A VAR Approach to measuring the effect of fiscal plans
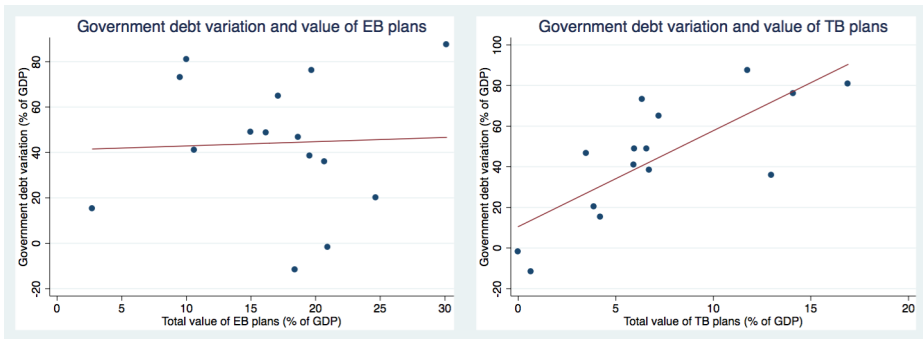
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February 2020

Introduction

- Suppose you are now interested in the dynamic response of the debt to GDP ratio to tax-based (TB) and expenditure-based (EB) fiscal adjustment plans

- There is by now a robust body of evidence in the empirical literature showing that the output effects of taxed-based adjustments are significantly larger than those of spending-based ones (Ramey 2018)

- A crucial criterion to assess the success of a stabilization plan is the response of the debt to GDP ratio, which is only partially determined by the GDP dynamics

Motivating evidence

Figure: Public debt variation and total value of EB and TB corrections for 15
OECD countries in our sample between 1978 and 2014

- ▶ Larger TB adjustments were associated with sharper debt increases,
  while this was not the case for EB plans

Empirical model

▶ To study the impact of a fiscal adjustment on the dynamics of the debt to GDP ratio, we specify a dynamic model in three parts:

1. A dynamic system for all the variables that enter the government inter-temporal budget constraint

2. The government inter-temporal budget constraint, specified as a (non-linear) identity determining the debt to GDP ratio

3. A system of equations to model fiscal plans, i.e. the *intra-* and *inter*-temporal correlations between unanticipated, announced and implemented fiscal measures

▶ As our plans are narratively identified as being motivated by past debt dynamics and not by the state of the cycle, some care is needed in the empirical analysis

  ▶ In the dynamic model no parameters are estimated in an equation projecting the debt dynamics or government interest expenses on fiscal adjustment plans

Empirical model I - Dynamic system

$$z_{i,t} = \begin{bmatrix} \Delta y_{i,t} \\ \Delta p_{i,t} \\ \Delta g_{i,t} \\ \Delta \tau_{i,t} \\ r_{i,t} \end{bmatrix} \quad a_i = \begin{bmatrix} a_{1,i} \\ a_{2,i} \\ a_{3,i} \end{bmatrix} \text{ similarly for } b_i$$

$$\Delta y_{i,t} = A_1(L)z_{i,t-1} + \begin{bmatrix} a_1' & b_1' \end{bmatrix} \begin{bmatrix} g_{i,t}^u \\ g_{i,t-1,t}^a \\ g_{t,t+1}^a \\ \tau_{i,t}^u \\ \tau_{i,t-1,t}^a \\ \tau_{t,t+1}^a \end{bmatrix} + \lambda_{1,i} + \chi_{1,t} + u_{1,i,t}$$

$$\Delta p_{i,t} = A_2(L)z_{i,t-1} + \begin{bmatrix} a_2' & b_2' \end{bmatrix} \begin{bmatrix} g_{i,t}^u \\ g_{i,t-1,t}^a \\ g_{t,t+1}^a \\ \tau_{i,t}^u \\ \tau_{i,t-1,t}^a \\ \tau_{t,t+1}^a \end{bmatrix} + \lambda_{2,i} + \chi_{2,t} + u_{2,i,t}$$

Empirical model I - Dynamic system

$$\Delta g_{i,t} = A_3(L)z_{i,t-1} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \end{bmatrix} \begin{bmatrix} g_{i,t}^u \\ g_{i,t-1,t}^a \\ \tau_{i,t}^u \\ \tau_{i,t-1,t}^a \end{bmatrix} + \lambda_{3,i} + \chi_{3,t} + u_{3,i,t}$$

$$\Delta \tau_{i,t} = A_4(L)z_{i,t-1} + \begin{bmatrix} \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \end{bmatrix} \begin{bmatrix} g_{i,t}^u \\ g_{i,t-1,t}^a \\ \tau_{i,t}^u \\ \tau_{i,t-1,t}^a \end{bmatrix} + \lambda_{4,i} + \chi_{4,t} + u_{4,i,t}$$

$$r_{i,t} = A_5(L)z_{i,t-1} + \lambda_{5,i} + \chi_{5,t} + u_{5,i,t}$$

Empirical model II - Govt intertemporal budget constraint

▶ The dynamics of the debt ratio for country i is determined in each period t by the inter-temporal government budget constraint:

$$d_{i,t} = \frac{1}{(1+x_{i,t})(1+\Delta p_{i,t})}d_{i,t-1} + (g_{i,t} - \tau_{i,t}) + r_{i,t} + ASFA_{i,t}$$

▶ $ASFA_{i,t}$ are determined by revenues from sales or purchases of financial and non-financial assets, revaluations (if debt is valued at market prices), and debt write-offs

  ▶ All these items do not enter the definition of the primary surplus $(\tau_{i,t} - g_{i,t})$
  ▶ The augmented version of SFA also contains the spending and revenues components unaffected by fiscal corrections that we did not include in neither $g_{i,t}$ nor $\tau_{i,t}$

▶ We verified within-sample the SFA consistency

Empirical model III - Modeling fiscal plans

▶ We complete the model above with a set of equations:
  ▶ modeling the share of tax and spending measures within EB and TB plans (*intra*-temporal correlation)
  ▶ describing the correlation between contemporaneous fiscal shifts and announcements (*inter*-temporal correlation)

$$\tau_{i,t}^u = \delta_0^{TB} e_{i,t}^u * TB_{i,t} + \delta_0^{EB} e_{i,t}^u * EB_{i,t} + \epsilon_{0,i,t}$$

$$g_{i,t}^u = (1 - \delta_0^{TB}) e_{i,t}^u * TB_{i,t} + (1 - \delta_0^{EB}) e_{i,t}^u * EB_{i,t} - \epsilon_{0,i,t}$$

$$\tau_{i,t,j}^a = \delta_j^{TB} e_{i,t}^u * TB_{i,t} + \delta_j^{EB} e_{i,t}^u * EB_{i,t} + \epsilon_{j,i,t} \quad j = 1, 2$$

$$g_{i,t,j}^a = \vartheta_j^{TB} e_{i,t}^u * TB_{i,t} + \vartheta_j^{EB} e_{i,t}^u * EB_{i,t} + \upsilon_{j,i,t} \quad j = 1, 2$$

Estimation

Table: Estimated coefficients in the equations for fiscal plans

δ_0^{TB}	δ_1^{TB}	δ_2^{TB}	δ_0^{EB}	δ_1^{EB}	δ_2^{EB}
0.7823	0.1552	0.0170	0.3918	-0.0415	0.0072
(0.0175)	(0.0278)	(0.0099)	(0.0104)	(0.0165)	(0.0059)

$1-\delta_0^{TB}$	ϑ_1^{TB}	ϑ_2^{TB}	$1-\delta_0^{EB}$	ϑ_1^{EB}	ϑ_2^{EB}
0.2177	0.1290	0.0305	0.6082	0.1590	0.0364
(0.0175)	(0.0315)	(0.0152)	(0.0104)	(0.0187)	(0.0091)

▶ The estimated parameters allow to:
  ▶ track the relative contribution of tax and spending measures to EB and TB plans
  ▶ reconstruct in simulation the typical package of implemented and announced tax and spending measures in EB and TB plans

Identification strategy

- Narrative identification of the exogenous (with respect to output) fiscal adjustment plans and their components

- Exogenous fiscal adjustment plans feature correlated expenditure and tax adjustments

- Extract two tax and expenditure adjustments from the data by organizing the data into EB and TB adjustments which are mutually exclusive

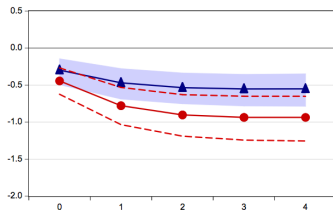- The estimation of the system for fiscal plans reveals the composition of EB and TB adjustment plans

Simulation and impulse responses

- The five equations in the dynamic system, as well as the fiscal plans regressions, are estimated simultaneously, and impulse responses are derived using the **?** generalized method:

$$I(\mathbf{z}_t, \eta, \delta, I_{t-1}) = E(\mathbf{z}_{t+\eta} \mid e_t = \delta, I_{t-1}) - E(\mathbf{z}_{t+\eta} \mid e_t = 0, I_{t-1})$$

- The structure of the fiscal correction $e_t = \delta$, in terms of the burden between immediately implemented and announced measures, is modeled using the system of fiscal plan equations

- Confidence intervals are computed using bootstrap simulations with block-resampling of the residuals from the system, so that the correlation of residuals across equation is preserved

Impulse responses for dynamic system variables I

Output (p.c.)

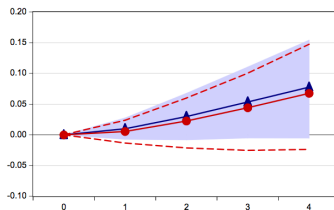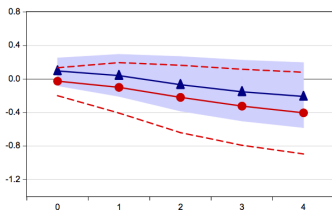## Inflation (left) – Net interest expenses (right)

Figure: Responses to an overall 1 percent fiscal correction. EB (blue) - TB (red)

Impulse responses for dynamic system variables II
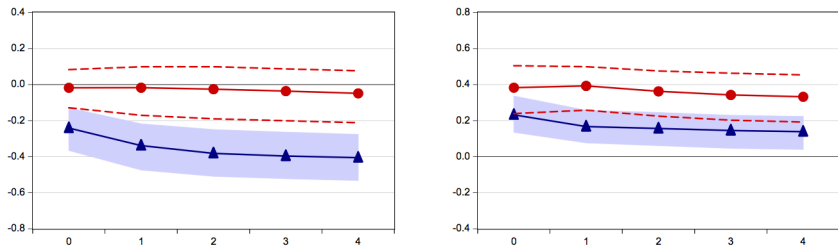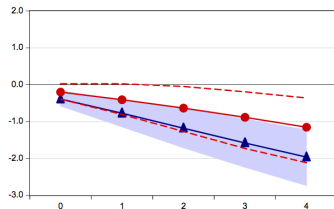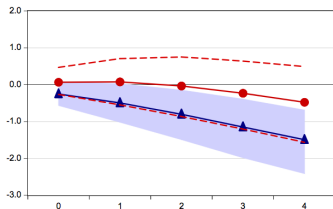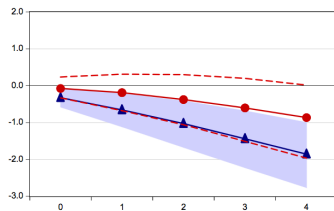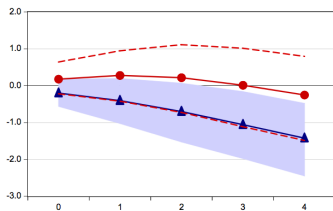
Spending (left) – Taxes (right)

Figure: Responses to an overall 1 percent fiscal correction. EB (blue) - TB (red)

Impulse responses for public debt: 4 scenarios

High cost of debt

Low cost of debt

High debt country (left) – Low debt country (right)

Output multipliers

- Fiscal multipliers of EB and TB permanent fiscal plans of one percent of GDP computed from the 5-equation model. Two definitions:

    1. Cumulated multiplier: $\sum_{t=0}^{4} \Delta y_t$

    2. Primary-surplus multiplier à la Woodford (2011): $\frac{\sum_{t=0}^{4} \Delta y_t}{\sum_{t=0}^{4} (\Delta \tau_t - \Delta g_t)}$

	$\sum_{t=0}^{4} \Delta y_t$	$\frac{\sum_{t=0}^{4} \Delta y_t}{\sum_{t=0}^{4} (\Delta \tau_t - \Delta g_t)}$
EB	-0.55	-1.02
	$(-0.78; -0.34)$	$(-1.43; -0.68)$
TB	-0.93	-2.47
	$(-1.25; -0.65)$	$(-3.69; -1.65)$