The Econometrics of Fiscal Policy

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Papers

This presentation is based on the following three papers:

- Alesina A., C.Favero and F.Giavazzi (forthcoming) "The Output Effect of Fiscal Adjustment Plans", Journal of International Economics
- Alesina A., Barbiero O., CA Favero, F.Giavazzi and M.Paradisi(2014) "Austerity in 2009-2013"
- Favero CA, M. Karamisheva (2015) "The Measurement of the Output Effect of Fiscal Adjustment"

Roadmap

- SVAR and Shocks
- The problem: Fiscal Foresight
- The solution: Narrative Identification
- From shocks to plans
  - How this can be done
  - What happens if you do not do it
- Empirical Results

SVAR and Shocks

- Empirical macro models (often SVARs) are used in the literature to establish empirical facts to be matched by theoretical models
  - VARs can be interpreted as (approximations to) reduced form of DSGE models
  - shocks are the "correct" experiment because the effect of shocks is measured without changing any parameter in simulation
- When analyzing the effect of economic policy VAR are reduced form approximation modelling jointly the structure of the economy and economic policy rules
- Exogenous deviations (obtained via appropriate rotations of the VAR innovations) from the rule are the interesting experiments to learn about the response of the macroeconomic variables to economic policy.

SVAR and Fiscal Policy

- Fiscal policy is conducted through rare decisions and it is implemented through multi-year plans.
- The very nature of fiscal policy and fiscal foresight prevent the application of standard identification techniques to construct the interesting experiments.

Fiscal Foresight

Fiscal foresight happens when agents receive signals on the taxes they will face in the future. Consider the simplest RBC model, adapted from Leeper(2008). The equilibrium conditions are the following:

$$\begin{aligned}
\frac{1}{C_t} &= \alpha\beta E_t\left(1-\tau_{t+1}\right)\frac{1}{C_{t+1}}\frac{Y_{t+1}}{K_t} \\
C_t + K_t &= Y_t = A_t K_{t-1}^{\alpha} \\
\tau_t &= \tau \exp\left(e_{t-p,t}^{\tau}\right) \\
A_t &= \exp\left(e_t^A\right)
\end{aligned}$$

This reduces (after log-linearization) to a bivariate model for capital and technology

$$\begin{aligned}
\theta E_t k_{t+1} - \left(1+\alpha\theta\right)k_t + \alpha k_{t-1} &= \rho E_t \tau_{t+1} - e_{A,t} \\
\theta &= \alpha\beta\left(1-\tau\right),\ \rho = \tau\frac{1-\theta}{1-\tau}
\end{aligned}$$

After solving the model we obtain the following representation:

$$
\begin{aligned}
k_t &= \alpha k_{t-1} + e_t^A - \rho \sum_{i=0}^{\infty} \theta^i E_t e^{\tau}_{t+1+i-p,t+1+i} \\
a_t &= e_t^A
\end{aligned}
$$

Consider now estimating a bivariate VAR in a_t, k_t and retrieving the two shocks from the VAR innovations. As the equilibrium looks different for different degrees of fiscal foresight, the outcome of this procedure would clearly be affected by it.

- In the case of no fiscal foresight the $(q = 0)$ the equilibrium is

$$
\begin{aligned}
k_t &= \alpha k_{t-1} + e_t^A \\
a_t &= e_t^A
\end{aligned}
$$

  and a VAR in a_t, k_t would feature stochastic singularity, as only one shock will drive the two variables.

- In the case of one-period fiscal foresight, $q = 1$, the equilibrium is

$$\begin{aligned} a_t &= e_t^A \\ k_t &= \alpha k_{t-1} + e_t^A - \rho e_{t,t+1}^{\tau} \end{aligned}$$

  and a Choleski identification for the innovations in the VAR in a_t, k_t would allow to correctly identify the structural shocks of interest.
- In the case of two-periods fiscal foresight, $q = 2$, the equilibrium is

$$\begin{aligned} a_t &= e_t^A \\ k_t &= \alpha k_{t-1} + e_t^A - \rho \left(e_{t-1,t+1}^{\tau} + \theta e_{t,t+2}^{\tau} \right) \end{aligned}$$

  and it would not be possible to identify the structural shocks of interest from the VAR innovations. In fact, for any $q \geqq 2$ we have non-invertibility of the moving average component of the time series of k_t (see Hansen and Sargent, 1991, Lippi and Reichlin, 1994).

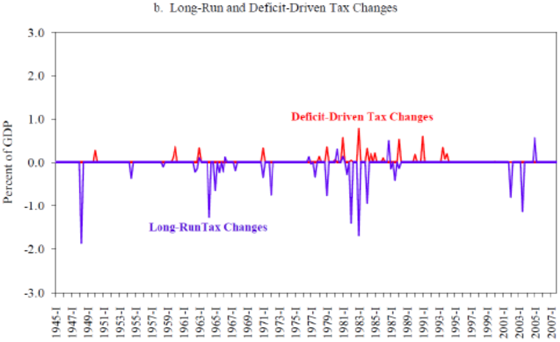
The R&R "narrative" approach

- A time-series of exogenous shifts in taxes is constructed using official documentation, such as congressional reports, etc.to identify the size, timing, and principal motivation for all major postwar tax policy actions
  - legislated tax changes are classified into endogenous (induced by short-run countercyclical concerns) and exogenous, taken to deal with an inherited budget deficit , or driven by concerns about long-run economic growth or politically motivayed: ε_{t-i}^{RR}
- ε_{t-i}^{RR} measure the impact of a tax change at the time it was implemented $(t-i)$ on tax liabilities at time t.
- the effect of ε_{t-i}^{RR} on output is estimated using quarterly data and OLS in a single equation, a truncated $(M{=}12)$ MA

$$\Delta y_t = a + \sum_{j=0}^{M} b_i e_{t-j}^{RR} + v_t$$

For $M{=}12$. Note that this equation is a truncated MA. Impulse responses

The R&R "narrative" approach



R&R shocks

- Devries et al (2011, D&al) and used in Guajardo et al (*forthcoming)*. These episodes cover 17 OECD countries between 1978 and 2009. Among all stabilization episodes these authors have selected those that were designed to reduce a budget deficit and to put the public debt on a sustainable path
- Cloyne(2012) does R&R for the UK

Fiscal Policy occurs through plans not shocks

- Narrative identification can be naturally used to study the response of output (and of other variables) to **multi-year fiscal consolidation plans** which is different from simulating the impact of **individual shifts** in tax revenue or in spending
- When fiscal policy is conducted through multi year plans, fiscal adjustments in each year — say year t — consist of three components:
  - unexpected shifts in fiscal variables (announced upon implementation at time t)
  - shifts implemented at time t but announced in previous years
  - future announced corrections (announced at time t for implementation in some future year).
- unanticipated and anticipated shifts and corrections in T and G are correlated

Pooling

- Fiscal plans are rare: pool episodes from different countries
    - pooling is dangerous in the presence of heterogeneity (Favero, Giavazzi, Perego 2012)
- AFG (2014) pool the data from different countries by allowing for **two sources of heterogeneity**
    - **within country** heterogeneity with respect to the type of fiscal adjustments: *TB* or *EB*
    - **between country** heterogeneity in the way fiscal policy is conducted, *e.g. persistence*

Step 1: Reconstructing plans

- Considering, for the sake of illustration, a forward horizon of 1 year, a narrative adjustments e_t can be described as follows:

$$\begin{aligned} e_t &= e_t^u + e_{t,0}^a + e_{t,1}^a \\ e_{t,1}^a &= \varphi_1 \; e_t^u + v_{t,1} \\ e_{t,0}^a &= e_{t-1,1}^a \end{aligned}$$

Step 1: The traditional approach

- In the traditional approach a truncated MA representation is adopted :

$$\Delta z_{i,t} = \alpha + B(L) e_{i,t} + \lambda_i + \chi_t + u_{i,t}$$

Two possible representation

- a truncated infinite MA from a VAR
- a specification to estimate an Average Treatment Effect

Step 2: A model to estimate and simulate plans without heterogeneity

Direct estimation of the MA representation:

$$\begin{aligned}
\Delta z_{i,t} &= \alpha + B_1(L) e^u_{i,t} + B_2(L) e^a_{i,t,0} + \\
&\quad + \gamma_1 e^a_{i,t,1} + \lambda_i + \chi_t + u_{i,t} \\
e^a_{i,t,1} &= \varphi_{i,1} e^u_{i,t} + v_{1,i,t} \\
e^a_{t,0} &= e^a_{t-1,1}
\end{aligned}$$

to be estimated on a panel of countries i for the variable of interest $\Delta z_{i,t}$.

- The standard MA representation is modified to allow flexibility in the effect of plans upon announcement and implementation.
- No distributed lag for the effect of future announced plans is introduced because the effect in time of announced adjustment is followed through the plan.

Step 3: A model to estimate and simulate plans with heterogeneity

But countries are different and plans are different so we propose:

$$
\begin{aligned}
\Delta z_{i,t} &= \alpha + B_1(L) e^u_{i,t} * TB_{i,t} + B_2(L) e^a_{i,t,0} * TB_{i,t} + \\
&\quad C_1(L) e^u_{i,t} * EB_{i,t} + C_2(L) e^a_{i,t,0} * EB_{i,t} + \\
&\quad + \gamma_1 e^a_{i,t,1} * EB_{i,t} + \delta_1 e^a_{i,t,1} * TB_{i,t} + \lambda_i + \chi_t + u_{i,t} \\
e^a_{i,t,1} &= \varphi_{i,1} \; e^u_{i,t} + v_{i,t,1} \\
e^a_{i,t,0} &= e^a_{i,t-1,1}
\end{aligned}
$$

$$
\begin{aligned}
e^u_{i,t} &= \tau^u_{i,t} + g^u_{i,t} \\
e^a_{i,t,0} &= \tau^a_{i,t,0} + g^a_{i,t,0} \\
if \; \left(\tau^u_t + \tau^a_{t,0} + \tau^a_{t,1}\right) &> \left(g^u_t + g^a_{t,0} + g^a_{t,1}\right) \Longrightarrow TB_t = 1, \; EB_t = 1 - TB_t
\end{aligned}
$$

Step 4: Putting the model at work

- Simulate, within sample, the output effect of fiscal adjustment plans (*i.e.* compute impulse responses)
- Simulate, out of sample, the effect of a specific plan (Austerity in 2009-2013)
  - auxiliary system non-necessary but useful to check that the simulated sample is not too different from the estimation sample
- Not a full econometric model, so out-of sample simulation does not produce a forecast of output conditioning upon a full information set, but rather conditioning upon a specific fiscal adjustment (that, if correctly identified, should be orthogonal to omitted info)

What are the consequences of collapsing plans into shocks?

$$e_t^{IMF} = e_t^u + e_{t,0}^a$$

1. Restrictions are imposed on the general model that allows for plans:

$$\begin{aligned} \Delta z_{i,t} &= \alpha + B_1(L)e_{i,t}^u + B_2(L)e_{i,t,0}^a + \\ &\quad + \gamma_1 e_{i,t,1}^a + \lambda_i + \chi_t + u_{i,t} \\ e_{i,t,1}^a &= \varphi_{i,1} e_{i,t}^u + v_{1,i,t} \\ e_{i,t,0}^a &= e_{i,t-1,1}^a \end{aligned}$$

$B_1(L) = B_2(L), \gamma_1 = 0$,(this is why the uncertainty surrounding our estimates is much smaller than that surrounding the IMF estimates). Auxiliary system for the style of plans not estimated.Simulated corrections might be very different from those observed in the sample used to estimate parameters.

What are the consequences of collapsing plans into shocks?

1. "Shocks" become predictable (Jordà and Taylor, 2013)

$$
\begin{aligned}
Cov\left(e_t^{IMF}, e_{t-1}^{IMF}\right) &= Cov\left(\left(e_t^u + e_{t,0}^a\right), \left(e_{t-1}^u + e_{t-1,0}^a\right)\right) \\
&= Cov\left(\left(e_t^u + e_{t-1,1}^a\right), \left(e_{t-1}^u + e_{t-1,0}^a\right)\right) \\
&= \varphi_1 Var\left(e_{t-1}^u\right)
\end{aligned}
$$

2. Similar consideration apply to R&R for which we have:

$$
\begin{aligned}
e_{i,t}^{RR} &= e_{i,t}^u + e_{i,t,1}^a \\
\Delta z_{i,t} &= \alpha + B(L) e_{i,t}^{RR} + \lambda_i + \chi_t + u_{i,t}
\end{aligned}
$$

imposes the restrictions that (i) shocks annouced now for the future have the same effect of shocks announced now and implemented now (ii) annouced shocks have no effect upon implementation

Exogeneity and Predictability

- Predictability of e_t^{IMF} by their own past does not necessarily imply violation of the relevant exogeneity concepts. Consider, for the sake of illustration, this simple representation

$$
\begin{aligned}
\Delta y_t &= \beta_0 + \beta_1 e_t^{IMF} + u_{1t} \\
e_t^{IMF} &= \rho e_{t-1}^{IMF} + u_{2t} \\
\begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} &\sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{pmatrix} \right]
\end{aligned}
$$

The condition required for e_t^{IMF} to be weakly exogenous for the estimation of β_1 is $\sigma_{12} = 0$, and it is independent of ρ.

Tax-based and spending-based plans: an example

Stabilization plans in Italy: 1991-1993												
year	τ_t^u	$\tau_{t,0}^a$	$\tau_{t,1}^a$	$\tau_{t,2}^a$	$\tau_{t,3}^a$	g_t^u	$g_{t,0}^a$	$g_{t,1}^a$	$g_{t,2}^a$	$g_{t,3}^a$	TB	EB
1991	1.69	0	-1.26	0	0	1.08	0	0	0	0	0	1
1992	2.85	-1.26	-1.2	0	0	1.9	0	0	0	0	0	1
1993	3.2	-1.2	-0.57	0	0	3.12	0	0	0	0	0	1

The Econometric Specification

$$\begin{aligned}
\Delta z_{i,t} &= \alpha + B_1(L)e^u_{i,t} * TB_{i,t} + B_2(L)e^a_{i,t,0} * TB_{i,t} + \\
&\quad C_1(L)e^u_{i,t} * EB_{i,t} + C_2(L)e^a_{i,t,0} * EB_{i,t} + \\
&\quad + \sum_{j=1}^{3} \gamma_j e^a_{i,t,j} * EB_{i,t} + \sum_{j=1}^{3} \delta_j e^a_{i,t,j} * TB_{i,t} + \lambda_i + \chi_t + u_{i,t}
\end{aligned} \tag{1}$$

$$\begin{aligned}
e^a_{i,t,1} &= \varphi_{1,i}\ e^u_{i,t} + v_{1,i,t} \\
e^a_{i,t,2} &= \varphi_{2,i}\ e^u_{i,t} + v_{2,i,t} \\
e^a_{i,t,3} &= \varphi_{3,i}\ e^u_{i,t} + v_{3,i,t} \\
e^a_{t,0} &= e^a_{t-1,1} \\
e^a_{t,j} &= e^a_{t-1,j+1} + \left(e^a_{t,j} - e^a_{t-1,j+1}\right)\ j \geqslant 1
\end{aligned}$$

- the model is estimated with SUR simultaneously for all 14 countries. It is a *quasi-panel*: cross-country restrictions on B_i, C_i, not on correlation between $e^a_{i,t,j}$ and $e^u_{i,t,j}$: we allow for heterogeneity in the style of fiscal plans
- z: (Y, C, I Business Confidence, Consuner Confidence, 3-mo Rate, Term spread) one at a time

Model Restrictions

$$
\begin{aligned}
\Delta z_{i,t} &= \alpha + B_1(L)\tau^u_{i,t} + B_2(L)\tau^a_{i,t,0} + \\
& C_1(L)g^u_{i,t} + C_2(L)g^a_{i,t,0} + \\
& + \sum_{j=1}^{3}\gamma^a_j\tau^a_{i,t,j} + \sum_{j=1}^{3}\delta_j g^a_{i,t,j} + \lambda_i + \chi_t + u_{i,t}
\end{aligned}
$$

$$
\begin{aligned}
\tau^a_{i,t,t+1} &= \varphi_{1,i}\ \tau^u_{i,t} + v_{1,i,t} & \tau^a_{i,t,t+1} &= \varphi_{7,i}\ g^u_{i,t} + v_{7,i,t} \\
\tau^a_{i,t,t+2} &= \varphi_{2,i}\ \tau^u_{i,t} + v_{2,i,t} & \tau^a_{i,t,t+2} &= \varphi_{8,i}\ g^u_{i,t} + v_{8,i,t} \\
\tau^a_{i,t,t+3} &= \varphi_{3,i}\ \tau^u_{i,t} + v_{3,i,t} & \tau^a_{i,t,t+3} &= \varphi_{9,i}\ g^u_{i,t} + v_{9,i,t} \\
g^a_{i,t,t+1} &= \varphi_{4,i}\ g^u_{i,t} + v_{4,i,t} & g^a_{i,t,t+1} &= \varphi_{10,i}\ \tau^u_{i,t} + v_{10,i,t} \\
g^a_{i,t,t+2} &= \varphi_{5,i}\ g^u_{i,t} + v_{5,i,t} & g^a_{i,t,t+2} &= \varphi_{11,i}\ \tau^u_{i,t} + v_{11,i,t} \\
g^a_{i,t,t+3} &= \varphi_{6,i}\ g^u_{i,t} + v_{6,i,t} & g^a_{i,t,t+3} &= \varphi_{12,i}\ \tau^u_{i,t} + v_{12,i,t} \\
g^u_{i,t} &= \varphi_{13,i}\ \tau^u_{i,t} + v_{13,i,t}
\end{aligned}
$$

- we estimate three $\varphi' s$ parameters instead of thirteen and then distinguish between tax-based and expenditure based adjustments.

ATE based on Local Projection Method

Consider first the case in which the narrative identified shocks satisfy the exogeneity property (selection on observables). In this case the average policy effect is

$$E\left[\left(y_{t,h}\left(d_j\right)-y_t\right)-\left(y_{t,h}\left(d_0\right)-y_t\right)\mid w_t\right]=\theta^h$$

can be calculated by the LPM (which is based again on a simplified MA representation)

$$y_{t+h}-y_t=\alpha^h+\theta^h e_t^{IMF}+\gamma^{h'}w_t+v_{t+h}$$

What is LPM ?

consider the following simple VAR, augmented with the observable, narratively identified, e_t^{IMF} shocks

$$Y_t = AY_{t-1} + \boldsymbol{\beta}_1 e_t^{IMF} + \epsilon_t$$

The MA if the VAR truncated at lag h is

$$\begin{aligned}
Y_{t+h} &= A^{h+1}Y_{t-1} + A^h \boldsymbol{\beta}_1 e_t^{IMF} + v_{t+i} \\
v_{t+i} &= \boldsymbol{\beta}_1 e_{t+h}^{IMF} + ...A^{h-1}\boldsymbol{\beta}_1 e_{t+1}^{IMF} + A^h \boldsymbol{\beta}_1 e_t^{IMF} + \\
&\quad + \epsilon_{t+h} + A\epsilon_{t+h-1} + ...A^i \epsilon_t
\end{aligned}$$

The impulse response

$$E\left(Y_{t+h} \mid e_t^{IMF} = 1, I_t\right) - E\left(Y_{t+h} \mid e_t^{IMF} = 0, I_t\right) = \frac{\partial Y_{t+h}}{\partial e_t^{IMF}} = A^i \boldsymbol{\beta}_1$$

can be obtained by a series of regressions

$$y_{t+h} = \pi_h' Y_{t-1} + \theta^h e_t^{IMF} + v_{t+i}$$

What is LPM ?

in practice the conditioning set Y_{t-1} can be augmented in LPM as LPM is based on a single equation estimation (after the identification of the shocks) and more degrees of freedom are available:

$$y_{t+h} = \gamma^{h'} w_t + \theta^h e_t^{IMF} + v_{t+i}$$

LPM regressions omit $e_{t+h}^{IMF}, ..., e_{t+1}^{IMF}$.This omitted variables problem would not lead to inconsistent estimates of the parameters of $A^i \boldsymbol{\beta}_1$ $(p\lim \hat{h}_i = A^i \beta_1)$ only if e_t^{IMF} were orthogonal to all omitted variables. Unfortunately, this orthogonality is lost when fiscal policy is implemented through plans because, as shown above, the very nature of plans generates a correlation in e_t^{IMF}. The hope for the LPM method is that w_t captures the relevant variation in all omitted variables.

ATE based on Local Projection Method and IPW

- If the IMF shocks can be predicted by controls and controls are correlated with output there is an allocation bias problem. Moving from plans to shocks is our route to solve this problem
- Jordà and Taylor (2013) proceed in a different way and try to apply the LPM after having purged the shocks from predictability :

(i) redefine e_t^{IMF} innovations as a 0/1 dummy variable,
(ii) estimate a *propensity score* deriving the probability with which a correction is expected by regressing it on its own past and predictors,
(iii) use the propensity score to derive an Average Treatment Effect based on Inverse Probability Weighting.

ATE based on Local Projection Method and IPW

Denote the policy propensity score $p^j(w,\psi)$ *for* $j = 1, 0$ (the predicted values from a probit projections of the policy indicator on the set of predictors w).

$$\begin{aligned}\theta^h &= E\left[\left(y_{t,h}(d_1) - y_t\right) - \left(y_{t,h}(d_0) - y_t\right) \mid w_t\right] \\ &= E\left[\left(y_{t,h} - y_t\right)\left(\frac{1\{D_t = d_1\}}{p^1(w,\psi)} - \frac{1\{D_t = d_0\}}{1 - p^1(w,\psi)}\right) \mid w_t\right]\end{aligned}$$

$$\begin{aligned}\hat{\theta}^h &= \frac{1}{T}\sum\left(y_{t,h} - y_t\right)\hat{\delta}_t \\ \hat{\delta}_t &= \frac{1\{D_t = d_1\}}{\hat{p}^1(w,\psi)} - \frac{1\{D_t = d_0\}}{1 - \hat{p}^1(w,\psi)}\end{aligned}$$

ATE based on Local Projection Method and IPW

In the LP framework ATE can be combined with LP in the following estimator LP-IWPRA estimator

$$\hat{\theta}^{h} = \frac{1}{T}\sum\left[\left(y_{t,h}-y_{t}\right)\hat{\delta}_{t}-\hat{\phi}_{t}m\left(w_{t},\gamma^{h}\right)\right]$$

$$\hat{\phi}_{t} = \frac{1\left\{D_{t}=d_{1}\right\}-\hat{p}^{1}\left(w,\psi\right)}{\hat{p}^{1}\left(w,\psi\right)}-\frac{1\left\{D_{t}=d_{0}\right\}-\left(1-\hat{p}^{1}\left(w,\psi\right)\right)}{1-\hat{p}^{1}\left(w,\psi\right)}$$

where $m\left(w_{t},\gamma^{h}\right)$ is the mean of $\left(y_{t,h}-y_{t}\right)$ predicted by the LP

Comments on Jorda-Taylor

- Replacing e_t^{IMF} innovations with a 0/1 dummy variable gives up relevant information on the intensity and the nature of the adjustment.
- The links between the announced and the implemented part of a stabilization plan are lost.
- the different effect of anticipated and unanticipated corrections depends only on the propensity score.
- Third, the presence of the forward looking component — which is omitted from the specification — might introduce a bias in the impulse response computed via local-projections whenever there is a systematic relation between the forward looking component and the unexpected component of the adjustment, as in the case in the D&al episodes.
- Fiscal plans are different across countries because the style of fiscal adjustments differs across countries: thus they cannot be assimilated to an identical common treatment administered to many patients.

Empirical Results

- use the narrative shocks by allowing for error-in-variables.
- not applicable to plans

Conclusions

- lots of work needed