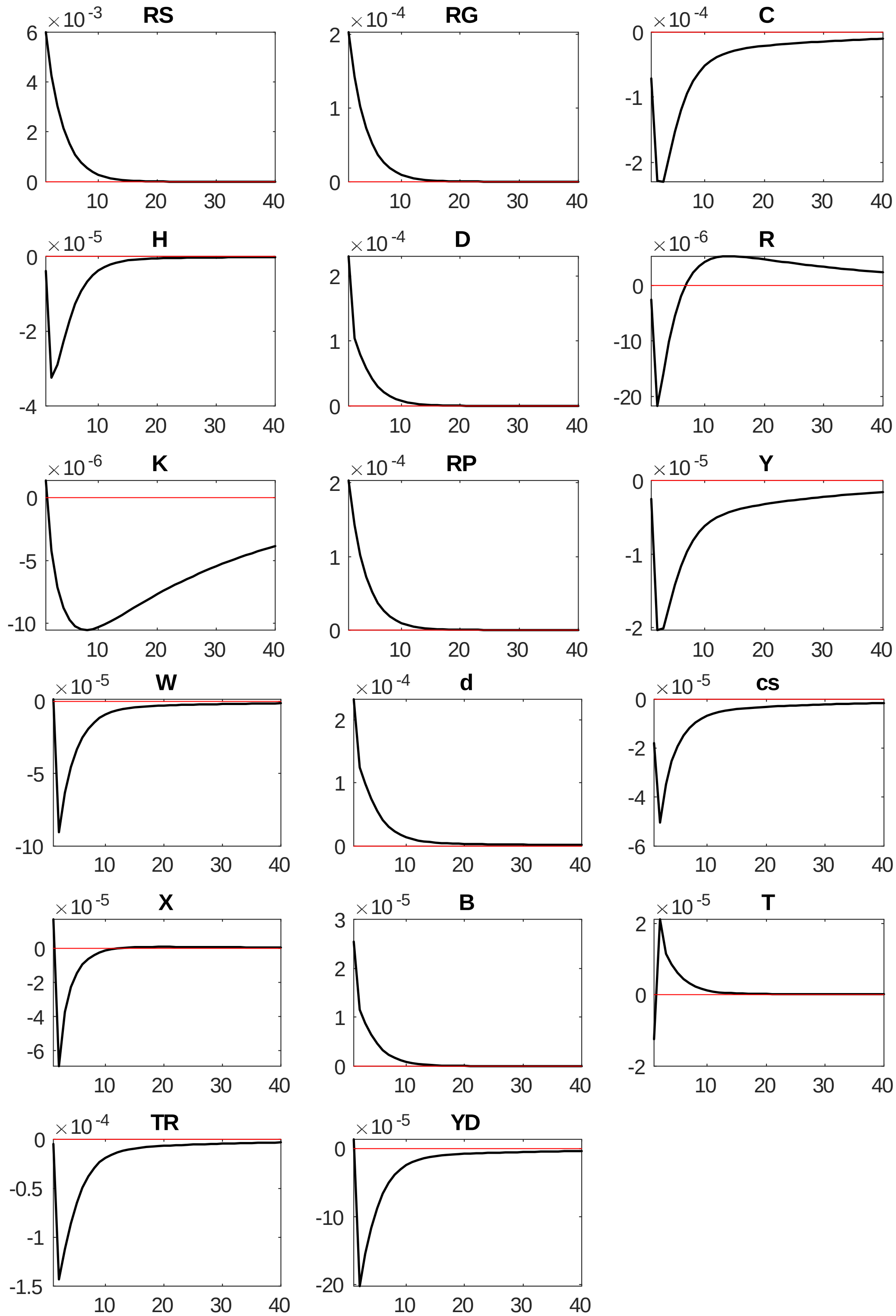


Figure 6: Impulse responses for a single period $\widehat{R}^*$ shock

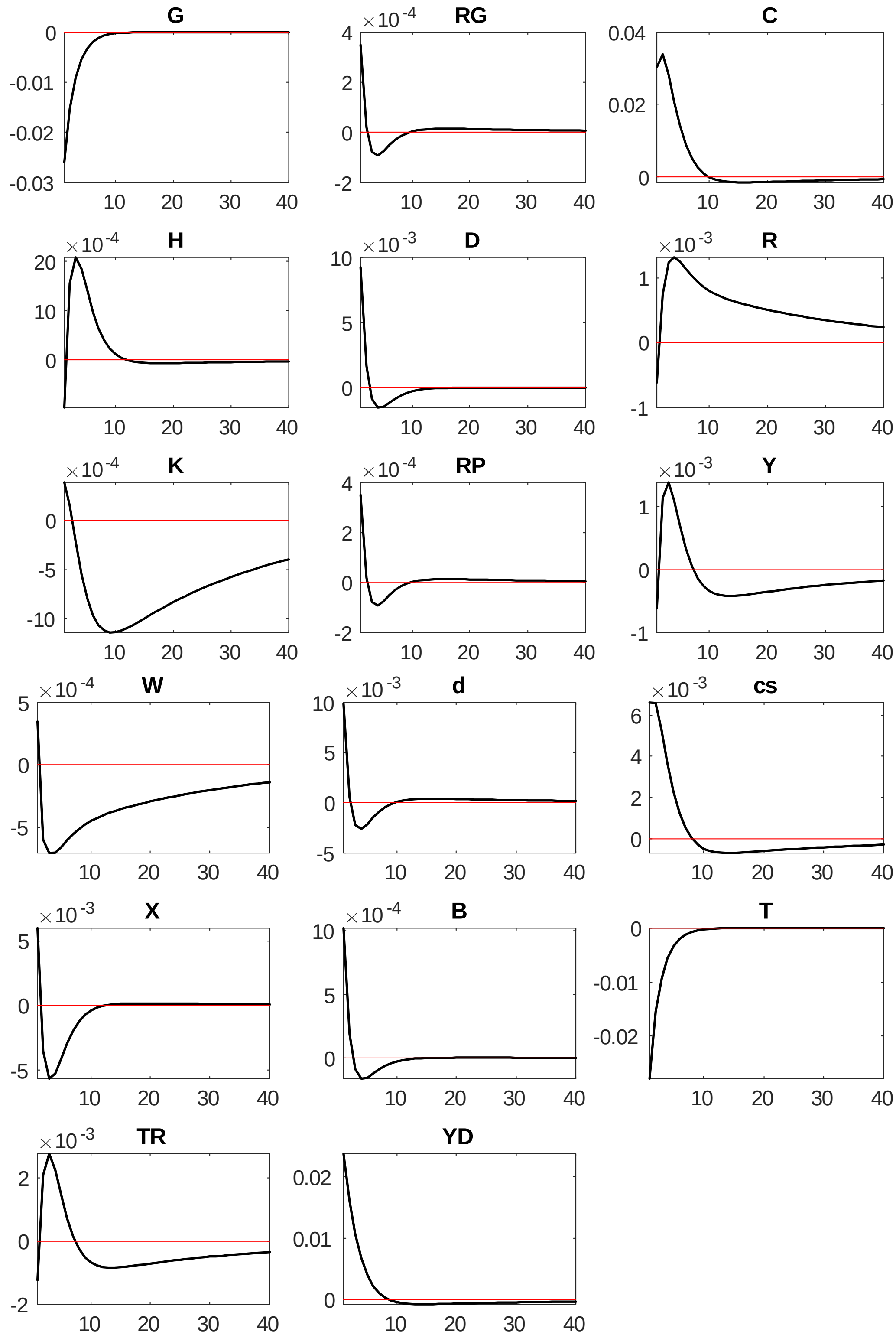


Figure 7: Robustness: Impulse responses for a single period $\widehat{G}$ shock for $\zeta < 1$