Not-for-Publication Appendix to:

What Is the Importance of Monetary and Fiscal Shocks in Explaining US Macroeconomic Fluctuations?

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This appendix provides a detailed description of the data. It also investigates whether the main findings in the paper (such as the differences in the relative importance of government spending and monetary policy shocks at various frequencies) are robust to sub-sample analysis, the inclusion of taxes, different monetary policy identification schemes, and changes in trend due to the great productivity slowdown.

For completeness, Figures 1 and 2 respectively report the impulse responses to both government spending and monetary policy shocks identified in eq. (1) in the main paper. The main results in the paper are robust to changing the order of the variables in X_t.

1 Data Description

Table 1: **Data Series Description and Sources**

Label	Frequency	Description	Source
GDP	Q	Gross domestic product	BEA (Table 1.1.5)
GCD	Q	Personal consumption expenditures on durable goods	BEA (Table 1.1.5)
GCN	Q	Personal consumption expenditures on nondurable goods	BEA (Table 1.1.5)
GCS	Q	Personal consumption expenditures on services	BEA (Table 1.1.5)
GPI	Q	Gross private domestic investment	BEA (Table 1.1.5)
GGE	Q	Government consumption expenditures and gross investment	BEA (Table 1.1.5)
GDPQ	Q	Real gross domestic product	BEA (Table 1.1.6)
P16	Q	Civilian non-institutional population, over 16	BLS (LNU00000000Q)
LBMNU	Q	Non-farm business hours worked	BLS (PRS85006033)
LBCPU	Q	Hourly non-farm business compensation	BLS (PRS85006103)
FYFF	M	Federal funds rate	St. Louis FRED
GGFR	Q	Federal tax receipts	BEA (Table 3.2)
GGAID	Q	Federal grants in aid	BEA (Table 3.2)
GGFTP	Q	Federal transfer payments to persons	BEA (Table 3.2)
GGFINT	Q	Federal interest payments	BEA (Table 3.2)
GGSR	Q	State and local tax receipts	BEA (Table 3.3)
GGST	Q	State and local transfer payments to persons	BEA (Table 3.3)
GGSINT	Q	State and local net interest payments to persons	BEA (Table 3.3)
TRARR	M	Total reserves	Federal Reserve Board
NONBORTAF	M	Non-borrowed reserves of depository institutions	Federal Reserve Board
M1SL	M	M1 money stock	Federal Reserve Board

Table 2: **Data Series in the VAR.**

Label	Description	Construction
GDPDEF	GDP deflator	GDPQ/GDP
NETTAX	Tax receipts net of transfer payments	GGFR+GGSR-GGAID-GGFTP-GGFINT-GGSINT
G_t	Real per-capita government spending	GGE/(P16*GDPDEF)
Y_t	Real per-capita GDP	GDPQ/P16
h_t	Per-capita hours worked	LBMNU/P16
c_t	Real per-capita consumption	(GCN+GCS)/(P16*GDPDEF)
i_t	Real per-capita investment	(GPI+GCD)/(P16*GDPDEF)
w_t	Real wages	LBCPU/GDPDEF
π_t	Inflation	Δ GDPDEF
r_t	Fed Funds rate	FYFF
T_t	Real net taxes	NETTAX/(P16*GDPDEF)
tr_t	Total reserves	TR
nbr_t	Non-borrowed reserves	NBR
m_t	M1 money supply	M1

Note: the VAR includes all series in log-levels, except for r_t, which is in levels.

2 Robustness Analysis

A. Sub-sample analysis

First, we assess whether our results are robust over time. We divide the data into sub-samples identified consistently with the Great Moderation (Stock and Watson, 2002 and 2003). We impose a structural break in 1984:1, the estimated date of the break in the volatility of US GDP growth documented by McConnell and Perez-Quiros (2000). The results from the spectral decomposition of GDP for the two sub-samples is given in Table 3. Due to the smaller sample size of the two sub-samples, we select the VAR lag length to be one, as suggested by the BIC criterion.

In the first sub-sample, the relative importance of government spending shocks at medium cycle frequencies is very high relative to business cycle frequencies, and the difference is much smaller for the second sub-sample. Overall, however, government spending shocks play a larger role at medium cycles *relative to* monetary policy shocks. In particular, government spending shocks explain a larger percentage of the variance of GDP at medium cycle relative to business cycle frequencies in *both* sub-samples. On the other hand, the importance of monetary policy shocks has changed over time: they are very important in explaining the variance of GDP at business cycle frequencies in the first sub-sample, similarly to the results previously reported in Section 2 for the full sample, but they play a limited role at both frequencies in the second sub-sample.

INSERT TABLE 3 HERE

B. Robustness to the inclusion of taxes

It is well known from basic macroeconomic models that the intertemporal government budget constraint has to be satisfied, and therefore, it might be important to include taxes in our empirical analysis. Table 4, Panel A, reports the contribution of the government spending shocks to output fluctuations at both business and medium cycle frequencies when net taxes are added to the baseline VAR. That is, we estimate the same VAR as eq. (1) in the main paper, except that now $Z_t = (G_t, T_t, X_t', r_t)'$, where T_t are tax receipts net of transfers and all other variables are as defined in Section 2.[1] By comparing Table 4 and Table 1, it is clear that our results for output are unaffected by the addition of taxes, and

[1]The tax variable is defined exactly as in Blanchard and Perotti (2002).

government spending shocks play an important role primarily in explaining medium cycle frequencies.[2]

INSERT TABLE 4 HERE

C. Other monetary policy identification schemes

An additional concern is that we identified the monetary policy shock as a shock to the federal funds rate in a VAR that does not include other monetary variables. We therefore consider alternative VARs that include nonborrowed reserves, total reserves and money supply (M1) following the benchmark recursive identification schemes discussed in Christiano et al. (2000, Section 4.2). In a first experiment, reported in Table 4, Panel B(i), we estimate the same VAR as in eq. (1) in the main paper, except that $Z_t = (G_t, X_t', r_t, tr_t, nbr_t, m_t)'$, where tr_t is total reserves, nbr_t is nonborrowed reserves plus extended credit, m_t is a measure of money supply (M1), and the other variables are as defined in Section 2.[3] Following Christiano et al. (2000), these additional monetary variables are ordered after the federal funds rate (r_t), so that the information set of the monetary authority includes current and lagged values of G_t and X_t, and lagged values of the other monetary variables. In a second experiment, reported in Table 4, Panel B(ii), the monetary policy shock is identified as a shock to nonborrowed reserves in a VAR with the following ordering: $Z_t = (G_t, X_t', nbr_t, r_t, tr_t, m_t)'$. The results reported in Panel B show that the percentage contribution of the government spending shock at both business and medium cycle frequencies is extremely robust to the inclusion of additional monetary variables. Looking at monetary policy, overall the contribution of the monetary policy shocks identified as shocks to nonborrowed reserves rather than a shock to the federal funds rate is smaller, a finding consistent with Christiano et al. (2000, Table 3). However, consistently with our previous results, we note that, again, the contribution of the monetary policy shock is more substantial at business cycle than at medium cycle frequencies.

D. Alternative de-trending procedures

The benchmark VAR specification in Section 2 assumes a linear deterministic time trend. However, linearly de-trending output with a constant time trend might induce low frequency

[2]Mertens and Ravn (2009) study the effects of tax changes identified on the basis of narrative evidence of Romer and Romer (2007), and conclude that tax shocks account for close to 20 % of variation in output at business cycle frequencies.

[3]Due to limited data availability for nonborrowed reserves, total reserves and M1, in this sub-section the VAR is estimated for data spanning 1959:1-2006:4.

movements in the presence of a substantial productivity slowdown such as that of 1973. It might be of concern that it is the government shock that captures those low frequency movements, since it is the most important shock at medium cycles. For these reasons, we also consider a VAR estimated with a break in trend:

$$Z_t = K + \Gamma_1 t + \Gamma_2 d_t t + A(L) Z_{t-1} + B(L) \varepsilon_t^R + u_t \quad (1)$$

where d_t is a dummy variable equal to one after 1973:1 and zero otherwise. The dummy variable captures the break in trend associated with the great productivity slowdown (see Baily and Gordon, 1988). The contributions of the government spending shock at the business and medium cycle frequencies become 2.3 and 21.3 respectively, thus showing that our main conclusions are also robust to breaks in trends associated with the productivity slowdown of 1973.[4]

References

[1] Baily, M.N., and R.J. Gordon (1988), "The Productivity Slowdown, Measurement Issues, and the Explosion of Computer Power", Brookings Papers on Economic Activity (2), 347-420.

[2] Blanchard, O. and R. Perotti (2002), "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes in Output", Quarterly Journal of Economics, 117-4, 1329-1368.

[3] Christiano, L., M. Eichenbaum and C. Evans (2000), "Monetary Policy Shocks: What Have We Learned and to What End", , in: Taylor, John B. and Woodford, Michael, eds. Handbook of Macroeconomics, Volume 1A. Amsterdam; New York and Oxford: Elsevier Science, North-Holland.

[4] McConnell, M. and G. Perez-Quiros (2000), "Output Fluctuations in the United States: What Has Changed Since the Early 1980's?", American Economic Review, 90(5), 1464-1476.

[4] We also verified that our main results are robust to estimating a stochastic rather than a deterministic trend, using a VAR where $Z_t = (\Delta G_t,\ \Delta(Y_t - h_t),\ h_t,\ c_t - Y_t,\ i_t - Y_t,\ Y_t - h_t - w_t,\ \pi_t,\ r_t)'$.

[5] Mertens, K. and M. O. Ravn (2009) "Empirical evidence on the aggregate effects of anticipated and unanticipated US tax policy shocks", National Bank of Belgium Research Series 200911-13.

[6] Romer, C.D. and D.H. Romer (2007), "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks", NBER Working Paper, 13264.

[7] Stock, J. H. and M.W. Watson (2002), "Has the Business Cycle Changed and Why?," in: M. Gertler and K. Rogoff (eds.), NBER Macroeconomics Annual.

[8] Stock, J. H. and M.W. Watson (2003), "Has the Business Cycle Changed? Evidence and Explanations", FRB Kansas City Symposium, Jackson Hole.

Table 3: **Sub-sample Robustness Analysis.**

	Business Cycle component $(\frac{\pi}{16} - \frac{\pi}{3})$	Medium Cycle component $(\frac{\pi}{100} - \frac{\pi}{16})$
Sub-sample I (1954:3-1984:1)		
Percentage contribution of $\epsilon_{g,t}$	7.1	26.5
Percentage contribution of $\epsilon_{r,t}$	41.5	24.9
Sub-sample II (1984:2-2006:4)		
Percentage contribution of $\epsilon_{g,t}$	10.1	10.3
Percentage contribution of $\epsilon_{r,t}$	1.2	5.4

Note: The top panel shows the contribution of government spending shock and monetary shocks in explaining GDP at the business and medium cycle frequencies for the first sub-sample (1954:3-1984:1), and the bottom panel shows the contribution of both shocks in explaining GDP for the second sub-sample (1984:2-2006:4).

Table 4: **Robustness Analyses.**

	Business Cycle component $(\frac{\pi}{16} - \frac{\pi}{3})$	Medium Cycle component $(\frac{\pi}{100} - \frac{\pi}{16})$
A. Including net taxes in the VAR		
Percentage contribution of $\varepsilon_{g,t}$	4.1	30.9
Percentage contribution of $\varepsilon_{r,t}$	21.1	13.8
B. Additional monetary variables in the VAR		
(i) Monetary policy shock identified as a shock to the FFR		
Percentage contribution of $\varepsilon_{g,t}$	2.9	29.2
Percentage contribution of $\varepsilon_{r,t}$	9.3	7.3
(ii) Monetary policy shock identified as a shock to Non-borrowed reserves		
Percentage contribution of $\varepsilon_{g,t}$	2.9	29.2
Percentage contribution of $\varepsilon_{nbr,t}$	3.5	0.9

Note: Panel A (top) reports the contribution of the government spending shock to output fluctuations at business and medium cycle frequencies when net taxes are added to the baseline VAR. Panel B (bottom) reports the contribution of the government spending shock to output fluctuations at business and medium cycle frequencies when additional monetary variables (nonborrowed reserves, total reserves and money supply) are added to the baseline VAR. The monetary policy shock is identified either as a shock to the federal funds rate – Panel B(i) – or as a shock to nonborrowed reserves – Panel B(ii).

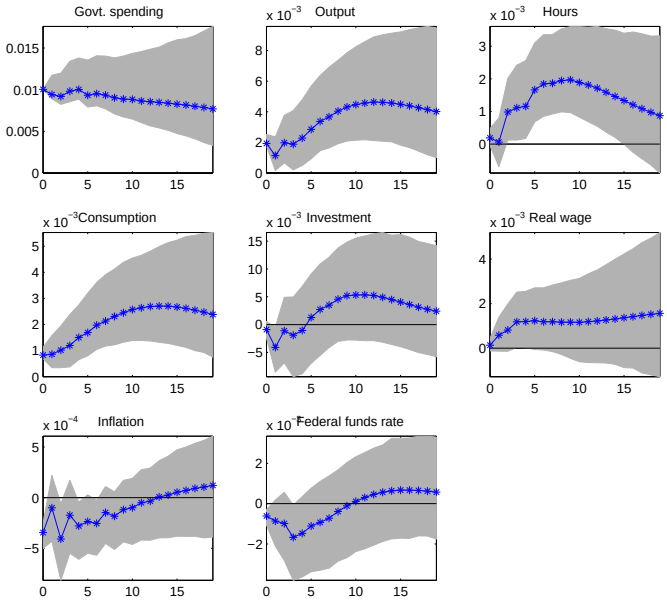

Figure 1: **Impulse Responses to the Government Spending Shock identified in eq.(1).** The shaded regions are 95% confidence bands obtained by Monte Carlo simulations.

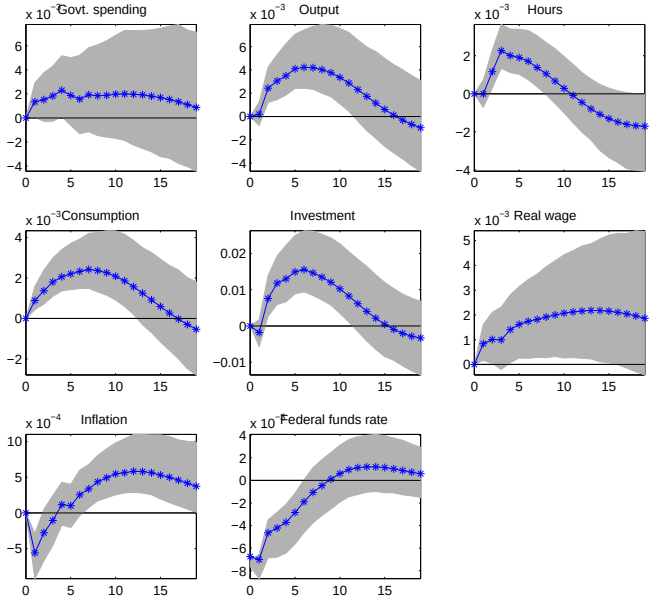

Figure 2: **Impulse Responses to the Monetary Policy Shock identified in eq.(1).** The shaded regions are 95% confidence bands obtained by Monte Carlo simulations.