# We just estimated twenty million fiscal multipliers

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JRC Fiscal Policy Modelling Workshop
February 2020

# Motivation and Research Question

- The estimation of fiscal multipliers (the ratio of the change in output to an exogenous change in government spending or taxes) is a central element in the evaluation of fiscal policy
- The precision in the estimation of fiscal multipliers contributes significantly to the quality of GDP growth predictions (Blanchard and Leigh, AER 2013)
- The estimates of fiscal multipliers in literature (even for the same country/time period) are notoriously heterogeneous
- How do methodological choices affect the size of empirical fiscal multipliers?
- We concentrate on fiscal multipliers estimated using structural VAR models and examine methodological choices:
  - Data definitions and transformations
  - Variables, lag length choice, deterministics in VAR model
  - Identification strategy for structural shocks

# Meta-analysis and fiscal multipliers

- Rusnak (Mimeo 2011) and Gechert (OEP 2015) conduct meta-analyses and concentrate on difference based on model characteristics (identification, number of variables, horizon, number of observations) ...
- ... but miss other important features (data composition, data transformations, ESA standard, VAR deterministics)
- Many possible combinations of all these characteristics, with few (or no) studies to cover the variability needed to identify the effects
- Many of these characteristics are considered innocuous by authors and are not even reported $\rightarrow$ let's compute them ourselves in a "controlled" manner

# Shock Identification

- Consider a reduced-form VAR model with macroeconomic and fiscal variables,

$$Y_t = \mu + M(L)Y_{t-1} + U_t,$$

where $A(L) = \sum_{j=0}^{p-1} M_j L^j$ is a lag polynomial and $U_t$ is a vector of potentially correlated error terms with $E(U_t U_t') = \Sigma_U$

- The vector of reduced-form shocks are related to (mutually uncorrelated) structural shocks through the matrices $B$ and $A_0$, so that

$$B\varepsilon_t = A_0 U_t$$

Restrictions on $B$ and $A_0$ need to be imposed to identify the structural shocks.

# The Recursive Approach

- Assuming $B = I$ and a lower-triangular $A_0$ matrix with unit diagonal implies a recursive structure in the reduced-form shocks.

- The VCV matrix of the reduced-form shocks is $\Sigma_u = A_0^{-1}\Sigma_\varepsilon(A_0^{-1})'$, which can be obtained using the Cholesky decomposition of $\Sigma_u$ after assuming a causal ordering of the shock responses:
  - spending
  - output
  - (prices)
  - taxes
  - (interest rates)

# The Blanchard-Perotti Approach

- In the simple three-variable case put forward by Blanchard & Perotti (QJE 2002),

$$
\begin{aligned}
t_t &= a_1 x_t + a_2 \varepsilon_t^g + \varepsilon_t^t \\
g_t &= b_1 x_t + b_2 \varepsilon_t^t + \varepsilon_t^g \\
x_t &= c_1 t_t + c_2 g_t + \varepsilon_t^x
\end{aligned}
$$

- Blanchard & Perotti fix the values of the parameters in this system by constructing the elast. to output of government purchases and of taxes, use the cyclically adjusted series as instruments to obtain $c_1$ and $c_2$ and then alternatively assume $a_2 = 0$ or $b_2 = 0$

# The Sign Restrictions Approach

Structural shocks can be identified via sign restrictions on the impulse responses of the VAR model:

- business cycle shock: the impulse responses of output and taxes are positive for at least the four quarters following the shock
- tax shock: the impulse responses of taxes are positive for at least the four quarters following the shock (and the shock is orthogonal to the business cycle shock)
- government spending shock: the impulse responses of government spending are positive for at least the four quarters following the shock (and the shock is orthogonal to the business cycle shock)

# From the VAR model to fiscal multipliers

We concentrate on discounted cumulative multipliers at time $T$, defined as

$$m(T) = \frac{\sum_{t=0}^{T}(1+i)^{-t}\Delta y_t}{\sum_{t=0}^{T}(1+i)^{-t}\Delta g_t},$$

where $i$ is the interest rate, $y_t$ is output at time $t$, $g_t$ is government expenditures at time $t$ and $\Delta$ denotes the deviation from benchmark.

Further differences across modelling frameworks emerge from:

- the group of macroeconomic variables included in the SVAR model
- the definition of the government spending and tax variables, as well as other macroeconomic covariates
- the existence of data pre-processing related to smoothing
- the specification of the VAR model in terms of inclusion of deterministic terms and lag length

# Further differences in models

Macroeconomic variables in the VAR:

- VAR models with three variables (government expenditures, government revenues, and output)
- VAR models with five variables (the former three plus inflation and the interest rate)

Definition of fiscal and other macroeconomic variables:

- Adjustment for automatic stabilizers like social transfers but also other components like interests, subsidies and others
- European System of Accounts 2010 (ESA 2010) versus ESA 95 methodology
- Inflation is also alternatively calculated from the GDP deflator or the harmonized index of consumer prices (HICP)
- Source and maturity of interest rates

# Further differences in models

Data preprocessing:

- TRAMO-SEATS versus moving averages
- Moving average smoothing

Lag length and deterministics:

- No intercept vs. intercept vs. intercept and trend
- Lag length of the VAR, typically from one to four lags (quarters)

# The Multipliers

- Using all possible combinations of the methodological choices we estimate SVAR models for all the EU-28 economies, Switzerland, Norway, and Iceland using quarterly data ranging from 1999 to 2014 (Eurostat)
- We obtain bootstrap distributions using 300 draws for each multipliers and calculate the median multiplier $m_{median}$ and, as a measure of accuracy, the percentile range between 16-th and 84-th percentiles $m_{16-84pr}$ (around 25 million multipliers)
- We concentrate on analysing the fiscal multipliers obtained from models that
  - are stable,
  - are among the best models according to information criteria, and
  - are among the models least burdened by residual autocorrelation.
- We base our inference on $N = 2{,}540{,}877$ multipliers

# Descriptive Statistics of the Multipliers

| | **min** | **5-th p.** | **16-th p.** | **median** | **84-th p.** | **95-th p.** | **max** |
|---|---|---|---|---|---|---|---|
| $m^{s}_{median}$ | $-115.53$ | $-3.82$ | $-1.67$ | 0.07 | 1.97 | 4.61 | 112.21 |
| $m^{\tau}_{median}$ | $-72.14$ | $-2.63$ | $-1.31$ | $-0.33$ | 0.21 | 0.91 | 118.67 |
| $m^{s}_{16-84pr}$ | 0.05 | 0.92 | 1.60 | 4.06 | 11.61 | 24.72 | 740.41 |
| $m^{\tau}_{16-84pr}$ | 0.02 | 0.23 | 0.42 | 1.33 | 4.23 | 9.02 | 458.78 |
| $n_{obs}$ | 27 | 32 | 34 | 43 | 58 | 69 | 136 |

# Explaining differences in multipliers

- The multiplier values or percentile ranges are then examined for methodological determinants with a regression

$$m = \alpha + \beta_c D_c + \beta_m D_m + \nu,$$

  where $D_c$ contains matrices of dummies for countries and $D_m$ collects matrices of dummies regarding modelling choices
- The regression is estimated using weighted least squares (WLS) with weights based on the inverse of the variance for the median multipliers and OLS for multiplier ranges $m^s_{16-84pr}$ or $m^\tau_{16-84pr}$.
- Choosing the baseline

# Baseline and Alternative specifications

| **Baseline specification** | **Alternative specification(s)** |
|---|---|
| Nominal variables deflated by GDP deflator | Nominal variables deflated by HICP |
| Recent European System of Accounts (ESA) 2010 | Older ESA 95 |
| Revenues definition: total revenues less interest, transfers, and social contributions | Several different revenues definitions. |
| Spending definition: total spending less transfers and social contributions | Several different spending definitions. |
| No smoothing of data | Fiscal data (+ also GDP) smoothed MA(3) or MA(5). |
| Identification of a 3-variable VAR with Cholesky ordering | Identification of 3- and 5-variable VARs with Cholesky, sign restrictions, and BP with various elast. |
| Outliers in fiscal time series detected and shift/jump dummies added | Possible outliers in the fiscal time series ignored. |
| Constant but no trend in the VAR | Constant + time trend in the VAR. |
| VAR with 4 lags. | VAR with 1, 2, or 3 lags. |
| Full time sample. | Time sample ends in 2008 or 2010. |

# Determinants, spending multiplier $m^s_{median}$

| Predictor | All | West | East |
|---|---|---|---|
| (a) Variable definitions and data source | | | |
| Nominal variables deflated by HICP | $0.122^{***}$ | $0.010^{***}$ | $0.107^{***}$ |
| | (48.4) | (2.9) | (26.6) |
| ESA 95 used | $0.119^{***}$ | $0.092^{***}$ | $0.083^{***}$ |
| | (48.6) | (28.3) | (20.7) |
| Revenues following Crespo Cuaresma et al. (2011) | $0.112^{***}$ | $0.126^{***}$ | $0.065^{***}$ |
| | (29.1) | (24.5) | (9.7) |
| Revenues following Muir and Weber (2013) | $0.021^{***}$ | $0.096^{***}$ | $-0.144^{***}$ |
| | (5.6) | (19.5) | (21.7) |
| Spending following Crespo Cuaresma et al. (2011) | $-0.035^{***}$ | $0.118^{***}$ | $0.026^{***}$ |
| | (7.6) | (19.3) | (3.5) |
| Spending following Muir and Weber (2013) | $0.025^{***}$ | $0.138^{***}$ | $-0.010$ |
| | (5.9) | (25.6) | (1.4) |
| Total spending less interest | $0.041^{***}$ | $0.079^{***}$ | $0.108^{***}$ |
| | (12.2) | (17.8) | (17.8) |
| (b) Data preprocessing | | | |
| Fiscal data is smoothed with MA(5) | $-0.045^{***}$ | $-0.027^{***}$ | $-0.028^{***}$ |
| | (10.8) | (4.9) | (4.0) |
| Fiscal data and GDP is smoothed with MA(5) | $-0.041^{***}$ | $-0.120^{***}$ | $0.148^{***}$ |
| | (8.3) | (16.6) | (19.1) |

# Determinants, spending multiplier $m^s_{median}$

| Predictor | All | West | East |
|---|---|---|---|
| (c) Structural identification | | | |
| 3-VAR with sign restrictions | $-0.080^{***}$ | $0.183^{***}$ | $-0.290^{***}$ |
| | (14.5) | (21.7) | (36.2) |
| 3-VAR with elast. from Crespo Cuaresma et al. (2011) | 0.003 | $0.031^{***}$ | $-0.061^{***}$ |
| | (0.7) | (6.1) | (10.3) |
| 5-VAR with Cholesky decomposition | $0.113^{***}$ | $0.046^{***}$ | $0.147^{***}$ |
| | (27.4) | (9.1) | (18.3) |
| 5-VAR with sign restrictions | $0.320^{***}$ | $-0.061^{***}$ | $0.836^{***}$ |
| | (30.1) | (4.6) | (45.9) |
| 5-VAR with elast. from Caldara and Kamps (2008) | $-0.058^{***}$ | $-0.130^{***}$ | $0.518^{***}$ |
| | (4.5) | (9.6) | (14.8) |
| 5-VAR with elast. from Crespo Cuaresma et al. (2011) | $-0.176^{***}$ | $-0.309^{***}$ | $0.471^{***}$ |
| | (11.0) | (18.3) | (10.9) |
| (d) VAR specification and sample | | | |
| No dummies for possible outliers in the fiscal time series | 0.004 | $-0.034^{***}$ | $0.078^{***}$ |
| | (1.2) | (7.1) | (11.6) |
| Constant + time trend in the VAR | $-0.123^{***}$ | $-0.174^{***}$ | $0.062^{***}$ |
| | (49.4) | (52.7) | (14.4) |
| VAR with 1 lag | $-0.103^{***}$ | $-0.133^{***}$ | $-0.061^{***}$ |
| | (16.4) | (16.1) | (5.4) |
| VAR with 2 lags | $-0.094^{***}$ | $-0.160^{***}$ | $-0.047^{***}$ |
| | (16.7) | (21.6) | (4.5) |
| Time sample ends in 2008 | $-0.105^{***}$ | $0.039^{***}$ | $-0.302^{***}$ |
| | (33.1) | (9.3) | (51.2) |
| Time sample ends in 2010 | $-0.146^{***}$ | $-0.218^{***}$ | $-0.178^{***}$ |
| | (40.8) | (46.3) | (25.6) |
| Observations | 420,986 | 218,791 | 132,054 |
| Number of regressors in model | 61 | 45 | 39 |
| $R^2$ | 0.47 | 0.30 | 0.46 |

# Main results: spending multipliers

- For spending multipliers, using HICP to deflate nominal variables (instead of a GDP deflator) and following ESA 95 (rather than ESA 2010) increases the estimate of the multiplier
- Narrower definitions of government revenues tend to lead to an increase in the multiplier (and the precision of its estimate), whereas a narrower definition of government spending leads to a decrease in the tax cut multiplier (and the precision of its estimate)
- Data treatment may also play a role. If the fiscal data is smoothed before estimation, the estimated multipliers are lower
- The choice of identification strategy and the number of variables in the VAR matter but the pattern of change in the multiplier is complex
- Using fewer lags and adding a time trend to the reduced-form VAR tends to reduce the volatility of the estimate.
- Higher multipliers in the post-crisis period and marked differences between eastern and western Europe

# Spending multipliers, 5-variable VARs

| Predictor | All | West | East |
|---|---|---|---|
| Deflator inflation, year-on-year | $0.051^{***}$ (35.6) | $-0.022^{***}$ (10.9) | $0.111^{***}$ (61.0) |
| HICP inflation, year-on-year | $0.007^{***}$ (4.2) | $-0.011^{***}$ (4.9) | $0.061^{***}$ (30.5) |
| HICP inflation, quarter-on-quarter, annualized | $0.049^{***}$ (40.5) | $0.024^{***}$ (15.0) | $0.082^{***}$ (46.6) |
| 3-month interbank rate | $-0.246^{***}$ (129.5) | $0.014^{***}$ (5.0) | $-0.494^{***}$ (202.0) |
| 6-month interbank rate | $-0.259^{***}$ (139.0) | $-0.012^{***}$ (4.4) | $-0.466^{***}$ (196.0) |
| Observations | 2,318,268 | 1,137,774 | 990,406 |
| Number of regressors in model | 60 | 48 | 41 |
| $R^2$ | 0.41 | 0.30 | 0.63 |

# Main results: spending multipliers

- The choice of interbank rates tends to reduce spending multipliers strongly
- The combined effects of several methodological choices can be very large
- Example of two settings:
  - ESA 2010, revenue - interest, transfers and social contributions, spending - transfers and social contributions, VAR(1) with 3 variables, Cholesky ordering, q-o-q deflator
  - ESA 95, revenue as in Crespo Cuaresma et al. (2011), spending - interests, VAR(4) with 5 variables, Cholesky ordering, q-o-q HICP inflation
  - On average, for scenario 1 the multiplier is larger by 0.537

# Main results: tax cut multipliers

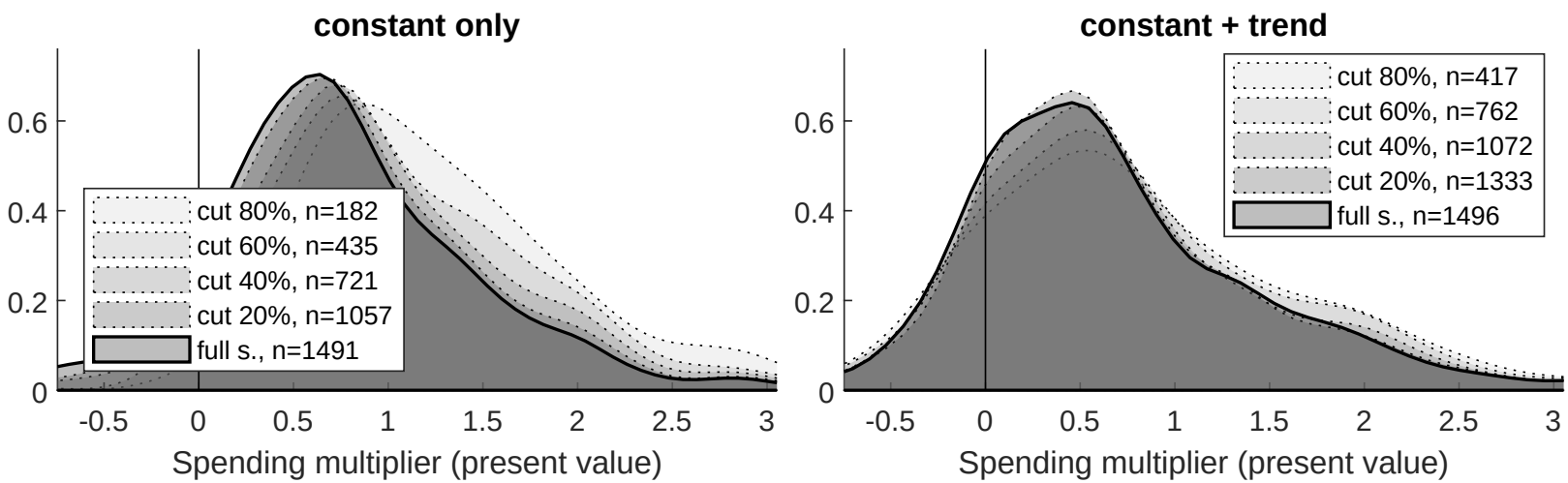
- The effects found in tax multipliers differ strongly from those in spending multipliers
- Again, data definition and preprocessing matters, but in different direction from the effects found in spending multipliers
- In addition, changing the variables in the specification of the 5-VAR model does not lead to strong differences in tax cut multipliers

# Other results & robustness checks

- Changing the horizon of the multiplier does not lead to qualitative differences in our results, although the data and methodology effects tend to be smaller for $h < 4$
- Relaxing the model selection criteria to choose multipliers (moving from 2.5 to 8.7 to 14.2 to 23 to 25 million observations) also leads to similar results

# Zooming in: Fiscal Multipliers in Austria

- Expand model specifications to include FAVAR models
- Out-of-sample predictive ability as a validation tool



# Conclusions

- Seemingly unimportant modelling choices (expenditure/tax definition, smoothing, deflator or data source) can have sizeable effects on the estimates of fiscal multipliers
- There are sizeable differences in the effects across multiplier types and between eastern and western Europe
- Strong evidence on changes in the size of multipliers during and after the crisis, with larger fiscal multipliers after 2010: crisis? zero lower bound? recession vs. expansion differences?