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In Search of the Transmission Mechanism of Fiscal Policy  
Roberto Perotti  
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### **ABSTRACT**

Most economists would agree that a hike in the federal funds rate will cause some slowdown in growth and inflation, and that the bulk of the empirical evidence is consistent with this statement. But perfectly reasonable economists can and do disagree even on the basic effects of a shock to government spending on goods and services: neoclassical models predict that private consumption and the real wage will fall, while some neo-keynesian models predict the opposite. This paper discusses alternative time series methodologies to identify government spending shocks and to estimate their effects. Applying these methodologies to data from the US and three other OECD countries provides little evidence in favor of the neoclassical predictions. Using the US input-output tables, the paper then turns to industry-level evidence around two major military buildups to shed light on the effects of government spending shocks.

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# 1 Introduction

Most economists would agree that an exogenous increase in the federal fund rate will lead to a fall in inflation and some slowdown in growth after a while; they would also probably agree that a large body of empirical research is consistent with this view, although the timing and size of the effect is subject to debate. In contrast, perfectly reasonable economists can and do disagree on the basic theoretical effects of fiscal policy, and on the interpretation of the existing empirical evidence. For instance, neoclassical models predict that private consumption and the real wage should fall following a positive shock to government consumption, while some models with neo-keynesian features predict the opposite. Especially in Europe, often journalistic and policy discussions take it for granted that government spending stimulates consumption.

Also in contrast to the case of monetary policy, the existing empirical evidence can be interpreted as supporting either view, depending on the methodology used to identify the fiscal policy shocks. The “Dummy Variable” approach of Ramey and Shapiro (1998), extended to a full-fledged VAR by Edelberg, Eichenbaum and Fisher (1999) and Burnside, Eichenbaum and Fisher (2004), is an application of the “event study” methodology developed by Romer and Romer (1989) to study monetary policy. It typically finds that during episodes of large, exogenous increases in defense spending output increases but private consumption and the real wage fall. These results are consistent with the neoclassical model: when government spending increases, the representative household is hit by a negative wealth effect due to the higher taxes it will have to pay, and consumption and leisure fall; the resulting outshift in labor supply causes a decline in the real wage, along a given labor demand.<sup>1</sup>

The results from the Structural Vector Autoregression approach of Fatás and Mihov (2001), Blanchard and Perotti (2002) and Perotti (2004) are typically of the opposite sign: following a government spending shock private consumption and the real wage increase. This is consistent with some neo-keynesian models, where government spending causes a shift in labor demand, for instance because of countercyclical markups generated by nominal price rigidities or other reasons; the resulting increase in the real wage can induce higher consumption, via a substitution effect or because of the presence of credit constraints.

This paper is an exercise on the robustness of these results, and an investigation of the underlying methodologies. I first show that the evidence from the Dummy Variable approach is due to the imposition of two restrictions: first, all Ramey-Shapiro episodes have the same dynamics, up to a scale factor; second, in a version of this approach fiscal policy explains *all* the deviation from “normal” of *all* endogenous variables for several quarters after the start of these episodes. The second assumption runs contrary to the spirit of this approach, which is based on the notion that we can learn from these episodes

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<sup>1</sup>See section 10 for a brief review of recent models of fiscal policy.

because they are exogenous and “big”, not because they are “different”. Once these restrictions are removed, the results from this method are comparable to those of the SVAR approach: private consumption and the real wage increase in response to the fiscal shocks of the Ramey-Shapiro episodes, and there is little sign of the movement in opposite directions of consumption and GDP that is the hallmark of the neoclassical model. The existing differences among the four episodes can in part be explained by the different patterns of behavior of taxation and of defense vs. civilian government spending in each episode: I then show that these differences also are consistent with the evidence from the SVAR approach. The latter, however, suffers from its own fundamental problem, namely the possibility that its estimated shocks are in reality anticipated by the private sector.

To overcome some of the problems of the two approaches, Ramey (2006) advocates the estimation of fiscal policy SVARs using long-run annual data. Over a sample extending back to 1889, the response of consumption to a government spending shock is again consistent with the neoclassical model, in contrast to the quarterly SVARs estimated over the post-war period. However, prior to the official BEA statistics that start in 1929 several components of government spending were interpolated linearly over long intervals, and had a number of other problems. When only the official BEA data from 1929 are used, again the responses of consumption and of the real wage to a government spending shock become positive, and can be estimated with a good degree of precision.

Two-sector versions of the neoclassical and neo-keynesian models imply different reactions of the real product wage in each sector, depending on the size of the government spending shock that falls on each sector. Hence, sectoral evidence around the Ramey-Shapiro episodes can shed light on the underlying mechanism. Using the US input output tables, I show that during the last two Ramey-Shapiro episodes the sectors that were most intensive in the government spending shock also experienced on average significantly higher increases in the real product wage. This is consistent with some neo-keynesian two-sector models, but difficult to reconcile with neoclassical two-sector models.

I then replicate the SVAR analysis in three more countries - Australia, Canada and the United Kingdom - for which both non-interpolated quarterly data and long run annual data on fiscal policy exist. The results from both the quarterly and the annual SVARs are qualitatively consistent with the US evidence, although in general the effects of fiscal policy shocks are smaller.

In this paper, I focus on the responses of consumption and the real wage. These variables are of independent interest to macroeconomists, but also as we have seen they respond very differently to government spending shocks in different models; hence they are useful to shed light on the underlying transmission mechanism of fiscal policy. I also present evidence on private investment, although here the predictions of alternative models are much less sharp, and depend on a number of factors that are difficult to control for in a VAR. Because of space constraints, I leave a detailed analysis of the responses of

the interest rate and of inflation to future work.<sup>2</sup>

I focus on shocks to current government spending on goods and services (“government spending” from now on) because this is the largest part of non-transfer spending, and the mechanisms driving its effects in the different models are clearly identifiable. Government investment introduces an entirely different effect - the externality on private sector productivity in the long run - which is also largely common to all models.<sup>3</sup> I also do not study the effects of tax shocks: these are more difficult to identify in a SVAR<sup>4</sup>, and, when taxation is distortionary, their theoretical effects depend crucially on the time profile of the tax response.<sup>5</sup>

This paper has several antecedents: some of the exercises that I perform here can be found in Blanchard and Perotti (2002), Fatás and Mihov (2001), Pappa (2005), and Ramey (2006). Of course, several other papers estimate impulse responses to fiscal shocks: these will be acknowledged along the way.

The structure of the paper is as follows. Section 2 presents the two empirical approaches introduced above. Section 3 discusses briefly the data and the specification of the models to be estimated. Section 4 presents the effects of fiscal shocks on GDP, private consumption and investment in the two approaches. Section 5 discusses alternative explanations of the differences among the Ramey-Shapiro episodes, mainly the tax policies accompanying the government spending shocks and the composition of government spending. Section 6 presents evidence from estimates that use long run annual data. Section 7 discusses the responses of labor market variables, namely hours and the real wage in the business sector and in manufacturing. Section 8 discusses the evidence from input-output tables around the Vietnam War and the Reagan buildup. Section 9 presents evidence from Australia, Canada and the United Kingdom. Section 10 discusses some recent models of fiscal policy and their key testable predictions. The last section concludes.

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<sup>2</sup>To estimate the effects of fiscal shocks on interest rates one probably needs to impose more structure than is present in the SVARs discussed in this paper. In fact, Favero and Giavazzi (2007) include debt and the cross-equation restrictions implied by the dynamic government budget in a Blanchard-Perotti SVAR. They show that, while the responses of all other variables are unaffected, it is now possible to estimate more precisely a positive response of the interest rate to government spending shocks. Dai and Philippon (2006) also add more structure to a Blanchard-Perotti SVAR by incorporating information from a large cross-section of bond prices; again they find a positive response of interest rates to a deficit shock.

<sup>3</sup>For a comparison of the effects of government consumption and government investment shocks, see Perotti (2004).

<sup>4</sup>In a promising recent development, Romer and Romer (2006) identify shocks to revenues in the post-war period from a detailed analysis of government documents.

<sup>5</sup>Using a standard neoclassical model, Cooley and Ohanian (1997) and Ohanian (1997) show that the different time profiles of the tax rates during WWII vs. the Korean War in the US, and during WWII and the postwar period in the UK vs. the US, had important effects on output and welfare.

## 2 Two approaches to the identification of fiscal shocks

I now describe briefly the two approaches to identify fiscal policy shocks that I will compare in this paper. At least a third approach has been used in the literature, based on sign restrictions, as in Mountford and Uhlig (2002) and Pappa (2005). For lack of space, I do not discuss this methodology here; however, Pappa (2005) and Caldara and Kemp (2006) show that it delivers responses of private consumption that are close to those estimated in the SVAR approach below: in particular, private consumption typically rises after a government spending shock.

### 2.1 The dummy variable approach

How to disentangle the exogenous, unanticipated component of fiscal policy changes? The “narrative” or “Dummy Variable” approach tries to isolate the typical deviation from the “normal” path of the endogenous variables caused by a series of post-war “abnormal” fiscal events, namely military buildups driven by foreign policy. On the basis of contemporary accounts in the press, Ramey and Shapiro (1998) identified three episodes of expansionary defense spending that could reasonably be interpreted as exogenous and unforeseen: the Korean War, the Vietnam War, and the Carter-Reagan buildup; following Eichenbaum and Fisher (2004) and Ramey (2006), I add the Bush buildup that started at the end of 2001.

#### 2.1.1 The DV1 methodology

Define the Ramey-Shapiro dummy variables  $D_{1t}$ ,  $D_{2t}$ ,  $D_{3t}$  and  $D_{4t}$  as taking the value of 1 at the start of each of the Ramey-Shapiro episodes, on 1950:3, 1965:1, 1980:1, and 2001:4 respectively. Define the “combined” Ramey-Shapiro dummy variable as  $D_t = D_{1t} + D_{2t} + D_{3t} + D_{4t}$ .

Let  $X_t$  be the vector of endogenous variables, whose first three elements are government spending  $g_t$ , taxes  $t_t$ , and output  $y_t$ . The first version of the Dummy Variable approach (“**DV1**” for brevity) was introduced in a univariate context by Ramey and Shapiro (1998), and applied in a multivariate context by Edelberg, Eichenbaum and Fisher (1999). It consists of estimating the reduced form VAR

$$X_t = A(L)X_{t-1} + B(L)D_t + U_t, \quad (1)$$

where  $A(L)$  is a polynomial of order  $n_A$ ,  $B(L)$  is a polynomial of order  $n_B + 1$ , and  $U_t$  is the vector of reduced form residuals. The typical effect of these fiscal shocks can be found by tracing the dynamic effects of a unit shock to the dummy variable: i.e., the response of the endogenous variables at  $t + k$  is given by the estimated coefficient on  $L^k$  in the expansion of  $(I - A(L)L)^{-1} B(L)$ .

Outside these Ramey-Shapiro episodes, the dynamic response of the economy to a shock to government spending is governed by the polynomial  $(I - A(L)L)^{-1}$ ; thus the response to a shock to the Ramey-Shapiro dummy variable represents the typical deviation of the economy from its normal behavior, when a Ramey-Shapiro episode occurs. Because the dummy variable appears in all equations of the system, this methodology assumes that during a Ramey-Shapiro episode not only the fiscal variables deviate from normal, but also that the dynamic response of all variables to the fiscal variables can change.

### 2.1.2 The DV2 methodology

The DV1 approach imposes a strong restriction on the data: the shape and size of the responses of all variables to the shock are the same in each Ramey-Shapiro episode. A less stringent version of this approach (introduced by Burnside, Eichenbaum and Fisher (2004)) consists in allowing each episode to have a different intensity, although the shape of the responses is still assumed to be the same. In this **DV2** variant of the approach, one estimates the VAR:

$$X_t = A(L)X_{t-1} + \sum_{i=1}^4 B(L)\theta_i D_{it} + U_t, \quad (2)$$

where  $\theta_1 = 1$  and  $\theta_2, \theta_3, \theta_4$  are scalars that measure the intensity of the last three Ramey-Shapiro episodes relative to the Korean War.

### 2.1.3 The DV3 methodology

The DV2 methodology still imposes the constraint that the shapes of the responses of a given variable must be the same in each episode. However, each episode might consist of different policies, like a tax cut in one episode and a tax increase in another. Table 1 lists all the quarters in the sample when the percentage change in government spending or the change in the Barro-Shasakul average marginal income tax rate on labor income<sup>6</sup> exceeded two standard deviations. It is clear that each episode had its own specific fiscal action. For instance, taxes increased repeatedly during the Korean War, in 1950, 1951 and 1952, while the Vietnam War was accompanied by tax cuts. Building on Fatás and Mihov (2001), who point out the differences between the individual Ramey-Shapiro episodes, in the **DV3** variant I allow the responses to each Ramey-Shapiro episode to have a different intensity *and* shape:

$$X_t = A(L)X_{t-1} + \sum_{i=1}^4 B_i(L)D_{it} + U_t, \quad (3)$$

where each  $B_i(L)$  is a  $n_B + 1$ -order vector polynomial.

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<sup>6</sup>This is an annual variable calculated by Barro and Sahasakul (1983), updated by Stephenson (1998) up to 1996 and by myself afterwards.

Table 1: **Large changes in fiscal variables in the US**

sd of $\Delta g = 0.02$				sd of $\Delta t = 0.55$			
$ \frac{\Delta g}{sd}  \geq 3$		$2 <  \frac{\Delta g}{sd}  < 3$		$ \frac{\Delta t}{sd}  \geq 3$		$2 <  \frac{\Delta t}{sd}  < 3$	
50:4	0.08	48:2	0.04	48:1	-3.2	50:1	1.2
51:1	0.09	50:3	-0.04	51:1	3.3	68:1	1.6
51:2	0.11	52:2	0.04	52:1	1.7	70:1	-1.3
51:3	0.10	54:1	-0.05	54:1	-2.4	83:1	-1.6
		54:2	-0.04	64:1	-2.3	02:1	-1.2
		67:1	0.04	78:1	2.1	03:1	-1.3
				79:1	-1.8		
				81:1	2.4		
				82:1	-1.8		

$g$ : log of government spending on goods and services, excluding non-defense capital spending.  $T$ : average marginal income tax rate on labor income.

#### 2.1.4 The modified DV methodology

Quite apart from the possible loss of precision in estimation, the DV3 approach suffers from an extreme version of a problem already present in the DV1 and DV2 approaches: since each dummy appears separately in *all* equations, the residuals of each equation at the onset of each Ramey-Shapiro event and during the following  $n_B$  quarters are set to 0; in other words, the method assumes that the “abnormal” fiscal events are entirely responsible for *all* the deviation from normal of *all* variables for  $n_B + 1$  quarters.

But the logic of the method is that we learn from the Ramey-Shapiro episodes because they are exogenous and “big”, thus highly informative on the working of fiscal policy, not because the economy behaves “differently” in some fundamental way.<sup>7</sup> Thus, a better interpretation of this logic consists in isolating the “abnormal” fiscal events and estimating the “normal” dynamic response of the non-fiscal endogenous variables to these events.

This interpretation can be formalized by including lags 0 to  $n_B$  of the dummy variables in the government spending and tax equations, and only lag 0 in the other equations. This can be done for the combined dummy variable (thus obtaining the **modified DV1** and the **modified DV2** methods) or for each Ramey-Shapiro variable (the **modified DV3** approach). In these specifications, after the impact effect the behavior of the non-fiscal variables is explained by their *normal* dynamics in response to the deviations from normal of the fiscal variables.

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<sup>7</sup>McGrattan and Ohanian (2006) emphasize this interpretation of the biggest such episode of all, WWII.



## 2.2 The SVAR approach

The SVAR approach starts from the reduced form specification:

$$X_t = A(L)X_{t-1} + U_t \quad (4)$$

$X_t$  is the vector of endogenous variables; for simplicity, in this section I assume that it consists of output  $y_t$ , government spending  $g_t$ , and taxes  $t_t$ . The reduced form residuals of the  $g_t$  and  $t_t$  equations,  $u_t^g$  and  $u_t^t$ , can be thought of as linear combinations of three components. First, the *automatic response* government spending and taxes to innovations in output, inflation and the interest rate. Second, the *systematic discretionary response* of policymakers to innovations in the other endogenous variables; for instance, reductions in tax rates implemented systematically in response to recessions. Third, *random discretionary shocks* to fiscal policies; these are the “structural” fiscal shocks, which unlike the reduced form residuals are uncorrelated with all other structural shocks.<sup>8</sup> This is also the component one is interested in when estimating impulse responses to fiscal policy shocks.

Formally, and assuming for illustrative purposes the vector  $X_t$  includes only three variables, one can posit the following relation between reduced form residuals and structural shocks:

$$u_t^t = \alpha_{ty}u_t^y + \beta_{tg}e_t^g + e_t^t \quad (5)$$

$$u_t^g = \alpha_{gy}u_t^y + \beta_{gt}e_t^t + e_t^g \quad (6)$$

where the coefficients  $\alpha_{ty}$  and  $\alpha_{gy}$  capture the first two components and  $e_t^g$  and  $e_t^t$  are the “structural” fiscal shocks, with  $cov(e_t^g, e_t^t) = 0$ . Clearly,  $e_t^g$  and  $e_t^t$  are correlated with the reduced form residuals, hence they cannot be obtained by an OLS estimation of (5) and (6).

The key to identification is the observation that it typically takes longer than a quarter for discretionary fiscal policy to respond to, say, an output shock, hence the second component, the *systematic discretionary response* is absent in quarterly data. As a consequence, the coefficients  $\alpha_{ty}$  and  $\alpha_{gy}$  in (5) and (6) capture only the *automatic response* of fiscal variables to economic activity. One can then use available external information on the elasticity of taxes and spending to GDP, inflation and interest rates to compute the appropriate values of these elasticities (see section 3);<sup>9</sup> with these, one can then construct the cyclically adjusted fiscal shocks:

$$u_t^{t,CA} \equiv u_t^t - \alpha_{ty}u_t^y = \beta_{tg}e_t^g + e_t^t \quad (7)$$

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<sup>8</sup>One could argue that, in a sense, all changes in fiscal policy are discretionary: in theory, policymakers can always undo the effects of changes in output and prices on revenues and spending. While this might be true over the long run, with quarterly data the distinction appears meaningful.

<sup>9</sup>Importantly, these values of the elasticities of government revenues and transfers are not estimated, but computed from institutional information on statutory tax brackets, the distribution of taxpayers by income classes, the statutory unemployment benefit, etc.

$$u_t^{g,CA} \equiv u_t^g - \alpha_{gy}u_t^y = \beta_{gt}e_t^t + e_t^g \quad (8)$$

which are linear combinations of the two structural fiscal policy shocks. The estimate of  $e_t^t$  and  $e_t^g$  can be obtained by orthogonalization, i.e. by assuming  $\beta_{gt} = 0$  or  $\beta_{tg} = 0$ ; since the correlation between  $u_t^{t,CA}$  and  $u_t^{g,CA}$  is always very low, the actual ordering does not matter; as a benchmark, I will use the first orthogonalization.

The two structural shocks thus estimated are orthogonal to the other structural shocks of the economy, hence they can be used as instruments in the remaining equations: thus, one can estimate the GDP equation  $u_t^y = \gamma_{yt}u_t^t + \gamma_{yg}u_t^g + e_t^y$ , using  $e_t^g$  and  $e_t^t$  as instruments for  $u_t^t$  and  $u_t^g$ . If there is another variable, like inflation, its residual is first subtracted from the  $g_t$  and  $t_t$  residuals - using an external elasticity - to obtain the cyclically adjusted fiscal shocks, as in (7) and (8); then the equivalent of the GDP equation above for inflation can be estimated, adding  $u_t^y$  to the rhs and using  $e_t^g$ ,  $e_t^t$ , and  $e_t^y$ , as instruments.<sup>10</sup> Once the structural shocks are identified, the impulse responses are constructed using the average elasticities over the relevant sample periods.

## 2.3 Discussion

The advantage of the Dummy Variable approach is that it does not require any further assumption to identify fiscal shocks. It suffers from two potential problems. The first is an extreme case of the small sample problem: obviously the identifying assumption of the method is that the dummy variable should be uncorrelated with the residuals of each equation contemporaneously and up to  $n_B$  lags; but with such a small number of episodes (in the case of the DV3 method, just one for each polynomial  $B_i(L)$ ), how does one know if the Ramey-Shapiro dummy captures the onset of the Korean War, or, say, the delayed effect of the 1948 tax cut (according to the classification of Romer and Romer (2006), the largest in US history), or other non-fiscal shocks?

A second question is again well illustrated by the Korean War dummy variable. Table 1 shows that this episode consisted of a string of large increases in government spending starting in the fourth quarter of 1950, raising the issue whether these were anticipated or not as of the beginning of the episode: does the path of private consumption from 1950:3 on represent the dynamic response to an unanticipated, one-off wealth effect occurring in 1950:3 which takes into account the whole increase in government spending during the episode; or does it represent the result of many small wealth shocks that occur each quarter after 1950:3?

More generally, one can interpret the deviation from normal behavior following the onset of an episode at time  $t_0$  in two ways: it could describe the predictable “typical” deviations from normal after these “abnormal” events; or it could capture a sequence of

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<sup>10</sup>The ordering of the remaining variables is immaterial if one is only interested in estimating the effects of fiscal policy shocks, as it is the case in this paper.

new fiscal shocks after  $t_0$ . In the former case the response of consumption at  $t_0$  reflects the wealth effect caused by the entire subsequent path of government spending; in the latter, the response of consumption in each period would reflect the new fiscal shocks.

It will come as no surprise to anybody that the overall costs of wars are difficult to predict. It is instructive to see by how much. On April 22, 2003, 1 months after the start of Operation Iraqi Freedom, a Congressional Research Service Report for Congress contained a range of estimates of the war on Iraq and of the ensuing occupation. The price tag on a two-months war plus the occupation for FY 2003 ranged from \$54bn to \$98.6bn. The costs of occupation per year was estimated at \$45.6bn for 200,000 troops. The Center for Strategic and Budgetary Assessment estimated the total cost of a 5-year occupation from \$25bn to \$105bn. Although the administration did not release estimates, the press reported an administration estimate of \$20bn per year, for two years. Thus, in April 2003 the highest possible price tag for the years 2003 through 2006 that a (very) well informed individual could have gathered from the debate was  $\$98.6\text{bn} + \$45.6\text{bn} \times 3 = \$235.4\text{bn}$ ; and this assuming that there would still be a very substantial military presence in 2006 - an event not many would have considered likely at the time. Using for instance the CSBA median estimate would have put the price tag at  $\$98.6\text{bn} + \$13\text{bn} \times 3 = \$138.7\text{bn}$ .

The most recent Congressional Research Service Report on the war, issued on September 22 2006, estimates cumulated appropriations through 2006, of which \$287.6bn for DoD alone. In 2005 the average troop level in Iraq was 202,000, yet the DoD obligations were \$70.9bn, against the \$45.6bn predicted in 2003 for an occupation force of 200,000 troops. The CBO now estimates that the cumulative cost of the global war on terror will be \$634bn in 2010 and \$808bn in 2016. It is hard to believe that the 2001:4 dummy captures anything remotely close to a wealth effect of \$808bn.<sup>11</sup>

The key question of the SVAR approach concerns the predictability of its estimated shocks. While decision lags help identify the fiscal shocks, implementation lags could cause the latter to be anticipated by the private sector; the resulting impulse responses would be biased. This is a legitimate and important concern. Suppose that the data are generated by the neoclassical model, but the government spending shocks estimated by the econometrician are in reality anticipated by the private sector by one period; as Ramey (2006) shows, the econometrician will find a positive response of consumption to her estimated government spending shock. The intuition is simple: in the neoclassical model, at the time of the true temporary shock consumption falls on impact, to return back to the steady state slowly as capital accumulates; the econometrician would then just capture the increasing part of the consumption path, after the impact effect. The first panel of Figure 1, which replicates a figure in Ramey (2006), displays the true and estimated responses of consumption to a government spending shock that is announced

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<sup>11</sup>McGrattan and Ohanian (2006) estimate transition matrices for different states (i.e., levels of government spending) in each year of WWII; once fed into a standard neoclassical model, they explain well the behavior of consumption during WWII.

one quarter in advance, in a simple model like Baxter and King (1993) with a Cobb-Douglas production function and utility of the form  $U_t = \log(C_t) + \log(500 - H_t)$ , where  $H$  is quarterly hours.

The same intuition suggests, however, that with habit persistence in consumption the model would still exhibit a negative consumption response. In the second panel, the utility function has been modified to  $U_t = \log(C_t - \gamma C_{t-1}) + \log(500 - H_t)$  where  $\gamma = .65$  as in Christiano, Eichenbaum and Evans (2005). Now the estimated response still exhibits a decline in consumption. Of course, if the shock were anticipated by more than 1 quarter the estimated decline in consumption would be smaller.

Ultimately, how much the estimated SVAR fiscal shocks are anticipated and how much this matters is an empirical question. Obviously I will not be able to provide a full answer, but I will provide some clues in section 4.3, after presenting the evidence from the DV and SVAR approaches. Note however that the same issue arises in the DV approach. Strictly speaking, the Ramey-Shapiro dummy variables should capture the moment the wealth effect manifests itself, i.e. the quarter in which a future military buildup becomes common knowledge. Assuming such a date can be defined, it is certainly easy for the econometrician to miss its timing by 1 or 2 quarters; and indeed, as discussed above there might not be a unique such shock.

### 3 The data and specifications

The benchmark specification of the VAR consists of 7 variables: government spending on goods and services  $g_t$ , the Barro-Sahasakul average marginal income tax rate  $t_t$ , real GDP  $y_t$ , private consumption on nondurables and services  $c_t$ , private gross fixed capital formation  $k_t$  (except for  $t_t$ , all in log of real, per capita values), the log of hours in the non-farm business sector  $e_t$ , and the log of the real product hourly compensation in the non farm business sector  $w_t$ . In alternative specifications, the two labor market variables are replaced by the GDP deflator inflation rate  $\pi_t$  and the 3-months nominal interest rate  $i_t$ ; in yet a different specification,  $t_t$  is represented by the log of real per capita net taxes.<sup>12</sup> I also experiment with a smaller 4-variable VAR that includes  $g_t$ ,  $y_t$ ,  $c_t$ , and  $k_t$ .

The average marginal income tax rate is the same variable used by Edelberg, Eichenbaum and Fisher (1999) and Burnside, Eichenbaum and Evans (2004), and proxies for the distortionary effects of taxation; net taxes, used by Blanchard and Perotti (2002), capture the net flow of resources from the private sector to the government, an important variable in a model with credit constraints. The interest rate controls for monetary policy. The small VAR is meant to facilitate comparisons with historical SVARs with annual data, which, because of the smaller sample size, will be based on this specification. In general, all these alternative specifications generate nearly identical results, hence I will

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<sup>12</sup>Net taxes are defines as tax revenues less transfers to households and subsidies.

focus on the benchmark 7-variable specification.

An important recent debate has focused on the robustness of SVARs estimates of the effects of technology shocks, depending on the method used to induce stationarity. I will discuss all results from two alternative variants of the specifications above, with a constant and a linear trend (“LT specification”), and with all variables in first differences (“I1 specification”).

Each equation includes 4 lags of the endogenous variables; the Ramey-Shapiro dummy variables are entered with lags 0 to 6.

All fiscal variables are defined at the level of the general government (i.e., the federal, state, and local governments, plus social security funds). Government spending on goods and services includes government consumption plus defense investment in machinery and equipment. Private consumption includes non-durables and services, and private investment does not include the change in inventories. The sample starts in 1947:1 and ends in 2005:4 (the average marginal income tax rate ends in 2003:4). Appendix A (available on the author’s web site) describes the data in greater detail.

The elasticities of government revenues are constructed from the annual elasticities computed by Giorno et al. (1995) and updated by Van der Noord (2002), based on the actual tax codes and the distribution of incomes across households; these have been adjusted to convert them into quarterly elasticities and to take into account possible collection lags.<sup>13</sup> Appendix B (available on the author’s web site) describes the construction of the tax elasticities. Note that the Barro-Shaskul average marginal income tax rate is a policy variable, hence by assumption it does not respond to shocks to the non fiscal endogenous variables within a given quarter; thus, in specifications that use this variable government spending shocks are identified via a simple Choleski ordering.<sup>14</sup>

## 4 Output and its components

### 4.1 The DV approach

Figure 2 begins with the DV1 and DV3 approaches on each column (results from the DV2 approach are nearly identical to those from the DV1 approach, and everything I

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<sup>13</sup>The OECD estimates of these elasticities start in 1960: for 1947-1959, I have assumed the 1960 value. This is certainly a crude approximation, but note that the estimated responses to a government spending shock, on which this paper focuses, are virtually invariant to the tax elasticities. Based on the identifying assumption that government spending cannot react to I have assumed a quarterly government spending output elasticity of 0, and a quarterly elasticity to the price level of -.5 (recall that government spending is in real terms).

The value of the elasticity of personal income taxes to income computed by the OECD displays a large discrete drop in 1992. Nothing would change if one were to use the average value of this elasticity over the sample, or a smoothed version of it.

<sup>14</sup>For simplicity, and somewhat improperly, I will continue to use the expression “SVAR” in these cases.

will say about the DV1 approach also applies to the DV2 approach). It displays the responses of government spending, the average marginal income tax rate, GDP, private consumption, and private investment, from the benchmark 7-variable VAR. All equations contain a constant and a linear trend. All endogenous variables are entered with 4 lags; the Ramey-Shapiro dummy variables with lags 0 to 6. The first five rows display the responses in the DV1 approach and in the individual episodes of the DV3 approach: the next five rows display the responses in the modified DV1 and DV3 approaches. Each panel displays the point estimate of the variable indicated on the row, with the 16th and 84th percentiles of the responses based on 500 Montecarlo simulations (on bootstrapping in the modified DV approaches). The responses of government spending, consumption and investment are expressed in percentage points of GDP by multiplying the log response by hundred times the average share of each variable in GDP.

The Korean war is by far the largest episode in terms of government spending, with a peak increase after two years of almost 7 percent of GDP above trend, followed by the Vietnam war with a peak of 1.5 percent after the same interval. The other two episodes exhibit no increase in government spending (the military expansion was compensated by a reduction in civilian spending of the same size).

It is well known that, largely due to an ideological aversion of President Truman to budget deficits, the Korean war buildup was mostly financed with taxes: in fact, row 2 shows that the average marginal tax rate on labor increases by 3 percentage points above trend 6 quarters after the start of the episode. The tax rate increased also, with a lag, in the Reagan buildup<sup>15</sup>, while it fell in the Vietnam and Bush buildups.

Output increases in the DV1 approach, and also in the Korean and Vietnam wars; it falls in the Reagan and Bush buildups. In the two quarters after the start of the Reagan buildup, quarterly GDP growth was -7.8 and -7.7 percent, then recovered to 7.6 and 8.4 percent, then fell to negative values for another 6 quarters; this patterns is captured clearly by the GDP response in the DV3 approach, since the latter attributes all the residual of the GDP regression to the buildup. A similar story holds for the Bush buildup.

In the DV1 approach consumption declines significantly, by almost 1 percent of GDP after 1 year. This result is similar to Edelberg, Eichenbaum and Fisher (1999), who however find a more modest, and insignificant, decline. Thus, the DV1 approach shows rising output and declining consumption, the typical neoclassical pattern after a government spending shock. However, when one separates the four episodes in the DV3 approach it becomes clear that, because of the constraints it imposes, the DV1 approach cannot capture the typical patterns of comovements between government spending and GDP on one hand, and consumption on the other, that occur in the individual episodes. Except for Korea, where consumption is flat, in the other episodes the response of consumption has the same sign and even the same shape as that of GDP. The DV1 approach captures

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<sup>15</sup>Although the timing is not exactly right because the average marginal income tax rate is an annual variable, this increase captures the Tax Equity and Responsibility Tax Act of 1982.

mostly the large increases in government spending and GDP in the first two episodes, and the large decline in consumption in the last two. Similarly, in the DV1 approach private investment (row 5) falls; but among the individual episodes it is only in Korea that investment moves in the opposite direction to GDP; in the others, it follows closely the GDP response. Estimation in first differences generates the same results (not shown).

The last five rows display the responses of the same variables in the modified DV1 and DV3 approaches. In row 3, the post-Vietnam GDP expansion was of similar size to the post-Korea one, despite the much smaller increase in government spending in the former. The modified method in row 8 does not attribute all the large post-Vietnam expansion to the Ramey-Shapiro episodes, but only the “normal” GDP response (taking into account possibly different patterns of the tax rate in the various episodes). Note also that now the methodology does not attribute the small recession of 1982 to the Bush fiscal episode, hence GDP rises above trend, despite the flat government spending response; one possible reason is the tax cut that accompanied this episode.<sup>16</sup> But GDP still falls in response to the Reagan episode: government spending is flat, but the tax rate increase.

Now consumption rises significantly above trend even during the Korean War; thus, it increases in all episodes except the Reagan buildup, when GDP fell. Hence, in the modified approach the consumption response has the same sign as the GDP in the DV1 approach, and in all individual episodes.

Conditional on a Ramey-Shapiro shock, the response of investment also mostly reflects that of GDP in the modified DV approaches too.

## 4.2 The SVAR approach

Figure 3 displays impulse responses from the SVAR approach. The shock to government spending is normalized to 1 percentage point of GDP.

In the first column, each equation in the VAR includes a linear trend, and the sample starts in 1947:1. Both GDP and consumption exhibit a hump-shaped response, with peaks of about 1.2 and .4 percentage points of GDP, respectively, after about 2 years. Thus, the SVAR evidence on consumption appears consistent with the DV3 evidence: conditional on a government spending shock, the response of consumption largely mimics that of GDP.

Quantitatively, however, in this sample the SVAR approach delivers a small response of consumption. Not surprisingly, it turns out that this depends strongly on the role of the Korean War. When the sample omits the fiscally turbulent late forties and early fifties and starts in 1954:1 (column 2), the positive response of consumption rises to a peak of

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<sup>16</sup>Eichenbaum and Fisher (2004) argue precisely that the different responses of taxes in the Bush buildup, relative to the typical response estimated via the DV2 method during the Ramey-Shapiro episodes, explains the decline in GDP.

about .9 percent of GDP after 3 years.<sup>17</sup> This is consistent with the evidence from the DV approach, since the sample now omits the Korean War with its large increases in government spending and in the tax rate. In fact, the tax rate rises in the long sample, and it is flat in the shorter sample.

In the I1 specification the results are similar: a small positive response of GDP and private consumption in the longer sample, and a larger and significant response in the shorter sample; the peak effects, however, are smaller than in the LT specification.

Investment falls, typically by between .4 and .8 percentage points of GDP. This is due in almost equal parts to machinery and equipment and to residential investment; investment in structures is flat.<sup>18</sup> All these results persist in the I1 specification.

### 4.3 Predictability of the SVAR fiscal shocks

Are the SVAR government spending shocks predictable?

Table 2: **Forecastability of R-S dummy and SVAR shocks**

		Full sample	Short sample
1	OLS: SVAR $g$ shock on 4 lags of the R-S combined dummy	0.03	0.85
2	OLS: SVAR $g$ shock on 4 lags of each R-S dummy	0.00	0.52
3	OLS: Ramey-Shapiro dummy on 4 lags of $g$ , $t$ and $y$ shock	0.02	0.01
4	Probit: Ramey-Shapiro dummy on 4 lags of $g$ , $t$ and $y$ shock	0.58	

In rows 1 to 3, the last two columns display the p-value of a test of the exclusion of all regressors in the equation. In row 4, the second to last column indicates the probability of 1950:3.

"Full sample": 1947:1-2003:4; "Short sample": 1954:1-2003:4.

Following Ramey (2006), a first obvious candidate as a predictor is the Ramey - Shapiro dummy variable itself. The first row of Table 2 shows that, like in Ramey (2006), over the full sample starting in 1947:1 the combined Ramey-Shapiro dummy Granger causes the government spending SVAR shock; the next row shows that the individual dummies are even more (jointly) significant in predicting the SVAR spending shock. However, row 3 shows that in a OLS regression the lagged government spending, tax and GDP shocks also predict the Ramey-Shapiro combined dummy, with a p-value of 2 percent.<sup>19</sup> As Leeper

<sup>17</sup>Galí, López-Salido and Vallés (2006) also start the sample in 1954:1, and find similarly higher responses of consumption.

<sup>18</sup>The responses of the components of private investment are obtained from 7-variable SVARs in which total private investment is replaced by each component in turn.

<sup>19</sup>Ramey (2006) finds that the government spending shock does not Granger cause the Ramey-Shapiro dummy. However, to assess whether the latter is forecastable there is no reason to limit oneself to the government spending shock as a predictor; in fact, the estimated tax and GDP shocks are equally plausible candidates, and turn out to have more forecasting power.



(1997) argues, a probit regression may be more appropriate than a linear one to predict a dummy variable; in this case, the lagged SVAR shocks are no longer jointly significant in predicting the Ramey-Shapiro dummy (not shown); however, the regression predicts the Korean event of 1950:3 with a probability of 58 percent (row 4).

A further examination of the OLS prediction equations for the government spending shock in rows 1 and 2 also reveals that the predictive power of the Ramey-Shapiro dummy comes mostly from the Korean War (by far the largest of all the episodes): the last column of Table 2 shows that over the shorter sample starting in 1954:1 the 4 lags of the Ramey-Shapiro dummy (or dummies) do not help predict the SVAR shocks. However, the SVAR shocks still predict the Ramey-Shapiro dummy, with a p-value of .01.

A second candidate to assess the predictability of the estimated SVAR shocks is independent assessments of the fiscal stance. Since 1984, the *Congressional Budget Office* publishes twice a year in *The Economic and Budget Outlook* (usually in February-March and August-September) revisions of changes of government spending and revenues during the year of the forecast, and up to 5 year thereafter, relative to the previous forecasts.<sup>20</sup> These changes are divided in three categories: technical, legislative, and economic (the latter are those that are due to changes in the economic environment).

Table 3: **Forecastability of SVAR shocks using CBO revisions**

	OLS regression of SVAR $g$ shock on CBO forecasts	Full sample	Short sample
1	SVAR shock on lagged CBO forecast revisions	0.62	.21
2	SVAR shock on contemp. CBO forecast revisions	0.15	.05

The last two columns display the p-value of a test of the exclusion of the regressor in the equation. "Full sample": 1947:1-2005:4; "Short sample": 1954:1-2005:4. The fiscal shocks are obtained from quarterly VARs estimated over these two samples. The p-values are obtained from a regression of these fiscal shocks on the CBO forecast, over the sample starting in the first semester of 1984:1.

In row 1 of Table 3 I take the average of the SVAR government spending shock (expressed as share of GDP by multiplication by the average spending / GDP ratio) in the first and second quarters and in the third and fourth quarters of year  $t$ , and regress this half-yearly variable on the sum of the legislative and technical CBO forecast revisions (normalized by potential output) for year  $t$  made in the previous semester. In both samples, the coefficient of the CBO forecast is insignificant.<sup>21</sup>

Thus, there is little evidence that the SVAR shocks are predictable: but do they make sense? When the SVAR government spending shock is regressed not on the lagged value,

<sup>20</sup>I thank Alan Auerbach for providing the data.

<sup>21</sup>The fiscal shocks are derived from VARs estimated on the full and shorter sample, respectively. Obviously the p-values of Table 3 are obtained from a regression estimated with the semi-annual data that start in 1984:1.

but on the contemporaneous value of the sum of the CBO legislative and technical forecast revisions, the p-value is .15 in the long sample and .05 in the short sample (Row 2 of Table 3). Thus, the data suggest that the SVAR government spending shocks estimated over the shorter sample are contemporaneously correlated with the information contained in the CBO forecasts.

## 5 Explaining the difference in the Ramey-Shapiro episodes

Besides the change in total government spending, fiscal policies during the four Ramey-Shapiro episodes differed markedly both in terms of the accompanying tax policies and in terms of the composition of government spending.

### 5.1 The role of taxes

Figures 4 and 5 display historical decompositions of consumption in the four episodes.<sup>22</sup> For each episode, two series are displayed. First, the deviation from the actual consumption path of the consumption forecast, based on information up to the start of the episode plus the sequence of government spending shocks during the five years of the forecast horizon (“g\_shocks”). This variable describes what the deviation from the actual consumption would have been if only the SVAR government spending shocks had occurred after the beginning of each episode. Second, the deviation of the consumption forecast from the actual consumption path, based on the sequence of net tax shocks only (“t\_shocks”), constructed in a similar manner. Both series are expressed as shares of GDP by multiplying the log response by the average consumption / GDP ratio.

The first panel is based on the VAR estimated over the long sample starting in 1947:1. Except in the Reagan buildup, government spending shocks make a positive contribution to consumption, and only slightly larger in the Korean war than in the Vietnam war or in the Bush buildup. Tax shocks make a negative contribution in the Korean war and the Reagan buildup, when taxes increased, and a positive contribution in the Vietnam and Bush buildups, when taxes fell. The contribution of tax shocks is generally smaller than that of government spending shocks.

The next panel is based on the shorter sample. The estimated contribution of government spending shocks in the Vietnam war increases considerably, to about 1.5 percent of GDP. In fact, the contribution of government spending by itself accounts for all the deviation of consumption from trend estimated by the DV3 approach during this episode.

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<sup>22</sup>Because the Barro-Sahasakul tax rate is an annual variable, to obtain tax shocks in this section I replace this variable with the log of real per capita net taxes.

## 5.2 The composition of government spending

The composition of the government spending changes in the four episodes was also different. Figure 6 displays impulse responses to the Ramey-Shapiro dummy variables, from the benchmark VAR where government spending has been split into its defense and non-defense components. The first row displays the response of civilian spending, the second of defense spending, and the third of their sum, total government spending. In all episodes defense spending increases and, except in Vietnam, civilian spending falls; and in the Reagan and Bush buildups the change in civilian spending is almost of the same size (in absolute value) as the change in defense spending, accounting for the limited change in total government spending.

In a SVAR, one must distinguish between shocks to defense and to civilian government spending. Columns 1 and 2 of Figure 7 display responses to a civilian and defense spending shock, respectively, from the same 8-variable VAR with civilian and defense spending instead of total government spending. In both columns the initial shock is renormalized so that total government spending increases by 1 percent of GDP. To derive the responses, civilian spending is ordered before defense spending, but the opposite ordering would produce the same results.

The response of total government spending to a civilian shock is much more intensive in defense civilian expenditure, but it is also much less persistent; yet the positive response of consumption to a civilian spending shock is much larger - almost 1.5 percentage points of GDP after 2 years, against .5 percentage points after a defense shock. The same considerations also hold in the I1 specification (columns 3 and 4); in fact, now the difference in the persistence of total government spending after the two shocks is larger, yet so is the difference in the response of consumption.

In response to a defense spending shock investment (row 6) always falls, while in response to a civilian shock it rises in the LT specification, and falls (but less than after a defense shock) in the I1 specification.

Thus, the evidence from the SVAR approach is that civilian government spending shocks appear to be associated with stronger responses of GDP and its components.

## 6 Evidence from long run annual data

To overcome the problems of both the DV and the SVAR approaches, Ramey (2006) advocates estimating a SVAR with annual data. The DV approach is based on very few episodes with different features; this can be mitigated by the longer sample available with annual data. And if changes in government spending are mostly anticipated by one or two quarters, then the estimated shocks have a better chance to be unanticipated (based on an information set of yearly variables).

But against this, there are two disadvantages. The SVAR approach to identification

hinges on decision lags in fiscal policy: by and large government spending on goods and services does not respond to macroeconomic news within a quarter. This identifying assumption is less plausible with annual data: but then, if government spending is used as a countercyclical tool, it is likely to impart a negative bias to the estimated response of consumption. Second, the quality of national account data deteriorates quickly as one moves backward in time; and this problem is particularly severe for the key variable, government spending.

Official US annual national account data are available starting in 1929 from the Department of Commerce; between 1889 and 1929, annual data have been estimated by Kuznets and revised by Kendrick. Aside from a few amendments to make Kuznets' series more consistent with the Department of Commerce definitions used from 1929 onward, for the purposes of this paper a major contribution of Kendrick's work consists in adding an estimate of government spending on goods and services. However, one should be aware of a few problems with this series. For instance, between 1890 and 1902 state and local purchases other than compensation of public school employees and new construction are interpolated by a straight line; and straight line interpolation (albeit at shorter intervals) is frequent for several other items. Also, as Kendrick acknowledges, the estimates of the government spending deflators are often speculative.<sup>23</sup>

With this in mind, Figure 8 displays responses from a small 5-variable VAR that includes government spending, GDP in the business sector,<sup>24</sup> total private consumption<sup>25</sup>, full-time-equivalent employment in the business sector, and wage and salary accruals per full time equivalent employee in the business sector. This last variable starts in 1929, the others in 1889; hence, when estimated over the longer sample the system consists of the first four variables only (also, employment is not in full time equivalent terms in this case). As usual, the system is estimated in levels with a constant and a time trend, or in first differences with just a constant.

This specification is similar to that of Ramey (2006) and, like there, the response of consumption initially drops slightly but significantly, by a similar amount to Ramey (2006), less than .2 percentage points of GDP. If one excludes the years 1941-47 (not shown), the initial drop remains, but then consumption rises slightly (but significantly)

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<sup>23</sup>The other key variable in this paper, private consumption expenditure, also has important problems prior to 1929. In Kendrick's work, this variable is obtained from Kuznets's "flow of goods to consumers" by subtracting government direct services to consumers, in turn proxied by personal tax and nontax payments. This is already a rough approximation; in addition, some components of this variable are interpolated by a straight line, such as state and local personal tax receipts between 1890, 1902 and 1913. Also, prior to 1919 there were no data on consumer expenditure on services; Kuznets used the ratio of expenditure on services and on commodities "from occasional family budget studies" (Kendrick (1961), p. 38).

<sup>24</sup>This uses the Kuznets-Kendrick data until 1929, ratio-linked with the BEA data afterwards. Results with the Balke-Gordon GNP series are virtually identical.

<sup>25</sup>Until 1929, consumption of non-durables and services is not available separately.

above trend.

However, these results depend heavily on the first part of the sample. If one estimates the same SVAR starting in 1929 (column 2), thus using only the BEA data based on a consistent definition and no interpolations, just like in the quarterly SVAR the response of private consumption of nondurables and services follows closely that of GDP (except for the initial jump in the latter, caused by the jump in government spending): it still declines very slightly on impact, but then increases to a peak of about .25 percentage points of GDP above trend after 3 years.

In this type of investigations, the treatment of WWII and the Korean War is crucial. Government spending on goods and services as a share of GDP rose from 14.8 percent of GDP in 1940 to 47.9 percent in 1944, and from 15.9 percent of GDP in 1950 to 23.9 in 1953; over the same periods, private consumption of nondurables and services decreased from 62.6 to 46.4 of GDP, and from 55 to 52.8 of GDP, respectively. As usual in these cases, it is not obvious whether one wants to treat wars as outliers, or as episodes that contain a lot of useful information; column 3 shows that, if one does leave out the years 1941-45 and 1950-53, the response of consumption rises considerably, to more than .4 percent of GDP after 1 year: interestingly, the standard errors are still quite small, and all responses are still highly significant.

However, what is perhaps even more unusual about wars is the dramatic, sudden decline in government spending once they are over: between 1944 and 1946 government spending fell from 47.9 to 17.8 percent of GDP, while between 1953 and 1955 it fell from 23.9 to 20.8 percent; consumption of nondurables and services increased from 46.4 to 57.8 percent of GDP after WWII, while it remained at around 53 percent after the Korean War. In fact, if one leaves out also the years 1946-47 and 1954-55 (column 4), the response of private consumption about doubles, reaching a peak of .8 percentage points of GDP after 1 year: this is very close to the response of the SVAR estimated in quarterly data from 1954:1.

The results in the I1 specification (columns 5 to 8) are very similar: in particular, one observes the same progression towards stronger responses of consumption as one moves to the right. Thus, once reliable data are used the historical SVAR evidence on consumption with annual data delivers results that are very similar to those of the quarterly SVARs, and to the DV3 approach.

Investment too displays stronger responses as one moves to the right. In the whole sample starting in 1889, the response is negative, and remains so for the first 3 years if the sample starts in 1929. When the war and post-war periods are excluded, it becomes positive and significant. This is different from the quarterly SVAR, where investment tends to fall after a government spending shock. Thus, the behavior of investment is more difficult to pin down than the response of consumption, and is less consistent with the quarterly evidence.

## 7 The labor market

### 7.1 The response of hours and the real product wage

With lump-sum taxation, virtually all models predict a positive effect of shocks to government spending on private and total hours. However, while the neoclassical model predicts a decline in the real wage, some neo-keynesian models with price stickiness (like Galí, López-Salido and Vallés (2006) or Linnemann and Schabert (2003))<sup>26</sup> or other reasons for countercyclical markups (like Rotemberg and Woodford (1992) or Ravn, Schmitt-Grohé and Uribe (2006)) predict the opposite.

It is important to be clear on the definition of the real wage. Obviously in a one sector model there is no distinction between the real consumption wage and the real product wage. But the logics of the different predictions of the neoclassical and neokeynesian models also survive with more than one sector. In a neoclassical model with frictions in reallocating capital between sectors like Ramey and Shapiro (1998), the sector that experiences the larger increase in government demand also displays the larger fall in the product wage, as employment shifts from one sector to the other along the sectoral labor demand curves. In contrast, in a two-sector neokeynesian model with nominal price rigidities and some costs of labor reallocation across sectors like Monacelli and Perotti (2007), the sector that receives the larger share of the government spending shock also exhibits the larger increase in the real product wage, as the markup falls more in that sector. Thus, sectoral evidence can shed light on the underlying transmission mechanism for fiscal policy.

Manufacturing plausibly receives a disproportionate share of the shocks to government spending on goods, hence the importance of this sector in testing alternative transmission mechanisms. On the other hand, a rise in the real consumption wage is the precondition for private consumption to increase in neokeynesian models (see section 10), hence the importance of checking the response of this variable too.

Figure 9 presents responses of hours and the real wage from the benchmark 7-variable specification, that includes government spending, the average marginal income tax rate, GDP, consumption, investment, plus an employment/hour variable and a wage variable. In the literature on the effects of technological shocks, several different employment and real wage variables have been used; as Chari, Kehoe and McGrattan (2005) note, the results are somewhat sensitive to the variable used. I use non-farm business sector hours and average weekly compensation (deflated by the value added deflator in the non-farm business sector), or manufacturing hours and hourly earnings (deflated by the manufacturing PPI). I also experiment with private and total employment, but these behave very much like business sector employment, hence I will not report their responses. For

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<sup>26</sup>The nature of the friction is important here: in general, models with nominal wage rigidity do not have the same prediction.

brevity, I will refer to both business sector compensation and manufacturing earnings as “real product wage”, or “real wage”.

In the DV1 case, and in each of the four episodes separately, the responses of hours follow closely that of GDP. Only in the Korean and Vietnam wars do hours increase, and in manufacturing more than in the business sector. The real wage in manufacturing also increases in these two episodes, by up to 13 and 6 percent, respectively. Like hours, it is flat in the Reagan buildup, and increases in the Bush buildup despite the decline in manufacturing hours. In the business sector the real wage does not move significantly.

The picture is similar in the modified DV approaches, except that now manufacturing hours, like GDP, decline in the Reagan buildup and increase (with a delay) in the Bush buildup. The manufacturing real wage also declines in the former episode, but increases with a lag in the latter. Thus, in the modified approach, the manufacturing real wage moves in the same direction as hours except in the Bush buildup.

The last two rows display the real product wage and the real after-tax consumption wage in the business sector.<sup>27</sup> The real product wage falls in the two episodes in which the tax rate falls, Vietnam and Bush, and rises in the other two. For neo-keynesian models it is the real consumption wage that is of particular interest, since only if it increases can private consumption also increase. The last row shows that there is a close correspondence between the response of this variable and that of consumption. The real after-tax consumption wage falls initially during the Korean War, due to the increase in taxation, then picks up; it increases during the Vietnam war, even if the pre-tax product wage falls; it falls during the Reagan episode, and it is nearly flat during the Bush buildup, due to the decline in taxation.

Figure 10 displays VAR responses to a government spending shock. In the LT specification, hours rise in both sectors, and more in the shorter sample starting in 1954, although in the case of manufacturing only after a sharp but brief decline. The real wage increases in both sectors, and much more in manufacturing (a peak of between 3 and 4 percent after about 2 years). In the I1 specification, hours are flat, but the real wage still increases in both sectors. These findings are consistent with those of Fatas and Mihov (2001), who identify government spending shocks via a Choleski decomposition, and of Pappa (2005), who uses a sign restriction approach.<sup>28</sup>

Hourly labor productivity in manufacturing declines, by 1 percent in the long sample and almost 2 percent in the short sample (this is derived from a VAR that includes real manufacturing value added besides the other 7 variables). The increase in the man-

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<sup>27</sup>The after-tax wage is computed by multiplying compensation in the business sector times 1 less the average marginal income tax rate.

<sup>28</sup>Using a BLS series of producer prices in manufacturing (discontinued after 1996:1) to deflate nominal manufacturing earnings, Edelberg, Eichenbaum and Fisher (2003) and Burnside, Eichenbaum and Fisher (2004) find a persistent decline in real product earnings in the DV1 and DV2 approaches, respectively. When I use this series, kindly provided to me by Jonas Fisher, I also find a decline in manufacturing earnings in the DV1 approach and in each of the episodes separately, and also in the SVAR approach.

ufacturing real wage, combined with a fall in productivity, seems inconsistent with the benchmark neoclassical model with perfectly competitive goods and labor markets. It is consistent with some neoknesian models with price stickiness or other reasons for countercyclical markups (although in general not with models with wage rigidity), where the fall in the markup allows the real product wage to rise despite the decline in productivity.

The last row of the figure shows that the after-tax real consumption wage in the business sector behaves very much like the pre-tax product wage; it only displays an initial decline, by almost 1 percent, in the longer sample; this is consistent with the positive response of the tax rate (in turn influenced by the Korean war) documented in Figure 3.

## 7.2 Government employment shocks and the labor market

All the discussion so far has implicitly assumed that government spending on goods and services falls entirely on goods produced by the private sector; in reality, typically about half of it consists of government wages, i.e. of services produced by the government sector itself. As Finn (1996) and Cavallo (2005) emphasize, in the neoclassical model the distinction between government employment and spending on goods has important implications. Both types of spending have a negative wealth effect on the consumer; but for plausible parameter values a government employment shock *raises* the real product wage and *reduces* private employment: the reason is that the higher labor supply caused by the negative wealth effect is less than the increase in government employment: hence, private employment falls, and the real product wage in the private sector increases. As shown in Pappa (2005), a government employment shock has similar effects on private employment and the real product wage in the private sector in a neoknesian model with price stickiness.

I estimate the same benchmark VARs as above, but now government spending is split into its two components: real spending on goods and real spending on government employment. As a measure of the latter I take the log of total government employment, divided by population. Figure 11 shows that the Ramey-Shapiro episodes were overwhelmingly on goods expenditure (in fact, government wage expenditure declined in the Reagan and Bush episodes).

In a SVAR, distinguishing the two spending components allows one to construct two government spending shocks that turn out to have very different properties. Column 1 of Figure 12 displays the responses to a government employment shock of government spending on wages, goods spending, and their sum total government spending<sup>29</sup>, then of GDP, consumption, and hours and the real wage in the business sector and manufacturing; column 2 displays the responses of the same variables, but to a goods spending shock.

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<sup>29</sup>The response of government employment is converted into the response of government spending on wages by multiplying the former by the average share of government wages in GDP.



In all cases the shocks are normalized so that the impact response of total government spending is equal to 1 percent of GDP. In the figure, the government employment and goods spending shocks are orthogonalized in this order; the results with the alternative ordering are nearly identical. The sample starts in 1954:1.

In all specifications, the government employment shock generates a highly persistent response of government employment itself, and a sizable response of goods spending; in contrast, the goods spending shock generates virtually no response of government employment, and much less persistence in total spending. Thus, the government employment shock is much more persistent, and more wage-intensive.

GDP and consumption increase much more in response to a government employment shock: for GDP, a peak of 4 percent against about .7 percent in response to a goods spending shock; for consumption, more than 1.5 percent against .4 percent. The responses of hours are also very different: both increase in response to a government employment shock, and are flat in response to a goods spending shock. As usual, the response is stronger in manufacturing, with a peak of about 6 percent after 1 year.<sup>30</sup> The product wage in manufacturing also responds much more strongly to a government employment shock; the business sector real wage instead is flat in both cases. In the II specification, the picture is similar, except that business sector hours do not increase after a government employment shock, and now even the business sector real wage responds positively to the same shock. The standard errors in the responses to the employment shock, however, become large.

These results are in line with Pappa (2005), who finds positive responses of the real wage and, less sharply, of private employment to a government employment shock using a sign restriction approach; with Linnemann (2006) who estimates a trivariate VAR with government and private employment and GDP, and finds similar positive responses of private employment to a government employment shock; and with Rotemberg and Woodford (1992), who find a positive response of private hours and the real wage to a shock to military employment.

This pattern of responses thus appears inconsistent with virtually all models we have of the effects of government employment shocks; in fact, it is very difficult to obtain a positive response of *both* private employment *and* the real private wage in either a neoclassical or a neokeynesian model. The neoclassical model studied by Finn (1996) predicts a positive response of the real wage in the private sector, but only because private hours decline; the neo-keynesian model of Pappa (2005) has the same predictions, although the mechanism is different. In Linnemann (2006) government employment is complementary to private consumption in the household's utility: if the complementarity is strong enough, a government employment shock can raise private consumption and therefore private employment: but now the real wage must fall, as the economy is moving

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<sup>30</sup>To put this response in perspective, note that a shock to the wage component of 1 percent of GDP is roughly equivalent to a shock of 10 percent to government employment, given government wages.

down a given labor demand in the private sector. .

### 7.3 Annual historical evidence on labor markets

Figure 13 presents responses to a government spending shock of 1 percent of GDP from the 5-variable VARs, that includes government spending, GDP, private consumption, an employment variable, and a real wage variable. In the first specification, the employment variable is full-time equivalent employees in the business sector (employees when the sample starts in 1889); the real wage variable is total wage and salary accruals in the business sector divided by full time equivalent employees in the business sector, and deflated by the business sector deflator. In the second specification, the output variable is total GDP; the employment variable is full time equivalent employees in manufacturing; the real wage variable is total wages and salaries in manufacturing divided by full time equivalent employees, and deflated by the price index of goods: this specification can be estimated only from 1929. In column 1, the sample starts in 1889; in column 2, in 1929; in column 3, in 1929, but the years 1941-45 and 1950-53 are excluded; in column 4, 1946-47 and 1954-55 are also excluded.

Both employment variables respond positively to a government spending shock, and again the response gets stronger as one moves rightward in the figure. Like before, manufacturing employment responds more strongly than business sector employment.

The real wage response is also positive, although now it is stronger in the business sector and it ceases to be significant in manufacturing when the major wars and their aftermaths are excluded. The I1 specification gives a very similar picture.

The last two rows display the paths of productivity per full time equivalent employee (in the case of manufacturing, this is derived from a VAR that includes real manufacturing value added in addition to the other 5 variables) Labor productivity increases in the business sector, while it falls in manufacturing. Ramey (2006) finds a similar result, but does not look at the behavior of the real wage. As she argues, the pattern of the productivity responses in the two sectors is consistent with a movement down a given labor demand in manufacturing, with perfectly competitive goods market; it could reflect a sectoral shift towards manufacturing industries, with higher returns to scale than the average, although each individually has decreasing returns to scale.

However, the increase in the manufacturing real wage does not seem to square with this interpretation; as argued in the discussion of the quarterly SVAR, it is instead consistent with a model with countercyclical markups.

## 8 Evidence from the input output tables of the US

As observed above, because manufacturing receives a disproportionate share of the increase in governments spending around the Ramey-Shapiro episodes, the evidence on this

sector is likely to be key to our understanding of the effects of fiscal policy. However, manufacturing consists of many industries, only a few of which were the target of substantial increases in government spending during the Ramey-Shapiro episodes. An alternative approach to VAR analysis could shed new light.

The US input-output tables provide information on government purchases by sector, at 4- and 6-digit levels, on dates that are almost exactly equally spaced about the starts of two Ramey and Shapiro episodes: in 1963 and 1967, and in 1977 and 1982. The *NBER Manufacturing Productivity Database* contains annual information on wages, employment, output and producer prices in 450 manufacturing industries at the 4-digit level between 1958 and 1991. These two datasets can be combined to obtain information on changes in real government purchases, real output, hours, employment, and the real hourly product wage, by manufacturing industry, during the last two Ramey-Shapiro episodes.<sup>31</sup>

Let  $G_i$  denote all defense and civilian purchases by the general government in sector  $i$ .<sup>32</sup> Let  $\frac{\Delta G_{i,67/63}}{Y_{i,63}}$  and  $\frac{\Delta G_{i,82/77}}{Y_{i,77}}$  denote the changes in  $G_i$  over the Vietnam War and the Carter-Reagan buildup, as shares of the initial year's industry output. Column 3 of Table 4 lists the first ten industries in the Vietnam War and the Carter-Reagan buildup, by the value of this variable; for each of these industries, column 4 shows the share of real government spending in output in the initial year of each episode,  $\frac{G_{i,63}}{Y_{i,63}}$  and  $\frac{G_{i,77}}{Y_{i,77}}$ . This list appears to make intuitive sense: most industries in it are clearly defense-related. The next columns of the table display the percentage changes of real output, of hours, and of the real hourly product wage of production workers. The percentage changes are calculated between the averages during the last two years of the episodes (1966-67 or 1981-82, respectively) and the averages during the first two years (1963-64 or 1977-78).

Not surprisingly, virtually all these industries experienced a large increase in output and hours. More interestingly, in both episodes the real product wage increased in 8 industries out of 10.

In the first row of Table 5, columns 2 to 4 displays the unweighted average of  $\frac{\Delta G_{i,67/63}}{Y_{i,63}}$  in the top, middle, and bottom 20 industries, respectively, by the value of this variable; columns 4 to 6 display the significance level of their differences. The next rows show that the order of the average changes in output, hours (with one exception), and the real wage in the three groups is the same as that of the average change in government spending.

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<sup>31</sup>The hourly wage is obtained by dividing total production worker wages by the total number of hours of production workers.

<sup>32</sup>The input-output tables do not provide separate information on the fixed capital formation component of non-defense spending, which was excluded from the definition of the government spending variable in the VARs estimated so far.

The tables contain data on both direct and total government purchases, but for the 1977 and 1982 tables only the latter information is available by industry (as opposed to commodities). Thus, in this section the expression "government purchases" refers to direct plus indirect purchases.

The real values are computed deflating the nominal quantities provided by the input-output tables by the industry's price index of shipments in the *NBER Manufacturing Productivity Database*.

Table 4: **Top 10 industries by change in government purchases**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>Vietnam War</b>							
Industry	IO63	SIC72	$\frac{\Delta G_{i,67/63}}{Y_{i,63}}$	$\frac{G_{i,63}}{Y_{i,63}}$	$\frac{\Delta Y_{i,67/63}}{Y_{i,63}}$	$\frac{\Delta H_{i,67/63}}{H_{i,63}}$	$\frac{\Delta W_{i,67/63}}{W_{i,63}}$
Ammunition, exc. small arms, nec.	1302	3483	347.62	80.97	260.83	170.01	-3.35
Small arms ammunition	1306	3482	167.75	43.35	151.06	147.81	10.32
Other ordnance and accessories	1307	3489	116.70	85.83	72.14	57.52	-4.79
Small arms	1305	3484	49.50	41.04	113.19	64.86	1.43
Semiconductors	5702	3674	43.75	41.67	94.73	52.88	33.58
Electronic components, nec	5703	3675	40.92	43.92	97.51	42.70	11.72
Watches and clocks and parts	6207	3873	29.59	11.72	34.33	17.08	9.02
Paving mixtures and blocks	3102	2951	29.19	50.36	18.65	2.69	8.96
Architectural metal work	4008	3446	25.11	28.37	11.50	-2.13	5.37
Misc. chemical products	2704	2861	24.98	16.77	28.42	18.46	13.95
<b>Carter-Reagan</b>							
Industry	IO77	SIC72	$\frac{\Delta G_{i,82/77}}{Y_{i,77}}$	$\frac{G_{i,77}}{Y_{i,77}}$	$\frac{\Delta Y_{i,82/77}}{Y_{i,77}}$	$\frac{\Delta H_{i,82/77}}{H_{i,77}}$	$\frac{\Delta W_{i,82/77}}{W_{i,77}}$
Semiconductors	570200	3674	81.26	25.42	128.84	16.04	71.53
Electronic computing equipm.	510101	3573	60.23	12.53	32.72	15.81	19.47
Ammunition, exc. small arms, nec.	130200	3483	57.44	68.62	313.01	43.49	147.78
Aircraft and missile equipm., nec	600400	3728	47.04	43.22	49.02	43.58	2.52
Aircraft and missile engines and parts	600200	3724	43.87	52.37	36.26	-1.12	12.32
Radio and TV communication equipm.	560400	3662	33.48	41.35	54.68	21.75	15.54
Electrical industrial apparatus, nec	530800	3629	30.56	12.88	14.73	-10.66	4.39
Guided missiles and space vehicles	130100	3761	30.53	82.44	33.74	34.27	-16.57
Other ordnance and accessories	130700	3489	27.28	62.05	27.47	9.94	14.55
Surgical appliances and supplies	620500	3842	24.79	22.03	-9.15	-1.56	-6.01

Source: see text. Column 1: Input-Output Industry Classification, 1963 and 1977 editions respectively. Column 2: Standard Industry Classification, 1972 edition. Column 3: change in real government spending in industry  $i$  between 1967 and 1963, as a share of output of industry  $i$  in 1963. Column 4: Government spending on industry  $i$  in 1963, as a share of output of industry  $i$  in 1963. Column 5: Percentage change in output in industry  $i$ , average of 1966-67 relative to average of 1963-64. Column 6: Percentage change in hours in industry  $i$ , average of 1966-67 relative to average of 1963-64. Column 7: Percentage change in real hourly product wage in industry  $i$ , average of 1966-67 relative to average of 1963-64.

Similar definitions apply to the second panel. The initial and end years are 1977 and 1982. The averages are taken over the years 1977-78 and 1981-82.

$G$ : total government spending on the sector;  $Y$ : real output of the sector;  $H$ : hours of production workers in the sector.  $W$ : real hourly product wage of production workers in the sector.

Table 5: Average changes, by industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		top 20	mid 20	bot 20	top-mid	top-bot	mid-bot
<b>Vietnam War</b>							
(1)	$\frac{\Delta G_{i,67/63}}{Y_{i,63}}$	53.14	3.46	-4.55	0.00	0.00	0.24
Average percentage changes							
(2)	$\frac{\Delta Y_{i,67/63}}{Y_{i,63}}$	61.49	17.10	16.34	0.00	0.00	0.94
(3)	$\frac{\Delta H_{i,67/63}}{H_{i,63}}$	37.77	8.95	10.23	0.00	0.00	0.85
(4)	$\frac{\Delta W_{i,67/63}}{W_{i,63}}$	8.03	5.47	5.29	0.34	0.31	0.95
Average log changes, deviations from trend							
(5)	$\frac{\Delta Y_{i,67/63}}{Y_{i,63}}$	71.23	22.17	10.96	0.00	0.00	0.33
(6)	$\frac{\Delta H_{i,67/63}}{H_{i,63}}$	62.28	23.92	22.93	0.00	0.00	0.93
(7)	$\frac{\Delta W_{i,67/63}}{W_{i,63}}$	5.74	3.69	-1.53	0.64	0.09	0.23
<b>Carter-Reagan</b>							
(8)	$\frac{\Delta G_{i,82/77}}{Y_{i,77}}$	31.13	0.05	-9.03	0.00	0.00	0.00
Average percentage changes							
(9)	$\frac{\Delta Y_{i,82/77}}{Y_{i,77}}$	42.39	-2.32	-13.13	0.00	0.00	0.17
(10)	$\frac{\Delta H_{i,82/77}}{H_{i,77}}$	10.01	-8.16	-15.56	0.00	0.00	0.18
(11)	$\frac{\Delta W_{i,82/77}}{W_{i,77}}$	15.90	4.39	0,29	0.02	0.00	0.39
Average log changes, deviations from trend							
(12)	$\frac{\Delta Y_{i,82/77}}{Y_{i,77}}$	39.86	-26.98	-48.78	0.00	0.00	0.10
(13)	$\frac{\Delta H_{i,82/77}}{H_{i,77}}$	20.39	-14.81	-28.08	0.00	0.00	0.25
(14)	$\frac{\Delta W_{i,82/77}}{W_{i,77}}$	10.86	-8.15	-17.18	0.01	0.00	0.20

Source: see text. Definition of variables: see previous table.

This holds whether one considers the actual changes in these variables (rows 2 to 4) or the changes of their detrended values (rows 5 to 7).<sup>33</sup> The same applies to the Carter-Reagan buildup (rows 8 to 14). In particular, the average change in the real product wage is always highest in the top 20 industries and lowest in the bottom 20 industries. For hours and output the difference between the top and middle and between the top and bottom groups is always significant; for the product wage, it is always significant in the Carter-Reagan buildup; in the Vietnam War, only the difference between the top and bottom groups in the detrended case is significant.

Note also that the average changes in output and hours imply that productivity on average rises in the top 20 industries, that experience an increase in government purchases, and declines or is stagnant in the bottom 20 industries, that experience a decline in government purchases.

Thus, the sectoral evidence provides independent confirmation of the main conclusions of the SVAR evidence on labor markets: the sectors that experienced the largest government spending shocks are also the sectors that experienced the largest positive changes in the real product wage. This result is consistent with two-sector neo-keynesian models but not with two-sector neoclassical models.

## 9 Outside the US

### 9.1 Quarterly data

The key constraint in estimating fiscal policy VARs in countries other than the US is the existence of non-interpolated quarterly data on government spending spanning a long enough period. I have assembled the relevant data for Australia (1959:3 - 2006:2), Canada (1961:1 - 2006:3) and the United Kingdom (1963:1 - 2006:2). As much as possible, the definitions are the same as in the US: all fiscal variables cover the general government, government spending on goods and services excludes government capital formation but, following the National Account guidelines, includes most expenditure on military equipment; private consumption includes nondurables and services, except in Australia where it is total private consumption. I use the same benchmark 7-variable specification estimated for the US, except that, since the average marginal income tax rate is not available for these countries, it is replaced by the log of real net taxes per capita.<sup>34</sup> Like in the US,

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<sup>33</sup>In her discussion, Valeri Ramey makes the point that, if one subtracts an average annual rate of TFP growth of 3 percent, the changes in the real product wage in Table 4 mostly become negative, thus supporting the neoclassical model. However, this would leave the ranking of the three groups in Table 5 unaffected. In addition, note that the average response of the real product wage in the top group of industries in Table 5 is positive even after the real wage has been detrended.

<sup>34</sup>In the case of Australia, data on wages and employment are available only from 1980. Hence, these two variables are replaced by the GDP deflator inflation rate and by the 3-months interest rate.

the alternative specifications give nearly identical results.

Row 1 of Figure 14 displays the response of government spending, GDP, consumption and investment. To facilitate comparison, the first column displays anew the US responses in the LT specification over the shorter sample starting in 1954:1, the following columns display Australia, Canada, the United Kingdom; columns 5 to 8 do the same for the I1 specification.

There are two key messages from this table: the responses of GDP and consumption tend to be positive in all countries and all specifications; but they are also smaller than in the US, and in a few cases insignificantly different from 0.

In the LT specification, the responses of GDP and consumption are positive and significant in all countries (although they turn negative in the UK after 6 quarters), but outside the US the consumption response is rarely larger than .5 percentage points of GDP, against a peak of more than 1 percent in the US. A similar pattern is displayed by the I1 specification, except that now GDP and consumption in Canada are insignificant, while in the UK they are now positive and significant over the whole horizon.

There is slightly less regularity across countries in the response of investment: in the LT specification, it is negative in the US, Canada, and the UK (after a small and brief positive impact response), and positive in Australia. Like in the US, this response is driven by machinery and equipment investment and, to a lesser extent, by structures; outside the US, private residential investment tends to increase slightly, by between .1 and .2 percent of GDP, after a government spending shock.

## 9.2 Historical evidence with annual data

Figure 15 displays impulse responses from a small 4-variable SVAR in government spending, GDP, private consumption, and investment, estimated using long-run annual data in Australia, Canada and the United Kingdom, plus the US as a comparison.<sup>35</sup> Over these long samples, outside the US only total private consumption is available. The first 4 rows display the responses of the 4 variables in the LT specification, the next 4 rows of the I1 specification.

For Australia, Butlin (1977) has assembled yearly data covering the period 1901-1948. However, until 1939 private consumption was computed residually from estimates of GDP and its other components, and is thus unusable; and most data for the war years are

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Germany also has quarterly data, but the amount of detail from the primary source is limited, and the large break in 1989 makes it difficult to estimate a meaningful VAR. Heppke-Falk, Tenhofen and Wolff (2006) estimate a SVAR on German data between 1974:1-2004:4, prolonging the data for Germany after 1991 backward using West German growth rates, and find a positive response of private consumption to a government spending shock. A few other countries, like France and Italy, have data starting in 1980, but the amount of interpolation is unclear.

<sup>35</sup>Long-run data for labor market variables are available only for the US and Canada, hence the smaller 4-variable specification to ensure consistency across countries.

considered “unreliable” by the author himself. The *Australian Bureau of Statistics* now publishes thoroughly revised annual data on a number of variables going back to 1949, with a consistent definition.<sup>36</sup> When the long sample - combining the Butlin data up to 1948 and the ABA data from 1949 - is used (column 3), the response of consumption is significantly negative; this is consistent with the mechanical negative correlation between government and private consumption due to the residual nature of the latter. When the VAR is estimated from 1949, thus using only the consistent ABA data (column 4), the response of consumption is now positive (after a small initial decline), sizeable (just below 1 percent of GDP), and significant at 2 years.

*Statistics Canada* publishes historical annual series with a consistent definition going back to 1926. Over the whole sample (column 5) the response of consumption is significantly positive, with a peak of .6 percentage points of GDP after 5 years. This is robust to the exclusion of WWII (column 6), although not in first differences (row 7).

In the United Kingdom, annual data on the variables of interest are published in the *Blue Book* from 1948 using a consistent definition; Feinstein (1972) provides data going back to 1870. But up to about 1920 many series are considered unreliable: in Feinstein (1972) GDP, depending on the decade gross fixed capital formation, consumers’ expenditure and central government spending get subjective “reliability assessments” of B or C (on a declining scale from A to C). For the period 1900-1938 “little information on actual expenditure or retail sales is available” (page 45); and importantly, the results of the government expenditure deflation “are very rough, and especially for the war years are best treated with extreme scepticism” (page 78).

Column 7 of Figure 15 shows that over the whole sample consumption drops significantly to about -.8 percentage points of GDP after 3 years. These results are robust to the exclusion of WWI (WWII is not in the sample because there are no data on private investment between 1938 and 1946). But again, if one starts with the official data in 1948 (column 8), the decline in consumption is smaller, and is insignificantly different from 0.<sup>37</sup> In first differences (row 7) consumption rises significantly above 0.

As usual, it is more difficult to identify a clear pattern in the investment responses, but outside the US investment increases only in Australia in the I1 specification and in Canada in the LT specification when wars are excluded.

Thus, when data of “good” quality are used (in particular non-interpolated, non-residual government spending and consumption data), out of the 8 country-specification pairs that exclude wars, the response of consumption is significantly negative (but small) in one case, flat in another, and significantly positive in the remaining 6 cases. Like in

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<sup>36</sup>On overlapping years, the discrepancy between the nominal values of these series and the earlier national account estimates, themselves more consistent with Butlin’s estimates for 1901-1939, can be of the order of 100 percent for some series.

<sup>37</sup>In addition, the decline in the post-war period is entirely due to the years 1974-76, when government spending increased substantially in response to what was perceived as a temporary negative shock.



quarterly data, the consumption response tends to be smaller than in the US.

Table 6 displays the cumulative GDP and consumption multipliers of government spending at 2 years from the quarterly SVARs (first panel) and from the annual SVARs (second panel), both in the LT and in the I1 specifications. In quarterly data, the consumption multiplier is nearly 0 in Canada; it is positive and quite similar (between .35 and .45) in the other countries, although in Australia it is not significant. In all cases the multipliers in the LT and I1 specifications are very close.

In annual data, in the US the consumption multiplier is large and nearly double the quarterly multiplier, but in the other countries there is more dispersion.

Table 6: **Cumulative multipliers of govt. spending at 2 years**

	USA	AUS	CAN	GBR	USA	AUS	CAN	GBR
	quarterly, LT				quarterly, I1			
GDP	0.98*	1.33*	-0.34	0.57	0.72*	1.26*	-0.46	0.66
CONS	0.42*	0.35	0.06	0.35	0.46*	0.23	-0.02	0.35*
	annual, LT				annual, I1			
GDP	3.05*	1.13*	1.59*	0.28	3.03*	1.68*	0.22	0.69
CONS	0.98*	-0.28	0.19*	-0.03	0.83*	-0.19	-0.27*	0.62*

First panel: cumulative GDP and consumption multipliers from 4-variable VAR estimated on quarterly data. Second panel: cumulative GDP and consumption multipliers from same 4-variable VAR estimated on annual data. Samples for annual VARs: USA: from 1929, WWII and Korean War excluded; Australia: from 1949; Canada: from 1926, WWII excluded; United Kingdom: from 1948.

An asterisk "\*" indicates that 0 is outside the region between the two one-standard error bands at that horizon.

### 9.3 The labor market

Figure 16 displays the results for labor market variables in the US, Canada and the UK (in Australia, data on wages and employment are available only from 1983). These are based on the usual benchmark 7-variable VAR also used to derive the responses of consumption and investment, that includes  $g$ ,  $t$ ,  $y$ ,  $c$ ,  $k$ ,  $e$  (a measure of hours or employment) and  $w$  (a measure of earnings or compensation). The first row displays the response of GDP; the second row of the employment variable with the largest coverage available (total employment in the US, the whole industry in Canada, and all civilian jobs in the UK); the third row of manufacturing hours (in the US) or employment (in Canada). The next two rows display the responses of the corresponding real product wages.<sup>38</sup>

<sup>38</sup>This is: in row 4, hourly business sector compensation deflated by its own deflator (USA); average weekly earnings of all employees in the industrial composite, deflated by the GDP deflator (Canada);

Outside the US, it is surprisingly difficult to find a positive response of employment variables to a government spending shock, despite the positive GDP response: only in the UK in the I1 specification can one find a positive response of overall employment. In all countries and specifications, the real product wage increases significantly, and again more in manufacturing.

## 9.4 Annual historical evidence on labor markets

Outside the US, only Canada has long enough historical annual series on employment and the real wage, and only in manufacturing. Figure 17 displays responses to a government spending shock of 1 percent of GDP from a 5 variable VARs that includes government spending, GDP, private consumption, manufacturing employment, and the manufacturing real wage, exactly like that estimated for the US. And like in the US, manufacturing employment rises in Canada, except in the I1 specification when wars are excluded (the same specification that exhibited no increase in consumption). The peak employment response is between 1 and 2 percent.

Like in the quarterly SVAR, the response of the manufacturing real wage is always positive and significant, with peaks of above 2 percent when wars are excluded.

## 10 A brief review of recent models of fiscal policy

This section briefly reviews the effects of purchases of goods and services by the government in the recent macro literature, to point out the key testable differences. In all cases, I will assume that taxation is lump-sum, government spending consists of purchasing goods produced by the private sector that are then thrown away, and there is only one sector in the economy. For the reasons discussed in the introduction, the discussion will focus on the effects of government spending on GDP, private consumption, employment, and the real wage.

In the standard **neoclassical model** studied by Baxter and King (1993) a forward-looking representative agent can borrow and lend freely at the market interest rate; the production function has constant returns to scale, all prices are flexible, all goods and factor markets are perfectly competitive, and the utility function is separable in consumption and leisure. From the intertemporal government budget constraint, an increase in government spending must be matched by an increase in taxation of the same value in present discounted value terms. Hence, the individual is poorer in lifetime terms, and reduces her consumption and leisure; as labor supply shifts out, output increases and the real wage falls along a given labor demand.

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average earnings index for the whole economy, deflated by the GDP deflator (UK). In row 5, average weekly earnings of manufacturing production workers (USA) and employees (Canada), deflated by the manufacturing PPI.

Thus, in this model the effects of a government spending shock on consumption and the real wage follow directly from two key features: the negative wealth effect, and the separability of consumption and leisure. Two broad classes of models eliminate or counteract these two features to reach different predictions about the response of private consumption, or the real wage, or both.

In the **non-separable model** of Linnemann (2006) the only difference is that the utility function is non-separable in leisure and consumption. As leisure falls following the negative wealth effect, the substitutability between consumption and leisure implies that the marginal utility of consumption must increase. Hence, both consumption and hours increase. However, as Bilbiie (2006) shows, for consumption to increase it must be the case that it is an inferior good; and for consumption and hours to move in the same direction, one of the two must be an inferior good.

The next modification of the neoclassical mechanism consists in allowing a government spending shock to cause a rightward shift in the aggregate demand for labor. If this effect is strong enough, the real wage can increase; in turn, this can (but not necessarily does) induce a higher consumption, through two basic mechanisms: the substitution effect and credit constraints. There is more than one way to get a government spending effect on the aggregate demand for labor: for lack of a better name, I lump this class of models based on movements in labor demand that are not caused by productivity shocks under the heading of **neokeynesian models**.

1) **Countercyclical mark-ups**. With some monopoly power in the goods market, labor demand is defined by the first order condition for profit maximization  $F_L(L_t, \dots) = \mu_t w_t$ , where  $F$  is the production function,  $L$  is labor demand,  $w$  is the real product wage, and  $\mu$  is the markup. If  $\mu_t$  falls when government spending increases, from  $F_{LL} < 0$  labor demand will increase for a given  $w$ . In the well known model of Rotemberg and Woodford (1992), a government spending shock increases current demand relative to future demand and therefore raises the incentives to undercut collusive pricing between oligopolistic firms. The only incentive compatible collusive agreement is then to reduce the mark-up when aggregate demand increases.

In Ravn, Schmitt-Grohé and Uribe (2006) the demand function facing each producer has a price-elastic component that is a function of aggregate demand, and a price-inelastic component that is a function of the producer specific habit. An increase in aggregate demand, caused for instance by a shock to government spending, increases the share of the price-elastic component and thus the elasticity of demand, which in turn makes the markup countercyclical.

2) **Nominal rigidities**. With price stickiness, monopolistically competitive firms meet the extra demand caused by a government spending shock by supplying more output; labor demand increases as output rises (thus, these models also exhibit countercyclical markups conditional on a government spending shock). As shown in Linnemann and Schabert (2003), if the interest rate rule does not put too much weight on output, the

real wage can increase despite the shift in labor supply. Note that the nature of the rigidity matters: with wage rigidity, the real wage might well fall after a government spending shock.

3) **Increasing returns.** In Devereux, Head and Lapham (1996), higher government spending raises the equilibrium number of firms that can operate in the intermediate good sectors, where there are increasing returns to specialization. Hence, the productivity of all firms in the sector increase, and despite the standard negative wealth effect on labor supply the resulting outshift in labor demand can lead to a higher equilibrium real wage. A similar mechanism operates in Bilbiie, Ghironi and Melitz (2005).

Once the real wage rises because of one of these three mechanisms, there are basically two ways to get a rise in consumption. First, the higher real wage induces individuals to substitute from leisure into consumption, thereby inducing an increase in consumption: this is the route taken by Ravn, Schmitt-Grohé and Uribe (2006) and Devereux, Head and Lapham (1996). In models with nominal rigidities, in general the increase in the real wage will not be enough, by itself, to generate an increase in consumption. The second route, taken by Galí, Lopez-Salido and Vallés (2006), is then to appeal to credit constraints: a share of the population cannot borrow or lend, and consume all their labor income in each period. As the real wage increases, their consumption increases too. With enough of these individuals, the model can generate a positive response of total private consumption to a government spending shock.<sup>39</sup>

Note that, in order to generate a positive consumption response, these models need a substantial real wage response. This runs counter to the notion that real wages tend to be acyclical (unconditionally) over the cycle. But the evidence we have seen is that they can be quite responsive to government spending shock.

Table 7 summarizes the key results discussed in this section.

Table 7: **Models of government spending**

	$L^s$	$L^d$	L	Y	W/P	C
Neoclassical	↑	=	↑	↑	↓	↓
Non-separable utility	↑	=	↑	↑	↓	↑
Neokeynesian	↑	↑	↑	↑	↑	↑

A “(↑)” indicates that the real wage or consumption *can* increase if the shift in labor demand is large enough.

This classification is obviously rather schematic. As we have seen, “neo-keynesian” models are consistent with a wide variety of responses, depending for instance on the nature of the nominal rigidity and the behavior of the monetary authorities. But in

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<sup>39</sup>López-Salido and Rabanal (2006), Forni, Monteforte and Sessa (2006), and Coenen and Straub (2005) all estimate small DSGE models with credit constrained households.

one sense it remains useful: because of the wealth effect, with lump-sum taxation the neoclassical model unambiguously generates a decline in private consumption following a government spending shock; and even with distortionary taxation, one would need rather extreme patterns of intertemporal substitution to generate a (temporary) increase in consumption in response to a negative wealth effect.

## 11 Conclusions

Are wars normal events from the point of view of fiscal policy, just “bigger”? If they are, it is difficult to escape the conclusion that private consumption declines in response to a shock to government spending: wars are plausibly exogenous, and during WWII the share in GDP of government spending on goods and services more than tripled in 4 years, from 14.8 percent in 1940 to 47.9 percent in 1944, while private consumption of nondurables and services declined from 62.6 to 46.4 of GDP. But even outside wars there is fiscal action that can be exploited: the problem is how to disentangle its exogenous, unanticipated component. The “narrative” or “Dummy Variable” approach tries to combine both ideas, by looking at the typical deviation from the “normal” path of the endogenous variable caused by a series of post-war “abnormal” fiscal events, namely four military buildups driven by foreign policy, that can plausibly be regarded as exogenous and unanticipated. In its original version, the method assumes that these “abnormal” fiscal events are entirely (in the DV3 approach), or “almost” entirely (in the DV1 and DV2 approaches) responsible for all the deviation from normal of all the variables during an horizon that is typically assumed to be between 6 and 8 quarters. Under these assumptions, the method delivers results that, especially in the DV1 and DV2 method, are supportive of the key neoclassical mechanism: in response to a government spending shock, private consumption and the real wage fall.

But possibly a better interpretation of the logic itself of the exercise consists in isolating the “abnormal” fiscal events and estimate the “normal” response of the non-fiscal endogenous variables to these events. Thus, this method allows for a number of non-fiscal shocks to hit the economy during the time of the abnormal fiscal event. In this case, the estimated normal response of consumption to abnormal events is now typically positive. This is consistent with the impulse responses from an approach based on a structural VAR. This last approach is subject to a different type of criticism: its estimated shocks might not be rally unanticipated by the private sector. To address this problem, Ramey (2006) proposes to estimate SVARs with long-run annual data. I show that, when reliable non-interpolated data are used, again the evidence supports the notion that the responses of consumption and of the real wage to a government spending shock are positive. Independent evidence from the US input-output tables also indicates that the real product wage increased more in the sectors that experience the greater increase in government spending as a share of their output.

Obviously there are many open questions, both in terms of methodology and in terms of evidence. I will indicate only two. It is frequently asserted that government spending is more effective in stimulating the economy in times of recessions and low capacity utilization. Although I know of no model that formalizes this idea, it is easy to see how a model with occasionally binding credit constraints could generate this result. In ongoing research with Ilian Mihov, we indeed find preliminary evidence that shocks to government spending generate a higher GDP and private consumption response in times of low GDP growth.

A second open issue concerns the stability of the results across periods. The variances of output and inflation have declined considerably after about 1980, and a growing literature studies how changes in the conduct of monetary policy and in its transmission mechanism might have contributed to this decline. There is evidence (see Perotti (2004) and Romer and Romer (2006)) that both the variance of fiscal policy shocks and their effects on GDP and consumption also have declined in the last 20 years. Investigating this issue further seems important to promote our understanding of the transmission mechanism of fiscal policy.

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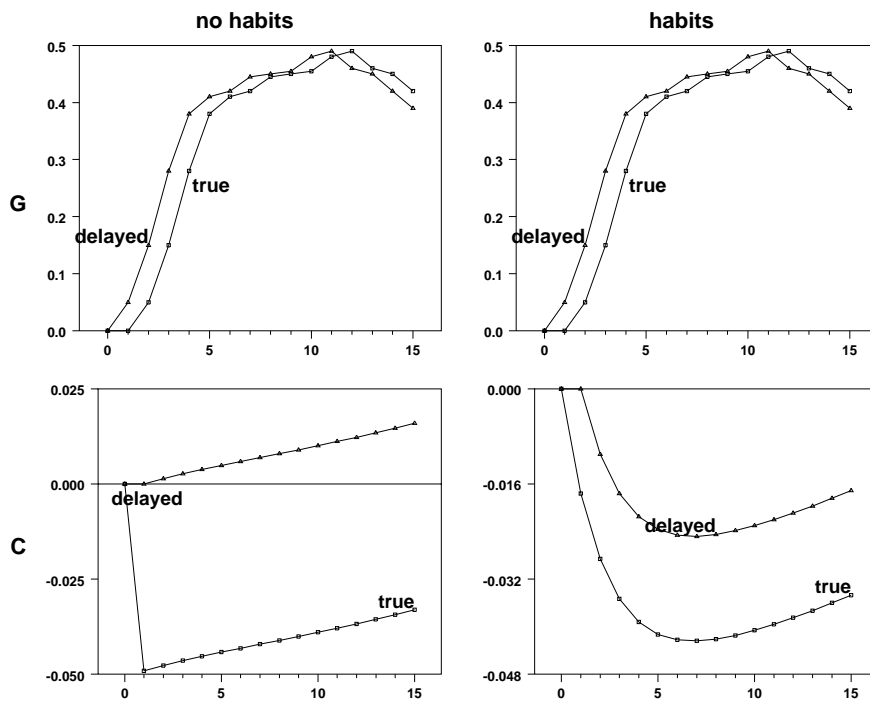


Figure 1: The effects of missing the timing with and without habit formation

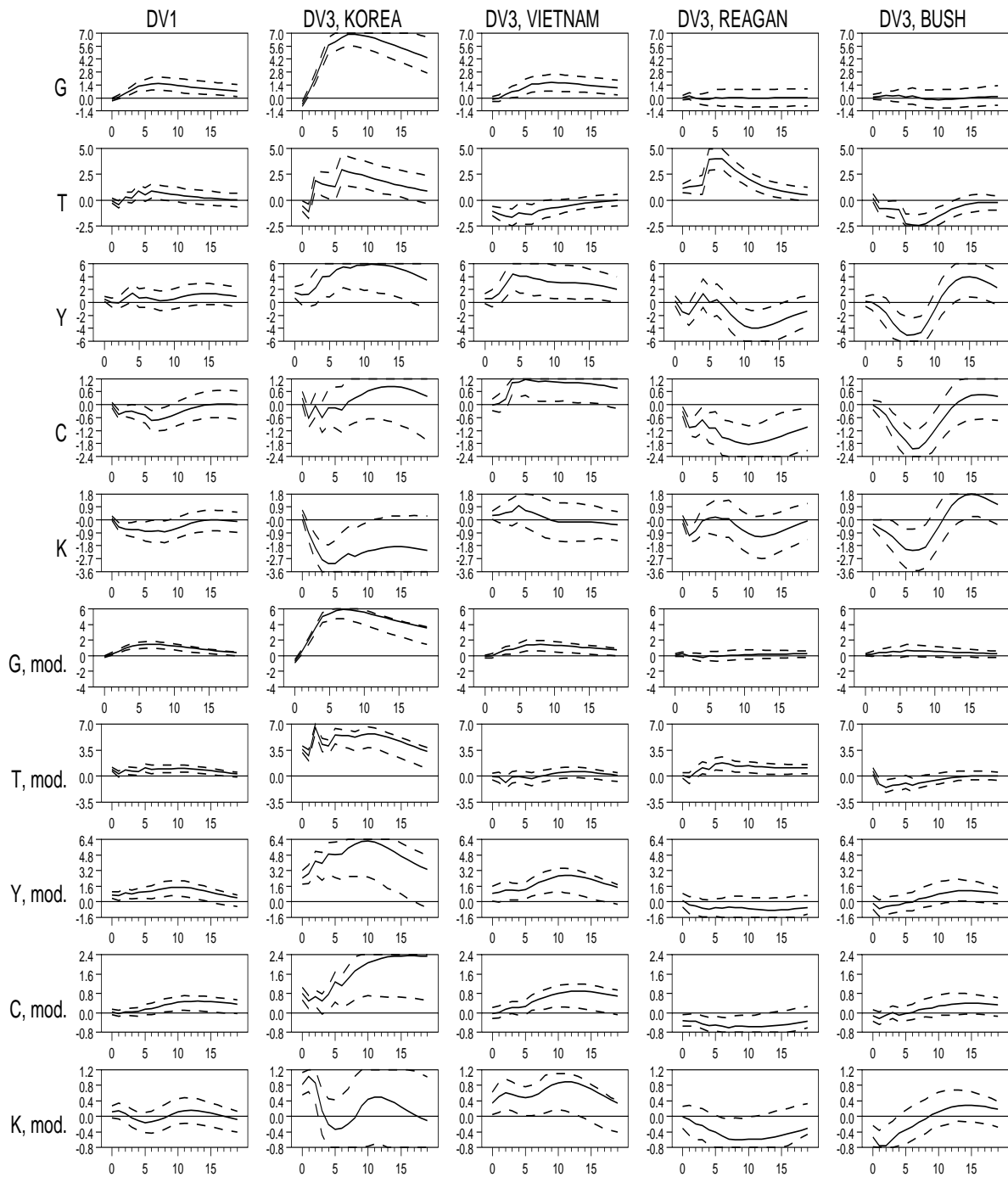


Figure 2: Responses to Ramey-Shapiro dummy variables

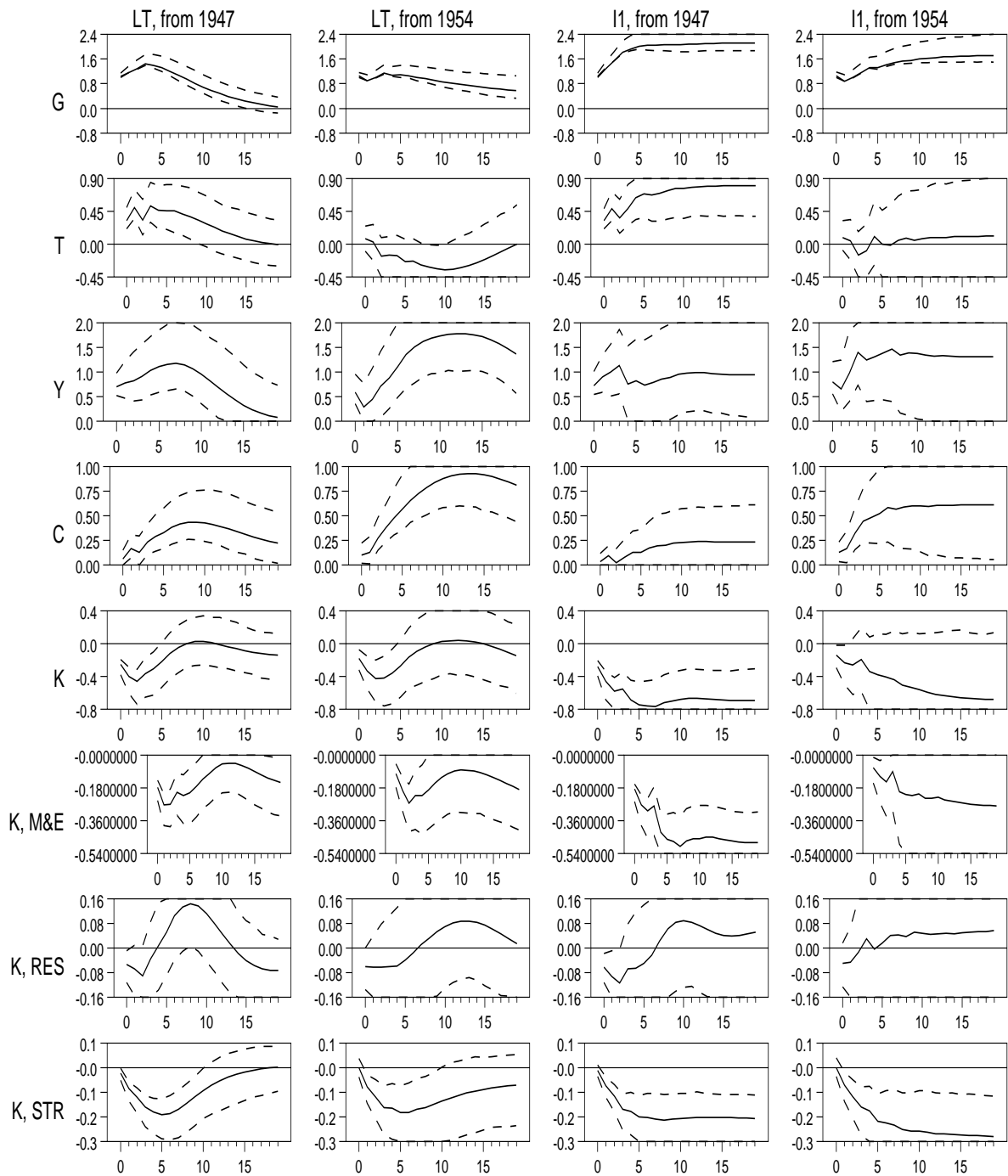


Figure 3: SVAR responses to government spending shocks

### Sample starts 1947:1

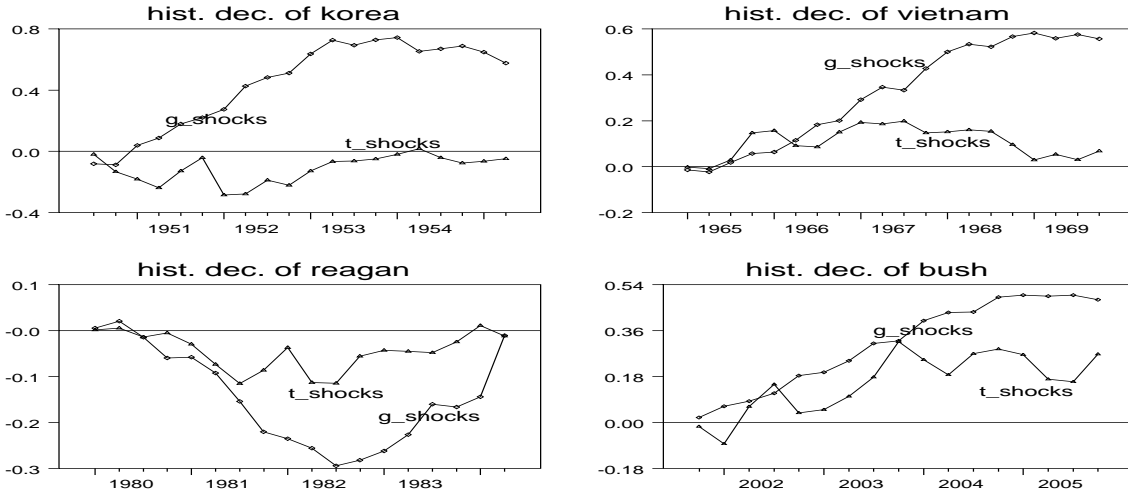


Figure 4: Historical decomposition of consumption, 1947:1-2005:4

### Sample starts 1954:1

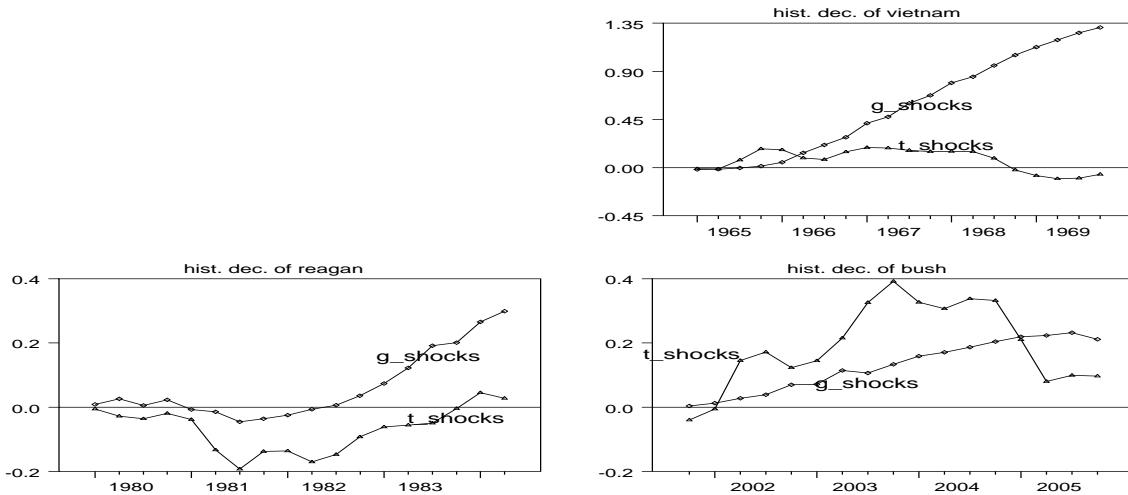


Figure 5: Historical decomposition of consumption, 1954:1-2005:4

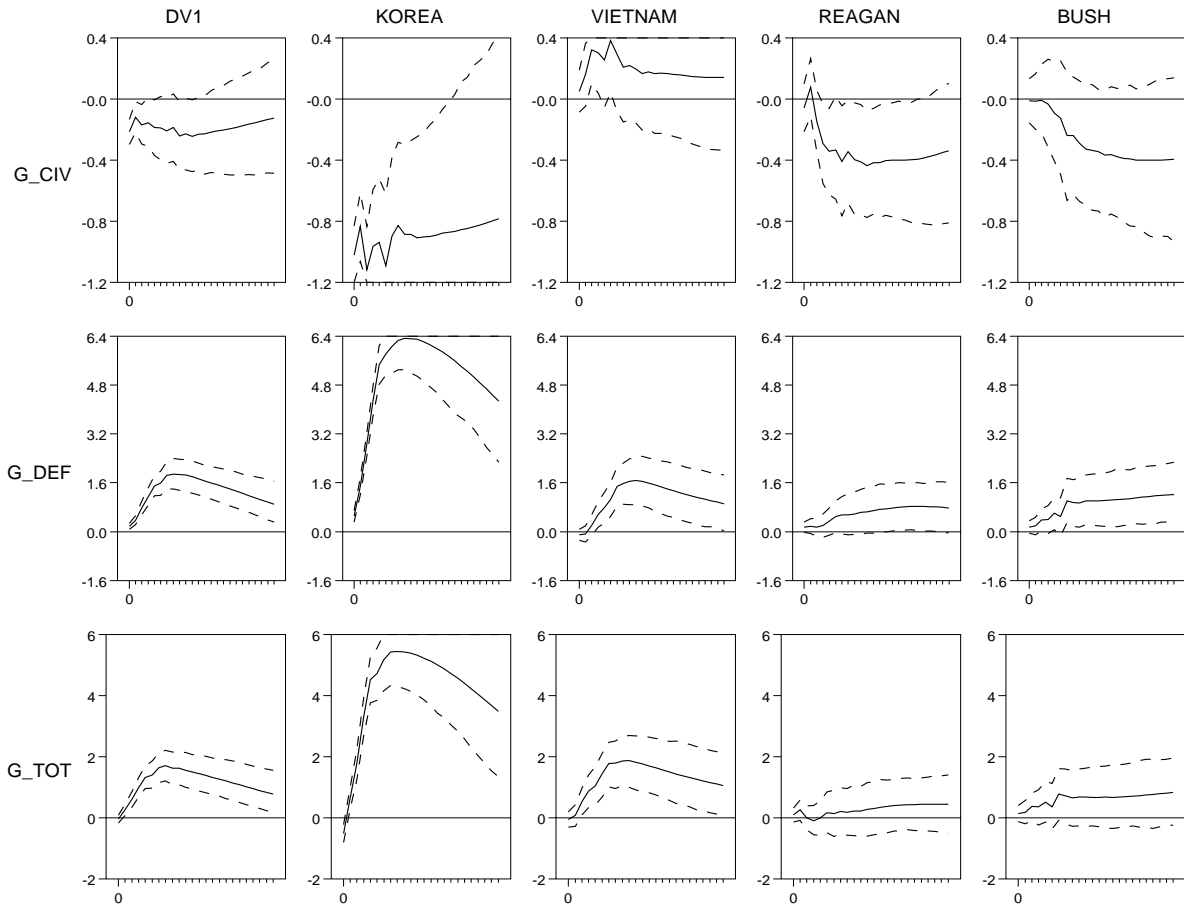


Figure 6: Response of civilian and defense spending to Ramey-Shapiro dummy variables

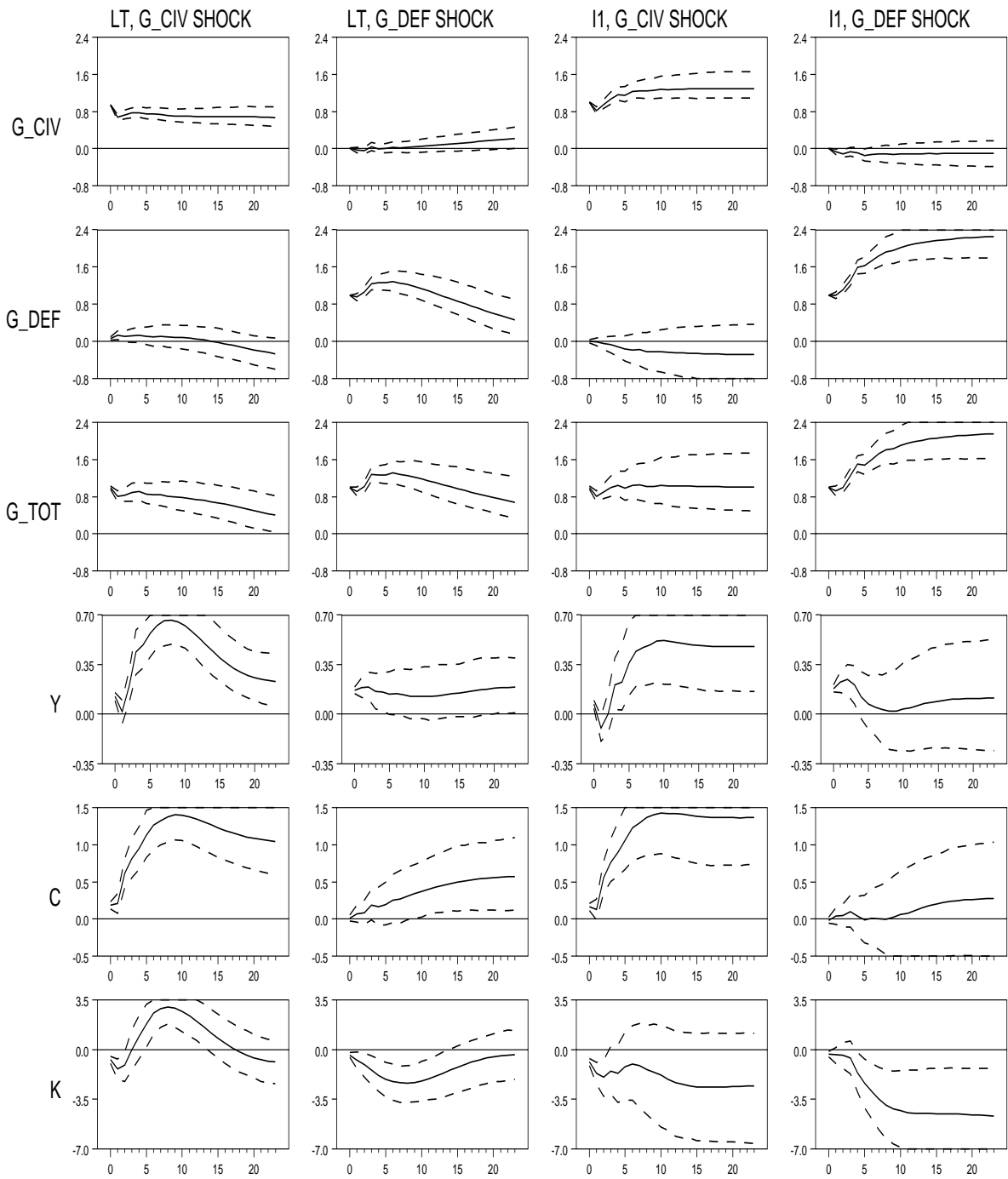


Figure 7: Responses to civilian and defense spending shocks, SVAR



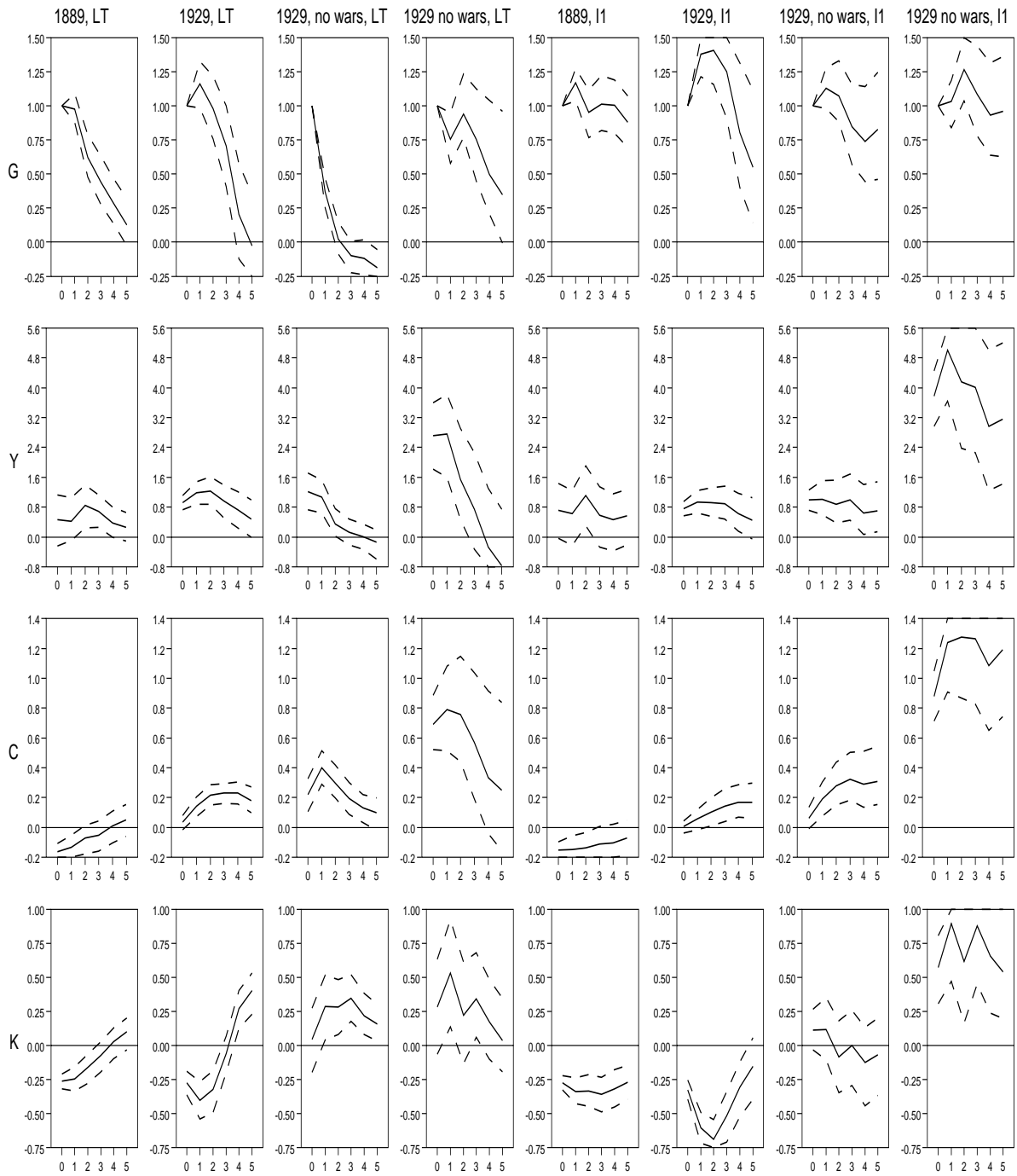


Figure 8: Responses to government spending shocks, annual historical data, SVAR

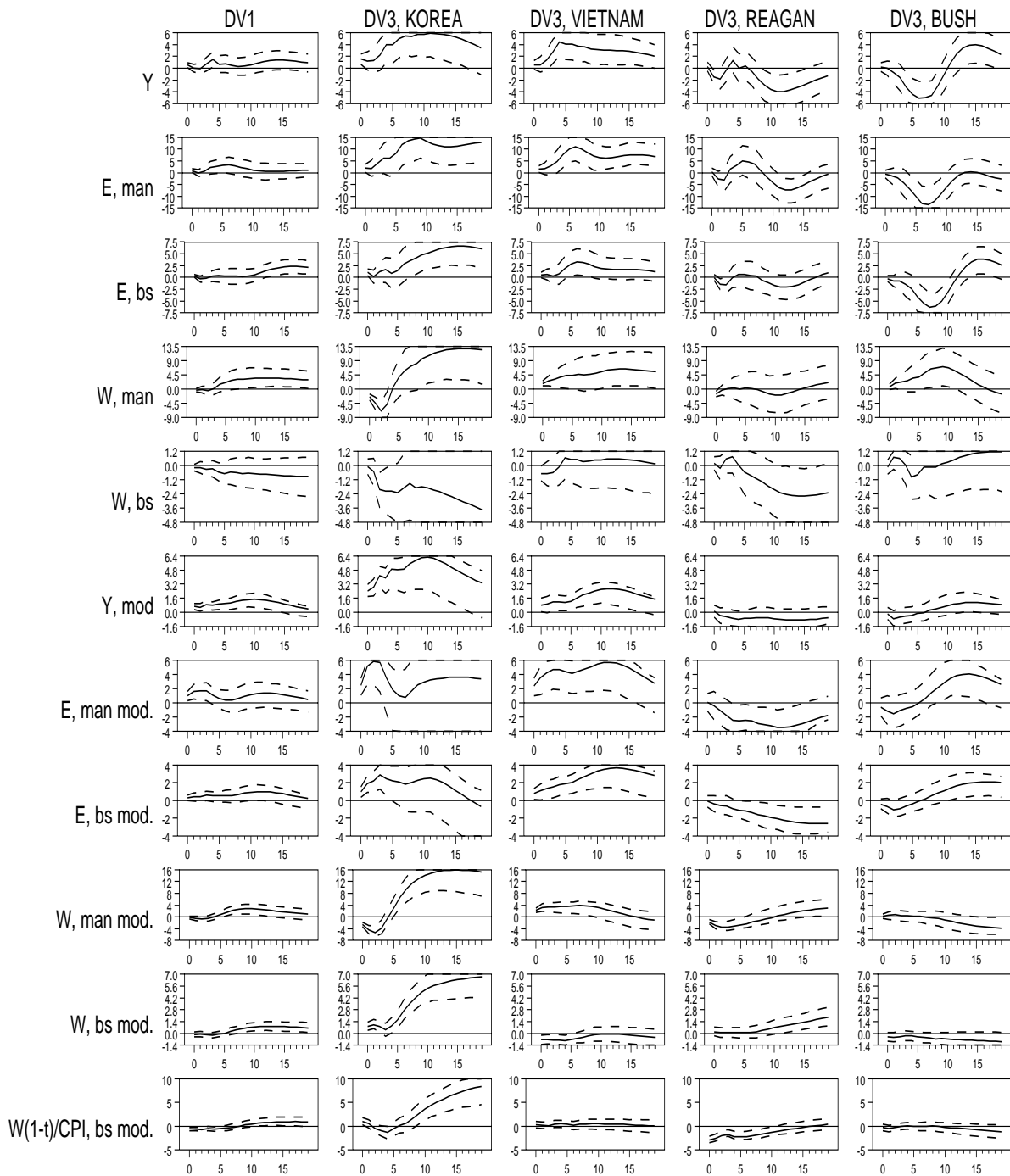


Figure 9: Responses of labor market variables to Ramey-Shapiro dummy variables

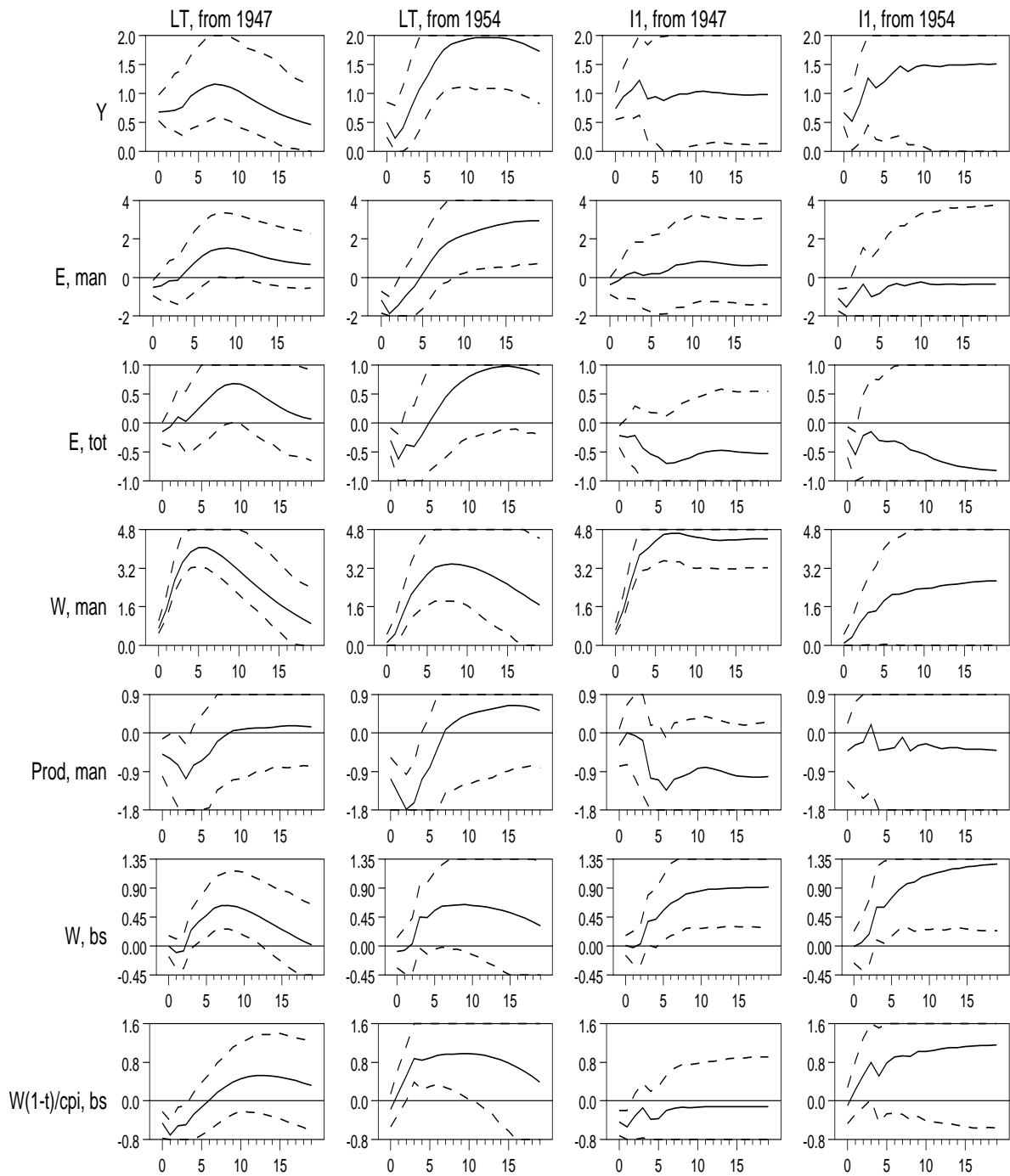


Figure 10: Responses of labor market variables, SVAR

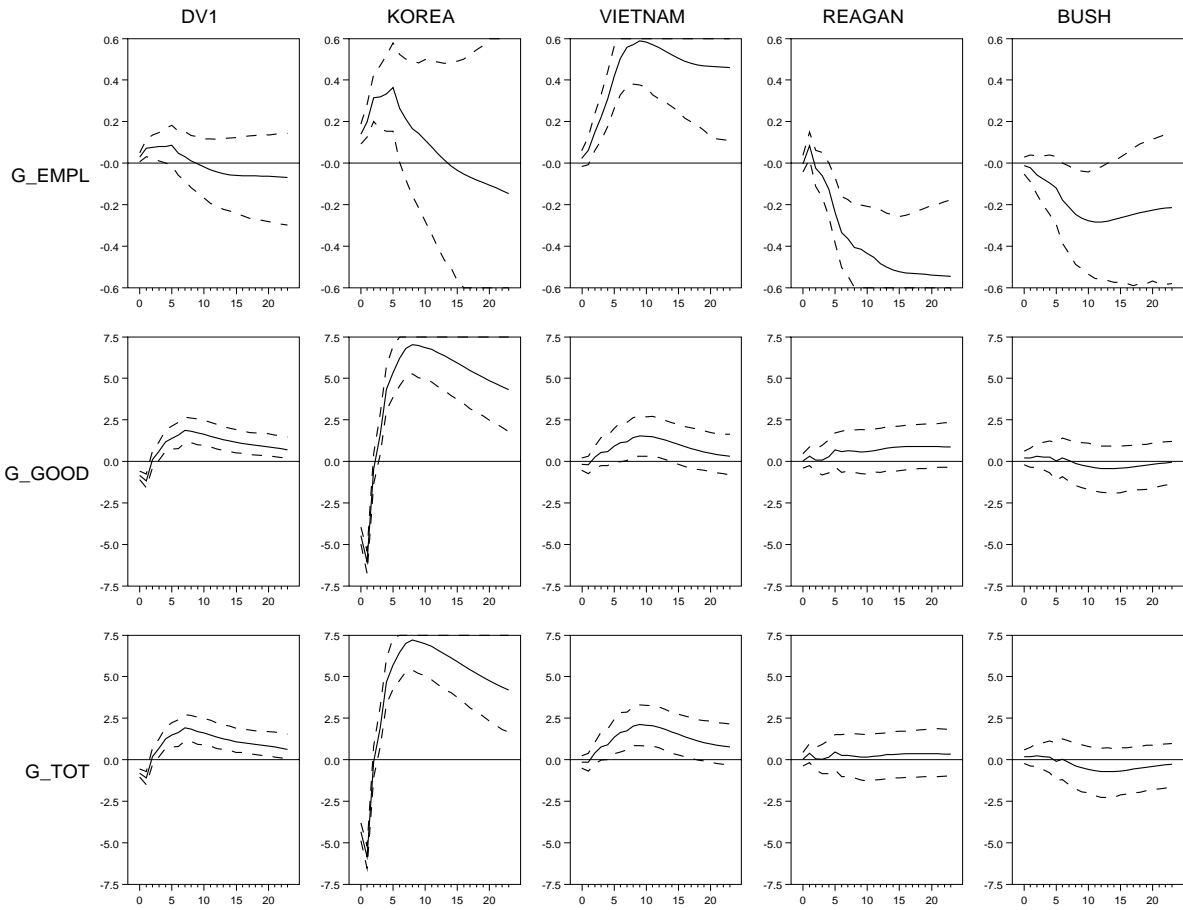


Figure 11: Responses of government spending on wages and on goods to Ramey-Shapiro dummy variables

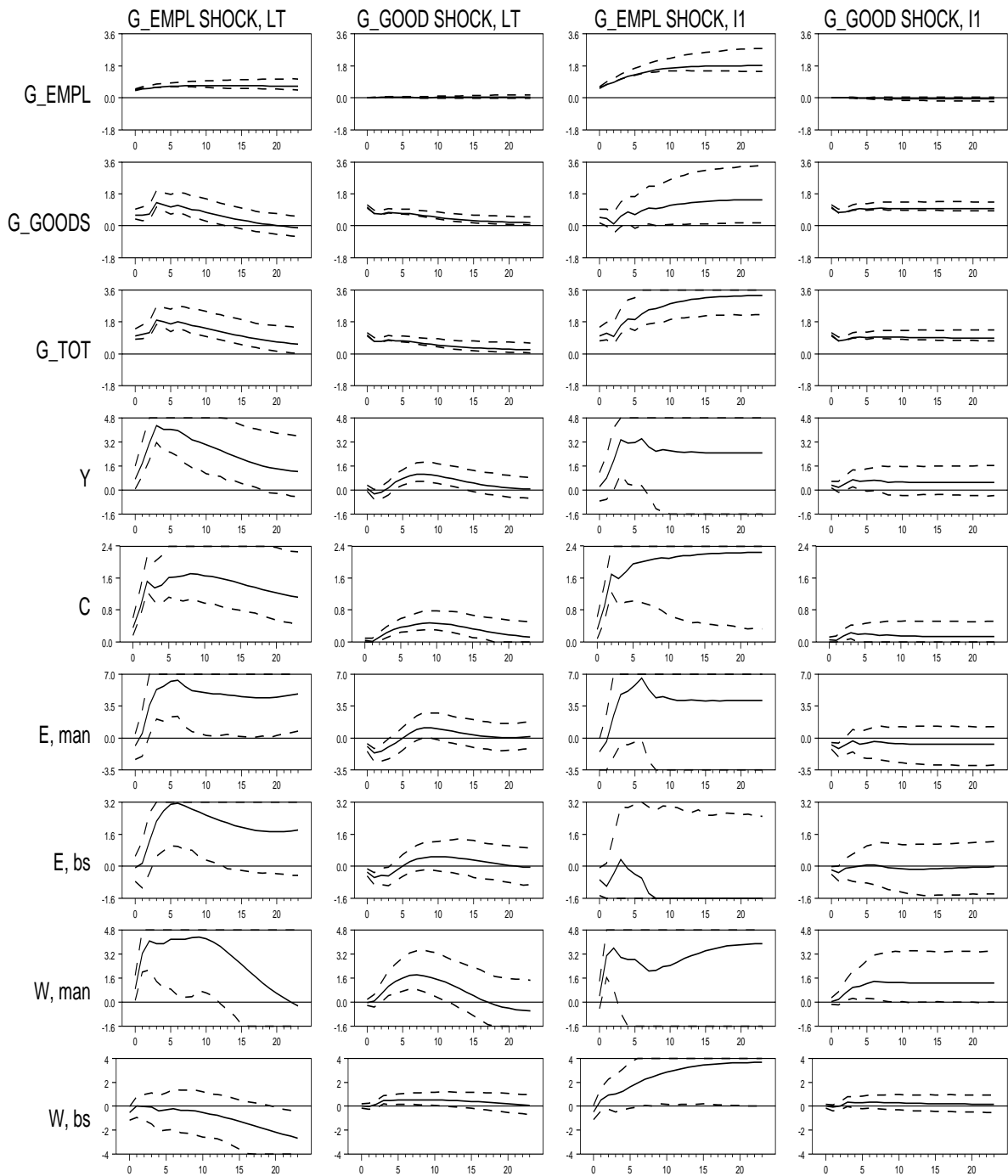


Figure 12: Responses to government employment and goods expenditure shocks, SVAR

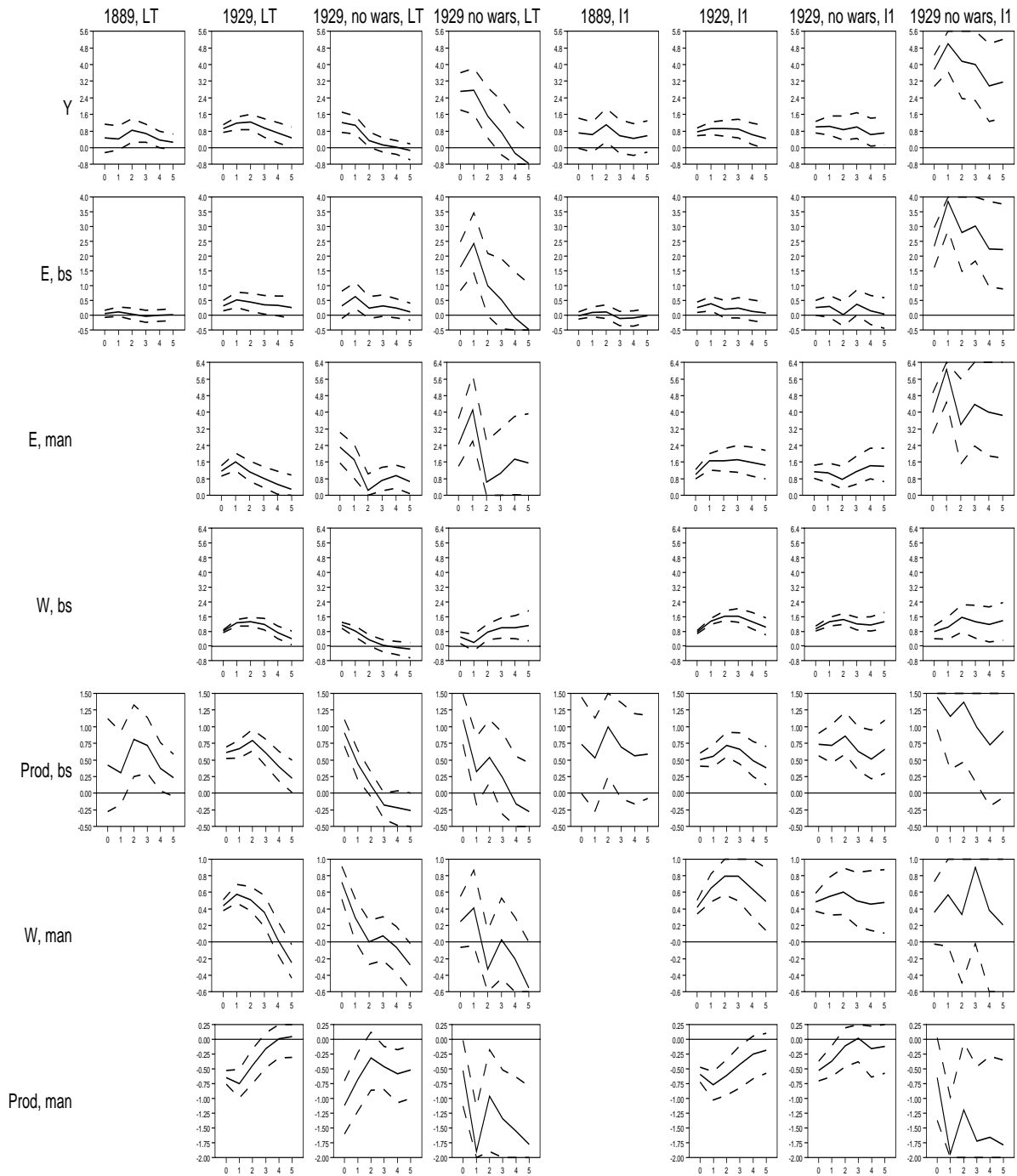


Figure 13: Response of labor market variables, annual historical data, SVAR

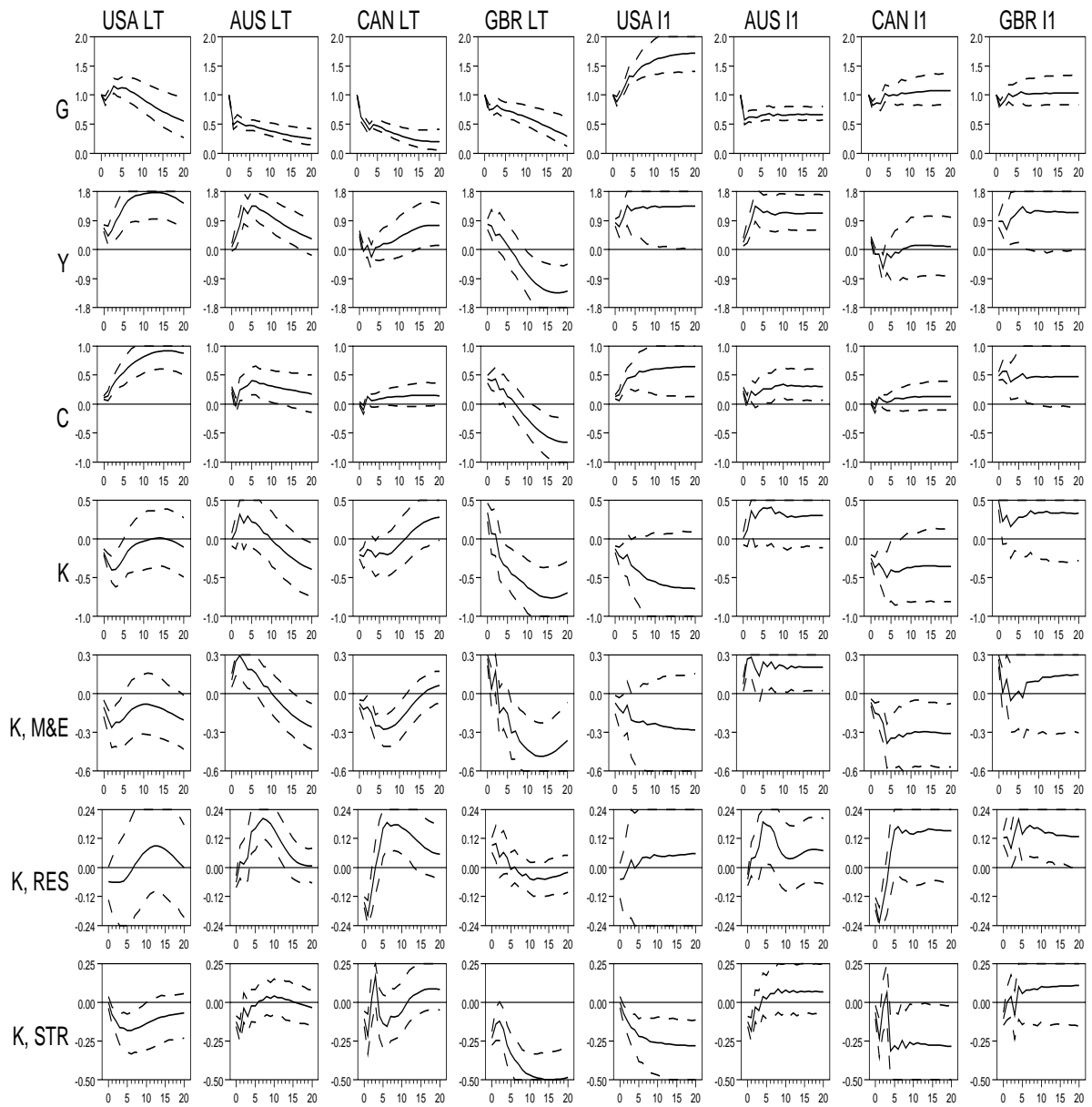


Figure 14: Responses to government spending shocks, all countries, SVAR

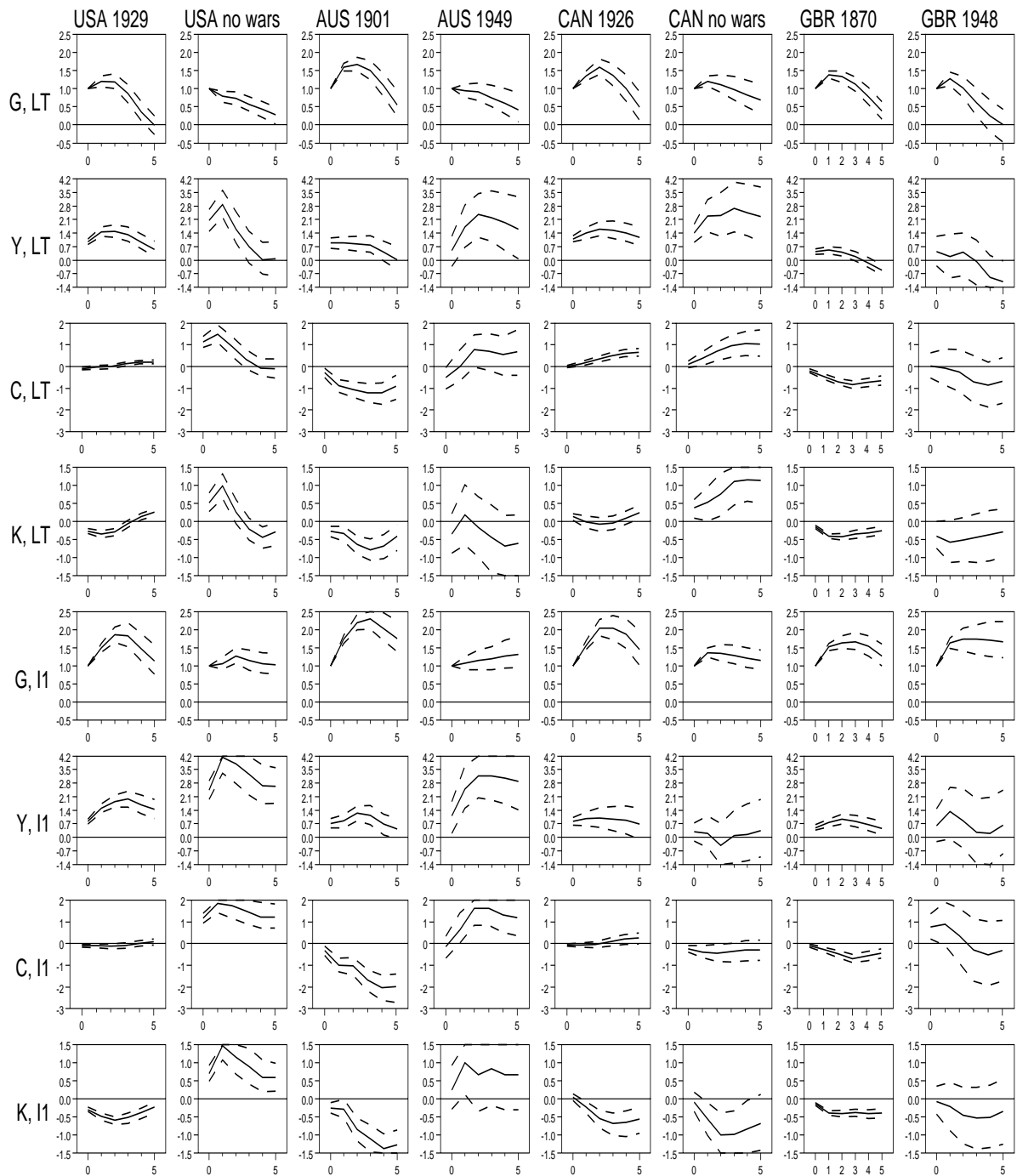


Figure 15: Responses to government spending shocks, annual historical data, all countries, SVAR



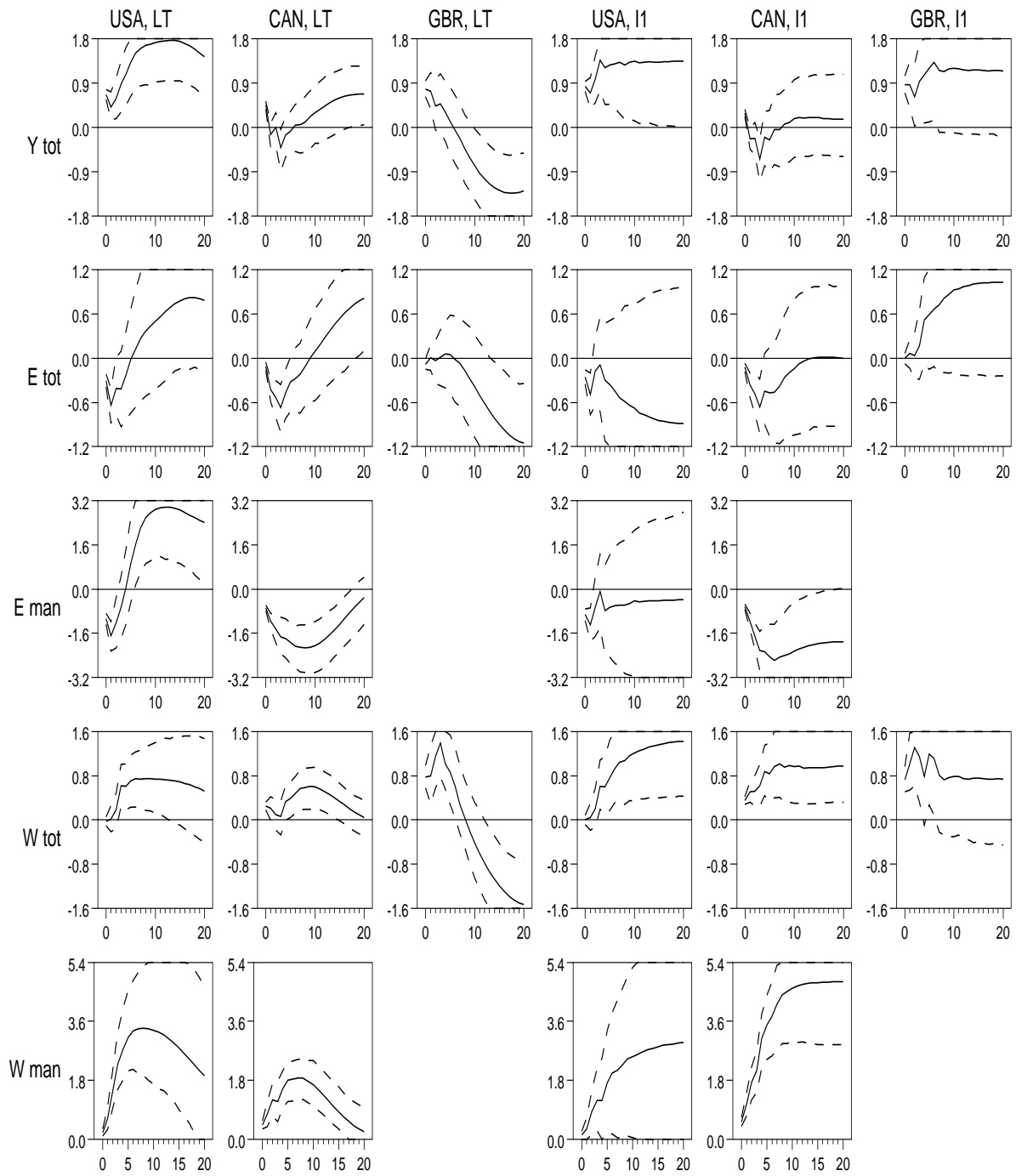


Figure 16: Responses of labor market variables, USA, Canada and UK, SVAR

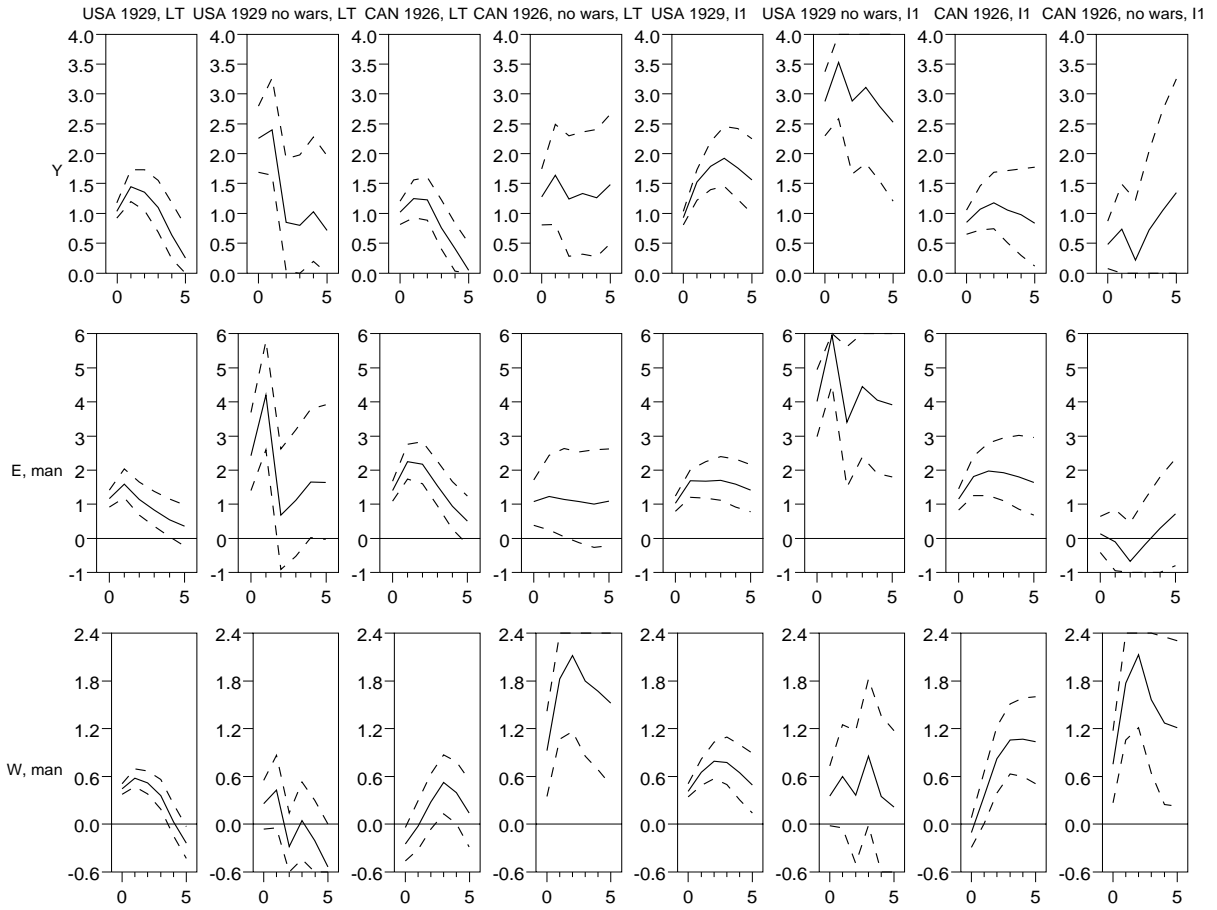


Figure 17: Responses of labor market variables, annual historical data, USA and Canada, SVAR