COMPANION APPENDIX TO

Spending cuts and their effects on output, unemployment and the deficit

(intended for online publication)

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A F.O.C. from the household's problem

Equations (2) for $j = p, g$, (3), and (6), can be summarized as:

$$n^p_{t+1} = (1-\sigma^p)n^p_t + \psi^{hpS}_t(1-s^S_t)u^S_t + \psi^{hpL}_t(1-s^L_t)u^L_t \tag{A1}$$

$$n^g_{t+1} = (1-\sigma^g)n^g_t + \psi^{hgS}_t s^S_t u^S_t + \psi^{hgL}_t s^L_t u^L_t \tag{A2}$$

$$u^S_{t+1} = \sigma^p n^p_t + \sigma^g n^g_t + (1-\xi)u^S_t - \left[\psi^{hpS}_t(1-s^S_t) + \psi^{hgS}_t s^S_t\right] u^S_t \tag{A3}$$

The problem of the household is to maximize (9) subject to (10), the budget constraint, and (A1)-(A3). In order to derive a relative price for public goods, $\frac{p^g_t}{p_t}$, we assume that households decide on the usage of public goods and pay a price, p^g_t. This implies that their budget constraint is determined by:

$$(1+\tau^c)c^p_t + i^p_t + \frac{p^g_t}{p_t}y^g_t + \frac{B_{t+1}}{p_t R_t} \leq \left[r^p_t - \tau^k(r^p_t - \delta^p)\right] k^p_t + (1-\tau^n_t)(w^p_t n^p_t + w^g_t n^g_t) + bu_t + \frac{B_t}{p_t} + \Pi^p_t - T_t$$

If we denote by λ_{ct}, $\lambda_{n^p t}$, $\lambda_{n^g t}$, $\lambda_{u^S t}$ the multipliers in front of the budget constraint, and (A1)-(A3), the first-order conditions from the optimization problem are:
[wrt c^p_t]

$$\Theta\left(c^p_t + zy^g_t\right)^{-\eta} = \lambda_{ct}(1+\tau^c) \tag{A4}$$

[wrt y^g_t]

$$z\Theta\left(c^p_t + zy^g_t\right)^{-\eta} = \lambda_{ct}\frac{p^g_t}{p_t} \tag{A5}$$

[wrt K^p_{t+1}]

$$\lambda_{ct}\left[1 + \omega\left(\frac{K^p_{t+1}}{K^p_t} - 1\right)\right] = \beta E_t \lambda_{ct+1}\left\{1 - \delta^p + [r^p_{t+1} - \tau_k(r^p_{t+1} - \delta^p)] + \frac{\omega}{2}\left[\left(\frac{K^p_{t+2}}{K^p_{t+1}}\right)^2 - 1\right]\right\} \tag{A6}$$

[wrt B_{t+1}]

$$\lambda_{ct}\pi_{t+1} = \beta E_t \lambda_{ct+1} R_t \tag{A7}$$

[wrt n^j_{t+1}]

$$\lambda_{n^j t} = \beta E_t\left[\lambda_{ct+1}(1-\tau^n_{t+1})w^j_{t+1} + \lambda_{n^j t+1}(1-\sigma^j) + \lambda_{u^S t+1}\sigma^j - U_{l,t+1}\right] \text{ for } j = p, g \tag{A8}$$

[wrt u^S_{t+1}]

$$\lambda_{u^S t} = \beta E_t\{\lambda_{ct+1} b + \lambda_{n^p t+1}\psi^{hpS}_{t+1}(1-s^S_{t+1}) + \lambda_{n^g t+1}\psi^{hgS}_{t+1}s^S_{t+1} + \lambda_{u^S t+1}\left[1-\xi-\psi^{hpS}_{t+1}(1-s^S_{t+1})-\psi^{hgS}_{t+1}s^S_{t+1}\right] - U_{l,t+1}\} \quad \text{(A9)}$$

[wrt u^L_t]

$$\lambda_{n^p t}\psi^{hpL}_t(1-s^L_t) + \lambda_{n^g t}\psi^{hgL}_t s^L_t + \lambda_{ct} b = U_{l,t} \quad \text{(A10)}$$

[wrt s^S_t]

$$\left(\lambda_{n^p t} - \lambda_{u^S t}\right)\psi^{hpS}_t = \left(\lambda_{n^g t} - \lambda_{u^S t}\right)\psi^{hgS}_t \quad \text{(A11)}$$

[wrt s^L_t]

$$\lambda_{n^p t}\psi^{hpL}_t = \lambda_{n^g t}\psi^{hgL}_t \quad \text{(A12)}$$

where $U_{l,t} \equiv \Phi l_t^{-\psi}$ is the marginal utility from leisure (labor market non-participation). Equations (A4)-(A7) are standard and include the arbitrage conditions for the returns to private consumption, the public good, private capital and bonds. Notice that (A4)-(A5) imply that $\frac{p^g_t}{p_t} = z(1+\tau^c)$. Equation (A8) relates the expected marginal value from being employed to the after-tax wage, the utility loss from the reduction in leisure, and the continuation value, which depends on the separation probability. Equation (A9) associates the expected marginal value from being short-term unemployed with the expected marginal values of being search active (rather than non-participating), $\lambda_{ct+1}b$, of being employed, $\lambda_{n^j t+1}$, weighted by the job finding probabilities, ψ^{hjS}_{t+1}, of being short-term unemployed weighted by the respective probability, $\left[1-\xi-\psi^{hpS}_{t+1}(1-s^S_{t+1})-\psi^{hgS}_{t+1}s^S_{t+1}\right]$, and finally with the utility loss from the reduction in leisure. Equation (A10) states that the value of being search active (rather than non-participating), $\lambda_{ct}b$, plus the expected marginal values of being employed, $\lambda_{n^j t}$, weighted by the job finding probabilities, ψ^{hjL}_t, and the respective share of outside jobseekers should equal the marginal utility from leisure, $U_{l,t}$. Equations (A11)-(A12) are arbitrage conditions according to which the choice of shares s^S_t and s^L_t is such that the expected marginal values of being employed, weighted by the job finding probabilities, are equal across the two sectors. Notice that in the case of the share of short-term unemployed seeking a public-sector job the expected marginal values of being employed are expressed net of the expected marginal value of being short-term unemployed.

B Derivation of the private wage

Substituting (16) and (22) in (27) we get:

$$(1-\vartheta)\lambda_{ct}(1-\tau_t^n)\left[x_t(1-\varphi)\frac{y_t^p}{n_t^p} - w_t^p + \frac{(1-\sigma^p)\kappa}{\psi_t^{fp}}\right] = \vartheta\left[\lambda_{ct}(1-\tau_t^n)w_t^p - U_{l,t} + (1-\sigma^p)\lambda_{n^pt} + \sigma^p\lambda_{u^It}\right]$$

$$\Rightarrow w_t^p = (1-\vartheta)\left[x_t(1-\varphi)\frac{y_t^p}{n_t^p} + \frac{(1-\sigma^p)\kappa}{\psi_t^{fp}}\right] - \frac{\vartheta}{\lambda_{ct}(1-\tau_t^n)}\left[-U_{l,t} + (1-\sigma^p)\lambda_{n^pt} + \sigma^p\lambda_{u^It}\right]$$

Evaluating (27) for the next period, and taking expectations given today's information set, we get:

$$(1-\vartheta)(1-\tau_t^n)E_t\Lambda_{t,t+1}V^F_{n^pt+1} = \vartheta\beta E_t\frac{V^H_{n^pt+1}}{\lambda_{ct}}$$

which, by using the FOC of the households and (21) and (22) for the left-hand side, becomes:

$$\lambda_{n^pt} = \frac{(1-\vartheta)\kappa(1-\tau_t^n)\lambda_{ct}}{\vartheta\psi_t^{fp}} \tag{B1}$$

Using (B1) in the above expression for the wage we get:

$$w_t^p = (1-\vartheta)\left[x_t(1-\varphi)\frac{y_t^p}{n_t^p} + \frac{(1-\sigma^p)\kappa}{\psi_t^{fp}}\right] - (1-\sigma^p)\frac{(1-\vartheta)\kappa}{\psi_t^{fp}} - \frac{\vartheta\left[-U_{l,t} + +\sigma^p\lambda_{u^It}\right]}{\lambda_{ct}(1-\tau_t^n)}$$

$$\Rightarrow w_t^p = (1-\vartheta)x_t(1-\varphi)\frac{y_t^p}{n_t^p} - \frac{\vartheta\left[-U_{l,t} + \sigma^p\lambda_{u^It}\right]}{\lambda_{ct}(1-\tau_t^n)}$$

Using (A10) it follows:

$$w_t^p = (1-\vartheta)x_t(1-\varphi)\frac{y_t^p}{n_t^p} - \frac{\vartheta}{\lambda_{ct}(1-\tau_t^n)}\left[-\left(\lambda_{n^pt}\psi_t^{hpO}(1-s_t^O) + \lambda_{n^gt}\psi_t^{hgO}s_t^O + \lambda_{ct}b\right) + \sigma^p\lambda_{u^It}\right]$$

Using (A12) we get:

$$w_t^p = (1-\vartheta)x_t(1-\varphi)\frac{y_t^p}{n_t^p} - \frac{\vartheta}{\lambda_{ct}(1-\tau_t^n)}\left(-\lambda_{n^pt}\psi_t^{hpO} - \lambda_{ct}b + \sigma^p\lambda_{u^It}\right)$$

Using (B1) we get:

$$w_t^p = (1-\vartheta)x_t(1-\varphi)\frac{y_t^p}{n_t^p} + \frac{\vartheta b}{(1-\tau_t^n)} + \frac{(1-\vartheta)\kappa}{\psi_t^{fp}}\psi_t^{hpO} - \frac{\vartheta\sigma^p\lambda_{u^It}}{\lambda_{ct}(1-\tau_t^n)}$$

$$\Rightarrow w_t^p = (1-\vartheta)\left[x_t(1-\varphi)\frac{y_t^p}{n_t^p} + \frac{\kappa}{\psi_t^{fp}}\psi_t^{hpO}\right] + \frac{\vartheta b}{(1-\tau_t^n)} - \frac{\vartheta\sigma^p\beta E_t V^H_{u^I t+1}}{\lambda_{ct}(1-\tau_t^n)}$$

C Steady state calculations and calibration

We calibrate the labor-force participation rate, the unemployment rate, and the share of public employment in total employment to match the observed average values from the US data ($1-l=0.65$, $\frac{u}{n+u}=0.065$, $\frac{n^g}{n}=0.16$). Then we get u, n, $\frac{n^p}{n}$, n^p, n^g as follows:

$$u = \frac{u}{n+u}(n+u) \overset{(1)}{=} \frac{u}{n+u}(1-l)$$

$$n = 1-l-u$$

$$\frac{n^p}{n} = 1 - \frac{n^g}{n}$$

$$n^j = \frac{n^j}{n}n$$

We set the following values for the separation rates, $\sigma^p = 0.05$ and $\sigma^g = 0.04$. Then we get m^j from the law of motion for employment at the steady state:

$$m^j = \sigma^j n^j$$

We set the private job finding rate, ψ^{hp} equal to 0.9. Then by definition:

$$u^p = \frac{\psi^{hp}}{m^p}$$

$$u^g = u - u^p$$

$$\psi^{hg} = \frac{m^g}{u^g}$$

Long-term unemployment, defined as the share of unemployed with a spell lasting longer than 27 weeks, represents 18% of total unemployment according to CPS data, i.e. $\frac{u^L}{u} = 0.18$, so we get:

$$u^L = \frac{u^L}{u}u$$

$$u^S = u - u^L$$

We calibrate the ratio of long-term unemployed in the public sector relative to the private sector to be $\frac{u^{gL}}{u^{pL}} = 0.3$. Then using $u^{pL} + u^{gL} = u^L$ we get:

$$u^{pL} = \frac{u^L}{1 + \frac{u^{gL}}{u^{pL}}}$$

$$u^{gL} = u^L - u^{pL}$$

Next, we can get the short-term unemployment for each sector $j = p, g$ as follows:

$$u^{jS} = u^j - u^{jL}$$

According to Barnichon and Figura (2011) having an unemployment spell lasting six months reduces the job finding probability by 1-1.5 percentage points. Hence assuming that $\frac{\psi^{hjS}}{\psi^{hjL}} = 1.015$ and the definition of the aggregate job finding rate in each sector $j = p, g$, i.e. $\psi^{hj} = \frac{u^{jL}}{u^j}\psi^{hjL} + \frac{u^{jS}}{u^j}\psi^{hjS}$, we get:

$$\psi^{hjL} = \frac{\psi^{hj}}{\frac{u^{jL}}{u^j} + \frac{u^{jS}}{u^j}\frac{\psi^{hjS}}{\psi^{hjL}}}$$

$$\psi^{hjS} = \frac{\psi^{hjS}}{\psi^{hjL}}\psi^{hjL}$$

Since there is no exact estimate for the value of the private vacancy-filling probability, ψ^{fp}, in the literature, we use what is considered as standard by setting it equal to 0.5 and then we assume that $\psi^{fp} = \psi^{fg}$. Hence, we get θ^j, υ^p by combining the definitions of matches and the hiring probabilities:

$$\theta^j = \frac{\psi^{hj}}{\psi^{fj}}$$

$$\upsilon^j = \theta^j u^j$$

We set the matching elasticity, α, equal to 0.4. Then the matching efficiencies in each sector $j = p, g$ are given by the definition of matches after using the definitions of the hiring probabilities:

$$\rho_m^{jS} = \psi^{hjS}\left(\frac{u^{jS}}{\upsilon^j}\right)^{\alpha} \quad \text{and} \quad \rho_m^{jL} = \psi^{hjL}\left(\frac{u^{jL}}{\upsilon^j}\right)^{\alpha}$$

and from the definition of matches for short- and long-term unemployed jobseekers we have:

$$m^{jS} = \rho_m^{jS} \left(\upsilon^j\right)^\alpha \left(u^{jS}\right)^{1-\alpha}$$

$$m^{jL} = \rho_m^{jL} \left(\upsilon^j\right)^\alpha \left(u^{jL}\right)^{1-\alpha}$$

The probability of a short-term unemployed becoming in the next period long-term unemployed, ξ, is determined by the corresponding law of motion at the steady state after using the transition equations for private and public employment:

$$\xi = \frac{m^p + m^g - m^{pS} - m^{gS}}{u^S}$$

We set the capital depreciation rates, δ^j, equal to 0.025. Then we derive $\frac{i^p}{k^p}$, $\frac{i^g}{k^g}$ from the laws of motion for private and public capital:

$$\frac{i^j}{k^j} = \delta^j$$

Following the literature, we set the discount factor, β, equal to 0.99. We set the average tax rates $\tau_k = 0.2$ and $\tau_n = 0.2$. Next, we get r^p and R from (A6) and (A7), respectively:

$$r^p = \frac{1}{(1-\tau_k)} \left(\frac{1}{\beta} - 1\right) + \delta^p$$

$$R = \frac{1}{\beta}$$

The elasticity of demand for intermediate goods, ε, is set equal to 11, which implies a gross steady-state markup, $\frac{\varepsilon}{\varepsilon-1}$, equal to 1.1, and the price of the final good is normalized to one. Then x is determined from the expression for the optimal price:

$$x = \frac{\varepsilon - 1}{\varepsilon}$$

We set the capital share in the production function of the private good equal to 0.36. Then we obtain $\frac{y^p}{k^p}$ from the FOC for private capital:

$$\frac{y^p}{k^p} = \frac{r^p}{\varphi x}$$

We set the shares of public capital in public production, μ, equal to 0.36 and of the public good in private production, ν, equal to 0.1. Further, using data from Kamps (2006) we set $\frac{k^g}{k^p} = 0.31$, equal to the mean value for 1970-2002. Since we restrict our case to a deterministic steady state, we normalize the productivity shock to one. Then combining the production function for the private and the public good k^p is determined by:

$$k^p = \left[\frac{y^p}{k^p} \left(\varepsilon^A n^p\right)^{-(1-\varphi)} \left(\varepsilon^A n^g\right)^{\mu\nu-\nu} \left(\frac{k^g}{k^p}\right)^{-\mu\nu} \right]^{\frac{1}{\varphi+\mu\nu-1}}$$

and then we get by definition i^p, y^p, k^g, i^g:

$$i^p = \frac{i^p}{k^p} k^p, \;\; y^p = \frac{y^p}{k^p} k^p \;\; \text{and} \;\; k^g = \frac{k^g}{k^p} k^p$$

$$i^g = \frac{i^g}{k^g} k^g$$

Following Hagedorn and Manovskii (2008), Galí (2011), and Brückner and Pappa (2012), we calibrate the cost of posting a vacancy, κ, by targeting vacancy costs per filled job as a fraction of the real private wage, $\frac{\kappa}{w^p}$, choosing 0.045 as a target as in Galí (2011). Also, we set the replacement rate, $\frac{b}{w^p}$, equal to 0.4, in accordance with the range [0.2,0.4] in Petrongolo and Pissarides (2001). Then, we can get w^p from the FOC for vacancies:

$$w^p = x(1-\varphi)\frac{y^p}{n^p}\left(1 + \frac{\sigma^p}{\psi^{fp}} \frac{\kappa}{w^p}\right)^{-1}$$

and it follows that κ and b are given by:

$$\kappa = \frac{\kappa}{w^p} w^p$$

$$b = \frac{b}{w^p} w^p$$

We set the steady-state public-wage premium equal to the observed average value from the data, $\frac{w^g}{w^p} = 1.03$. It follows from the public wage rule:

$$w^g = \frac{w^g}{w^p} w^p$$

and from the production function for the public good:

$$y^g = (\varepsilon^A n^g)^{1-\mu} (k^g)^\mu - \kappa \upsilon^g$$

We set the preference parameter for the public good, z, equal to 0.1 and we derive total output in the steady state:

$$y = y^p + z(1 + \tau^c) y^g$$

We set the steady-state output share of public consumption spending equal to the observed average value from the data, $\frac{c^g}{y} = 0.08$. It follows from the aggregate resource constraint:

$$c^g = \frac{c^g}{y} y$$

$$c^p = y^p - i^p - c^g - i^g$$

For the parameter that regulates the strength of the wealth effect in the utility function, we set $\gamma = 0.8$. Then at the steady state we have:

$$Z = C^p + z y^g$$

$$\Theta = \frac{C^p + z y^g}{Z} = 1$$

We set the steady-state debt to GDP ratio, $\frac{B}{y}$, equal to 60%, so that by definition:

$$B = \frac{B}{y} y$$

Next, we calibrate the steady state value for lump-sum transfers, T, so that in the steady state the deficit to GDP ratio is 3%. From the definition of the government deficit we have:

$$DF = c^g + i^g + w^g n^g + bu - T - \tau^k (r^p - \delta^p) k^p - \tau_n (w^p n^p + w^g n^g) - \tau^c c^p$$

We set the intertemporal elasticity of substitution, $\frac{1}{\eta}$, equal to 1, the Frisch elasticity of labor supply, $\frac{1}{\psi}$, equal to 0.25 (in the range of Domeij and Floden (2006)), and the bargaining power, ϑ, by the Hosios condition equal to the matching elasticity, α. Then we get from (A4) and (27):

$$\lambda_c = \frac{\Theta \left(c^p + z y^g\right)^{-\eta}}{(1 + \tau^c)}$$

$$\lambda_{u^S} = \frac{\lambda_c}{\sigma^p} \left\{ b + \frac{(1 - \tau_n)}{\vartheta} \left[-w^p + (1 - \vartheta) \left(x (1 - \varphi) \frac{y^p}{n^p} + \frac{\kappa}{\psi^{fp}} \psi^{hpL} \right) \right] \right\}$$

and then from the household's FOCs at the steady state:

$$\lambda_{n^p} = \frac{\lambda_c \left[(1 - \tau_n) w^p - b \right] + \sigma^p \lambda_{u^S}}{\psi^{hpL} - 1 + \sigma^p + \frac{1}{\beta}} \quad \text{[see (A8) after using (A10), (A11)]}$$

$$\Phi = \left(\lambda_c b + \lambda_{n^p} \psi^{hpL} \right) l^{\psi} \quad \text{[see (A10) after using (A12)]}$$

$$\lambda_{n^g} = \lambda_{n^p} \frac{\psi^{hpL}}{\psi^{hgL}} \quad \text{[see (A12)]}$$

Finally, the model's steady state is independent of the degree of price rigidities, the monetary policy rule, the debt-targeting rule for lump-sum taxes, the size of the capital adjustment costs, and the elasticity of public wages with respect to private wages. We set the probability that a firm does not change its price within a given period, χ, equal to 0.75, the Taylor rule coefficient, ζ_π, equal to 2.5, the coefficient on the debt-targeting rule, $\zeta_{\text{ß}}$, equal to 2.05, the adjustment costs parameter, ω, equal to 5.5, and the public wage elasticity equal to 0.94. Finally, we set the parameters for the persistence of the fiscal shocks and the public wage shock, $\boldsymbol{\varrho}_g^{\psi}$ and $\boldsymbol{\varrho}^{w_g}$, equal to 0.85, and the parameters for the persistence of the productivity and the monetary policy shocks, $\boldsymbol{\varrho}^A$ and $\boldsymbol{\varrho}^R$, equal to 0.95 and 0.65, respectively.

D Data sources and definitions

All data are quarterly and come from the OECD Economic Outlook No. 90. Real per capita variables are deflated by the GDP deflator and divided by the population. A description of the variables follows.

- *Population*: Population (hist5), all ages, persons
- *GDP*: Gross domestic product
- *GDP Deflator*: Gross domestic product, deflator (2005=100)
- *SSRG*: Social security contribution received by general government
- *SSPG*: Social security benefits paid by general government
- *TSUB*: Subsidies
- *Net Tax Revenue*: Direct Taxes + Indirect Taxes + SSRG – SSPG – TSUB
- *Indirect Taxes*: Taxes on production and imports
- *Total Government Expenditure*: Government final consumption expenditure, GDP expenditure approach
- *Government Wage Expenditure*: Government final wage consumption expenditure
- *Gross Fixed Investment*: Gross government fixed capital formation
- *Average Public Wage*: Government final wage consumption expenditure divided by public employment
- *Public Employment*: General government employment
- *Total Employment*: Total employment
- *Unemployment Rate*: number of unemployed persons as a percentage of the labor force (total number of people employed plus the unemployed)
- *Labor Force Participation Rate*: ratio of the labor force to the working age population, expressed in percentages

- *Average Private Wage*: Wage rate of the private sector
- *Interest Rate*: Short-term interest rate
- *Oil prices*: OECD crude oil import price, CIF, USD per barrel

E Additional Results

Table E1: Robustness analysis

		Deficit/GDP multipliers associated with shocks to:				
		c^g	i^g	υ^g	w^g	G
Canada (Cholesky)	0	1.25*	1.67*	0.79*	0.77*	1.08*
	4	1.53*	1.21*	1.37*	1.04	1.52*
	12	1.18*	1.68*	2.33*	1.42	1.66*
	20	1.18*	2.32*	2.47*	2.63	1.59*
Japan (Cholesky)	0	0.96*	0.92*	-0.53	-0.01	0.91*
	4	0.67	0.68*	0.60	0.35	0.81*
	12	0.11	0.41*	1.29	0.90*	0.73*
	20	0.13	0.76*	0.19	0.93*	0.87*
UK (Cholesky)	0	0.24	1.22*	0.58	0.78*	0.84*
	4	0.41*	1.24*	-0.42	0.95*	0.83*
	12	0.59*	1.20*	-0.48	0.98*	0.73*
	20	0.47	0.92*	-0.43	1.05*	0.58*
US (Cholesky)	0	0.69*	0.14	0.81*	2.45	0.61*
	4	0.33	0.60*	0.49	2.79*	0.77*
	12	0.22	0.64*	-0.01	1.97	0.60*
	20	0.48	0.57	0.25	0.89	0.49*
US (Expectations)	0	1.60*	1.69*	2.22	3.35*	0.84*
	4	0.97	1.29*	1.39	2.39*	0.34
	12	1.00	1.10	-0.10	1.15	0.82
	20	1.27	1.41	0.15	1.35	1.34

Table E2a: Subsample analysis: Unemployment multipliers, pre- and post-1980s

		Canada				Japan				UK				US			
shock		0	4	12	20	0	4	12	20	0	4	12	20	0	4	12	20
c^g	pre	-0.26	-0.69	-1.18*	-1.00	0.54	0.87	1.06*	0.64	-0.15	-0.91*	-0.80	-0.70	-0.32	-0.82	-0.86	-0.79
	post	0.23	0.41	-0.64	-0.99	-0.13	-0.35	-0.40	-0.31	-0.12	-0.24	0.01	-0.03	-0.73*	-0.39	-0.09	0.19
	Dif.	0.49	1.10	0.54	0.01	-0.67	-1.22	-1.46*	-0.95	0.03	0.67*	0.81	0.67	-0.41*	0.42	0.77	0.98
i^g	pre	0.84	-0.91*	-0.97	-1.00	0.00	-0.04	-0.08	-0.06	-0.09	-0.53	-0.53	-0.42	-0.40	-0.95	-0.99	-0.83
	post	-0.44	-0.01	-1.56	-1.00	-0.10	-0.29	-0.25	-0.16	-0.14	-0.23	-0.04	-0.03	-0.52	0.10	0.43	0.50
	Dif.	-1.28	0.91*	-0.59	0.00	-0.10	-0.25	-0.17	-0.11	-0.05	0.30	0.49	0.39	-0.12	1.05	1.43	1.32*
υ^g	pre	0.10	-0.02	-0.61	-0.61	0.01	-0.05	-0.05	-0.01	-0.27	-0.40	-0.50	-0.68	-0.82	-1.36	-1.29	-0.90
	post	-0.34*	-0.27	-0.28	-0.13	-0.17	-0.46*	-0.38	-0.26	-0.41*	-0.51*	-0.18	-0.06	-1.25*	-0.47	0.37	0.06
	Dif.	-0.43*	-0.25	0.33	0.48	-0.17	-0.41*	-0.33*	-0.25	-0.14	-0.11	0.32	0.62	-0.43*	0.89	1.66	0.96
w^g	pre	0.47*	1.41*	-0.72	-0.90	0.09	0.06	0.00	0.01	0.04	0.06	0.05	-0.10	0.72	0.10	-1.03	-0.98
	post	0.54	0.87*	1.06	0.64	0.28	0.59	0.21	-0.17	0.24	0.25	0.36	0.16	1.40	0.10	0.05	0.05
	Dif.	0.07	-0.53	1.79	1.54	0.19	0.53	0.21	-0.18	0.20	0.19	0.31	0.27	0.68	0.00	1.08	1.03

Table E2b: Subsample analysis: Deficit/GDP multipliers, pre- and post-1980s

		Canada				Japan				UK				US			
shock		0	4	12	20	0	4	12	20	0	4	12	20	0	4	12	20
c^g	pre	1.29*	0.76	1.16	0.94	1.22*	0.80	1.01	1.19*	0.06	0.46	0.88	0.98	1.58*	0.25	0.15	0.21
	post	-0.97	0.61	1.40	1.19	0.78*	0.56	0.57	0.31	1.42*	1.47	1.47	1.02	1.33*	1.04	1.57	1.90
	Dif.	-2.26	-0.16	0.24	0.25	-0.44	-0.24	-0.44	-0.88	1.36*	1.01	0.59	0.05	-0.25	0.79	1.42	1.69
i^g	pre	-0.53	0.86	0.87	0.65	1.08*	0.86*	0.48	0.81*	0.65	0.59	0.84	0.84	1.26	0.34	0.19	0.23
	post	-0.42	0.77	0.95	1.21*	0.82*	0.78	0.55	0.59	1.72	1.70	1.66	0.82	1.13*	1.43*	1.92*	1.99*
	Dif.	0.11	-0.09	0.07	0.55	-0.26	-0.08	0.07	-0.22	1.07	1.11	0.82	-0.02	-0.13	1.09	1.73*	1.76*
v^g	pre	1.37*	1.66*	1.31	1.15	0.76*	0.60	1.01*	1.15*	0.66*	0.77*	0.80*	0.99	2.97*	0.48	0.01	0.22
	post	1.44*	1.73*	1.83*	1.93*	1.12	1.59	1.52	1.15	0.99*	0.84	0.46	0.62	2.92*	1.13	0.91	0.36
	Dif.	0.07	0.07	0.52	0.78	0.37	1.00	0.51	0.00	0.33	0.07	-0.33	-0.37	-0.05	0.64	0.90	0.14
w^g	pre	1.79	2.56	0.82	0.73	0.78*	0.95	0.91	1.08*	0.82*	0.76*	0.79	0.92*	3.98*	1.82*	0.50	0.12
	post	1.68*	2.01*	2.40*	2.11	0.94*	0.90	0.36	0.13	2.69*	3.63*	3.09*	1.90	3.23*	2.50*	1.23*	1.46
	Dif.	-0.11	-0.54	1.58*	1.38	0.16	-0.05	-0.55	-0.95	1.86*	2.88*	2.30*	0.98	-0.75	0.67*	0.74*	1.34

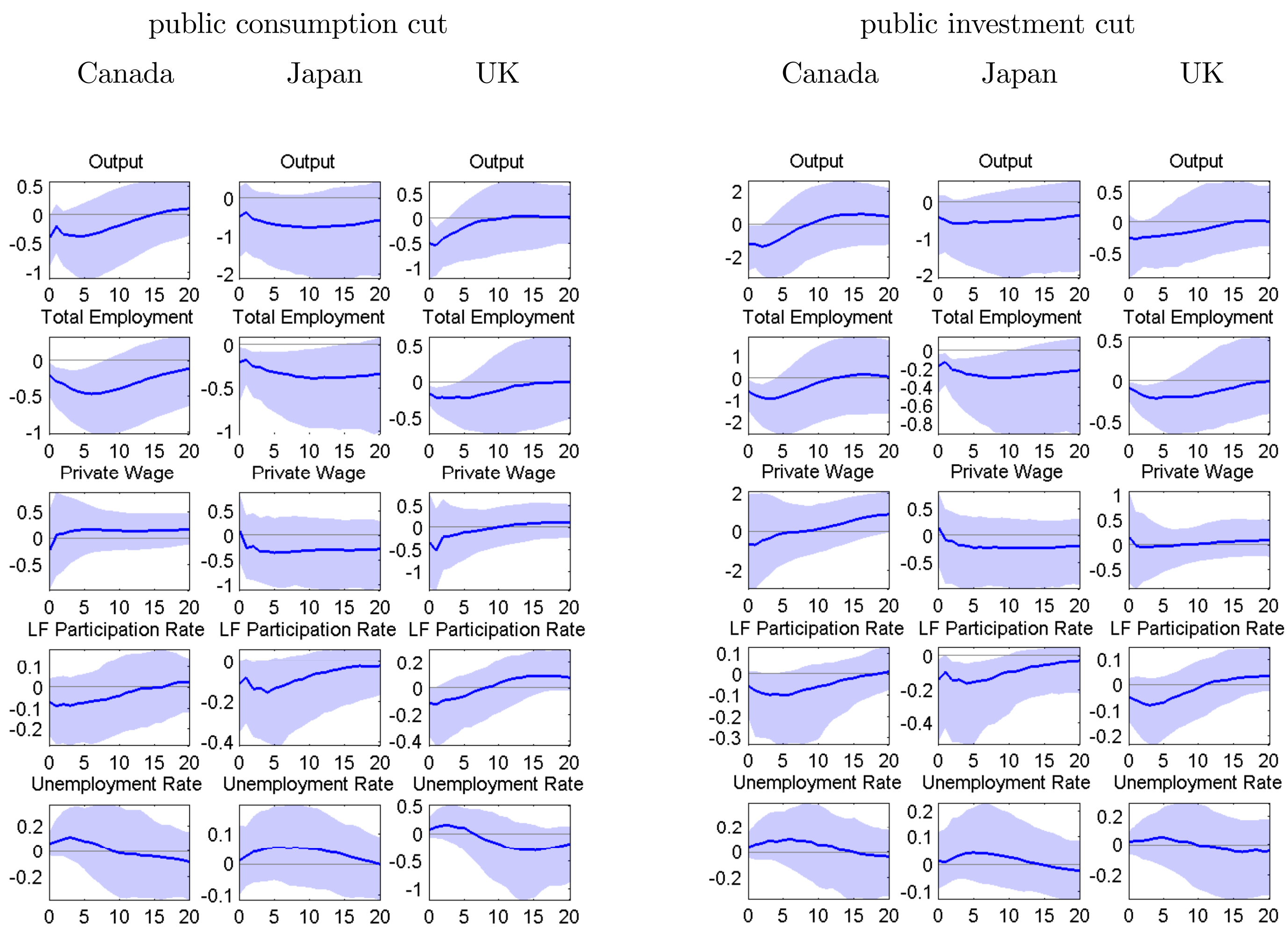

Figure E1: Impulse responses in other OECD countries

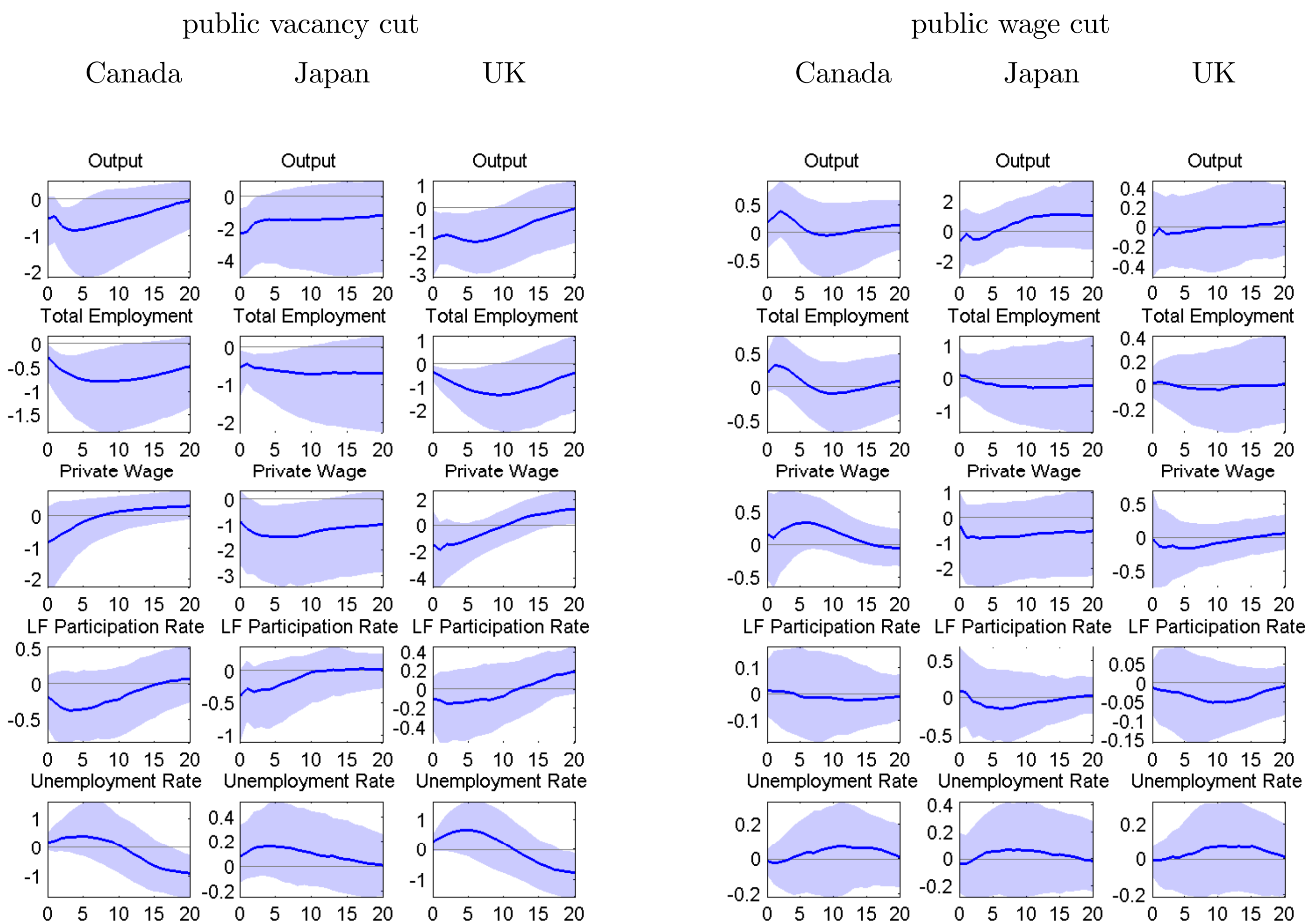

Figure E1: Impulse responses in other OECD countries (continued)

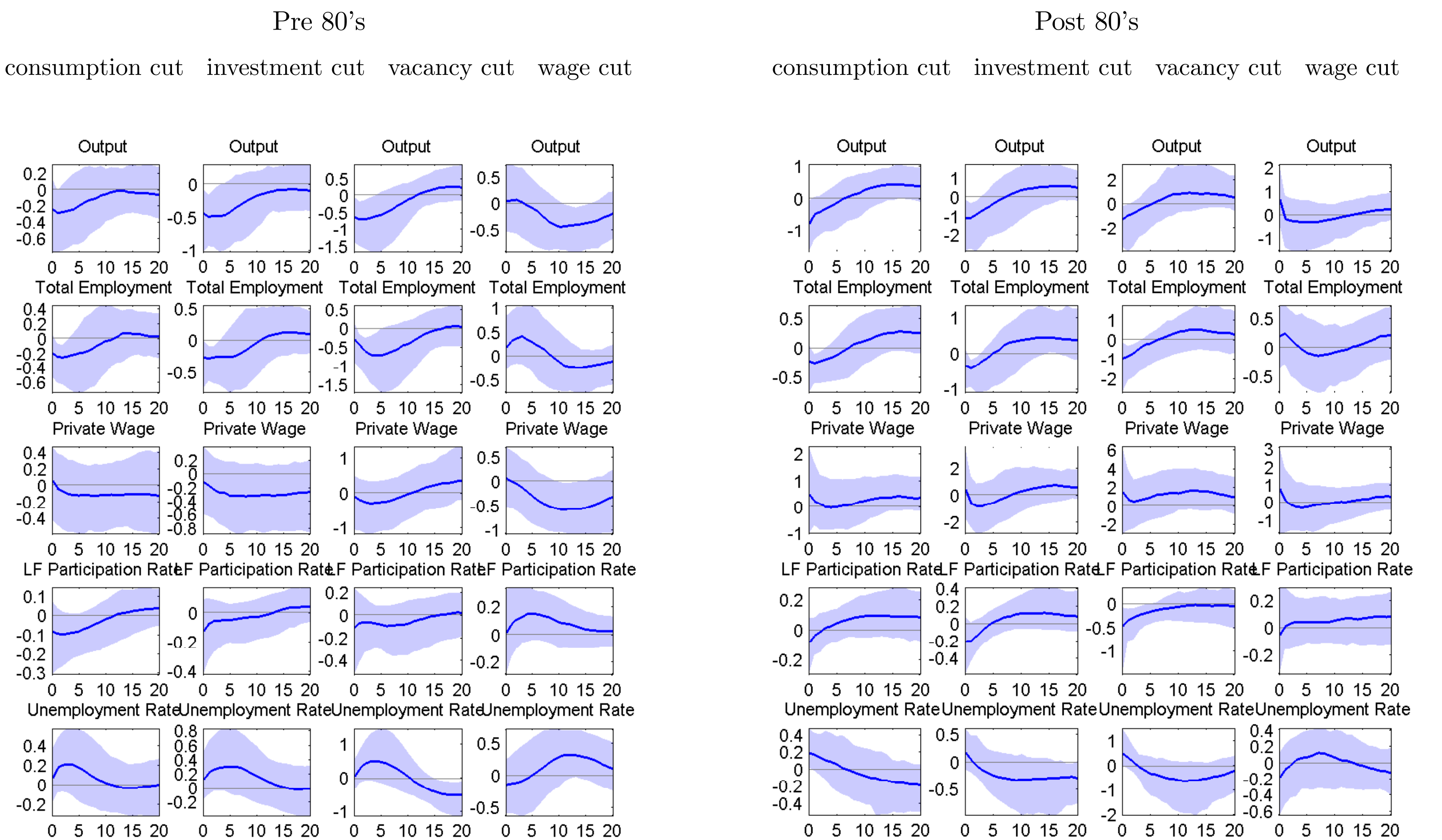

Figure E2: Subsample impulse responses for the US consumption cut investment cut vacancy cut wage cut

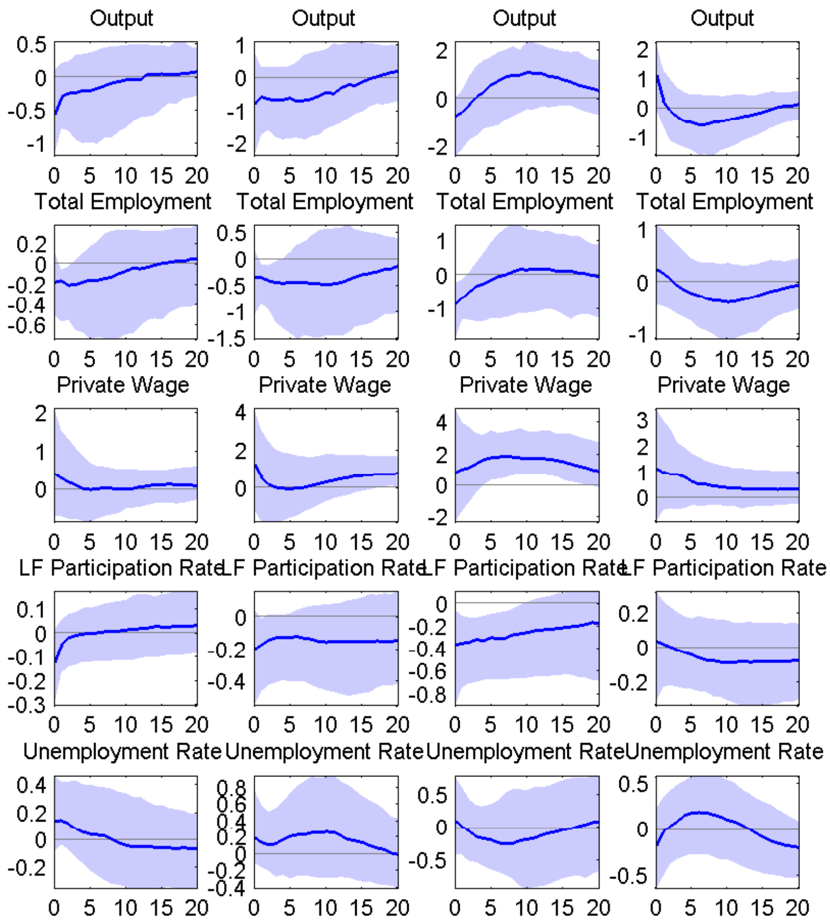

Figure E3: Impulse responses to different fiscal shocks in the US, controlling for expectations

F Alternative VAR specification

The benchmark VAR contains the average public wage as an endogenous variable and it is implicitly derived by dividing the public wage bill by the public employment. However, one may think that this definition of public sector wage has some drawbacks since changes in composition of the labour force may contaminate the results. To this end, we exntend to a robustness analysis replacing the average public wage by the wage bill deflator since the latter could also be considered as a measure of public wages and, at the same time, it avoids the problem beforementioned. The results of the new VAR exercise are depicted in the table below. Multipliers do not change substantially neither in a qualitative nor a quantitative way, and it confirms that our benchmark results are not affected by the definition of the public wages.

Table F1: Alternative VAR

		Output multipliers associated with shocks to:				Unemployment multipliers associated with shocks to:				Deficit/GDP multipliers associated with shocks to:			
		c^g	i^g	v^g	w^g	c^g	i^g	v^g	w^g	c^g	i^g	v^g	w^g
Canada	1	1.28	1.87	1.74*	-0.29	-0.25	-0.39	-0.39	0.41	1.58*	1.42	1.57*	1.66*
	4	1.17	1.52	2.82*	-0.91	-0.26	-0.72	-1.07	0.66	1.61*	1.04	1.23	1.78
	12	0.34	0.16	1.05	-0.12	-0.07	-0.30	-0.27	0.10	1.57*	1.51*	1.50*	0.64
	20	-0.11	-0.14	0.36	1.19	0.23	0.14	0.16	-0.02	1.62*	1.68*	1.58*	0.64
Japan	1	1.01	1.24	1.45	-1.55	-0.08	-0.13	-0.50	-0.32	0.95*	0.84*	1.02*	2.09*
	4	0.70	2.20	0.80	-2.72*	0.01	-0.07	0.06	0.21	0.66	0.69	0.93	2.84*
	12	1.19	1.23	1.64	-3.03	0.03	-0.04	0.02	0.35	0.91	0.68	0.71	4.05
	20	0.98	0.93	1.58	1.58	0.04	0.00	0.01	-0.07	0.74	1.00	0.87	1.30
UK	1	1.84	0.81	3.58*	-0.34	-0.20	-0.06	-0.81	-0.01	1.21*	1.10*	2.56*	1.91*
	4	1.43	0.53	2.44*	-0.71	-0.24	-0.06	-0.82*	0.05	0.82*	1.07	1.10	1.78*
	12	0.27	-0.13	1.03*	-0.56	0.04	-0.11	-0.54	0.28	1.07	1.23	0.85	1.95*
	20	0.00	-0.10	0.47	-0.93	0.30	-0.03	-0.10	0.38	1.29*	0.94	0.91*	2.17*
US	1	2.62*	3.17	3.68*	-1.92	-0.54	-0.36	-0.96	0.96	1.44*	1.19*	1.11	3.65*
	4	2.50*	2.06	3.35*	-1.24	-0.63*	-0.48	-1.20*	1.45	0.48	0.90	0.96	2.88*
	12	1.38	0.84	2.44	-0.09	-0.16	-0.24	-0.49	0.75	0.75	1.33*	0.99	2.09*
	20	1.19	0.79	1.80	0.08	0.02	-0.18	-0.22	0.33	0.82	1.20*	1.15	1.75

G A narrative perspective

Despite the fact that results are quite robust, some readers might still find hard to believe our evidence for government vacancy and wage shocks. To provide further evidence on the issue we identify government vacancy shocks using a narrative approach.[1] The suspension of conscription can be thought of as a positive government vacancy shock, since the abolition of the compulsory military draft implies an increase in government recruitment for national defense.[2] Many European countries have adopted reforms that decreased or even suspended mandatory military service during the last 20 years. We restrict the analysis to military draft reforms that occurred in 29 European countries, presented in Table G1. To perform our experiment we adopt a standard approach with the following model:

$$X_{i,post} - X_{i,pre} = \alpha_0 + \alpha_1 D_i + \alpha_2 X_{i,pre} + \varepsilon_{i,t}$$

where X is either real per capita GDP, real compensation per employee (proxy of the wage rate) or real per capita public employment expenditure, and D_i is a dummy variable taking the value 1 if a country has abolished military conscription and 0 otherwise. We control for bias in the estimation of the parameter α_1 including the initial condition $X_{i,pre}$ for country i as a regressor. Thus, countries that have adopted a draft reform form the treatment group, while countries that have not undergone any reforms form our control group. The variables $X_{i,pre}$ and $X_{i,post}$ correspond to values one year before and one after the draft reform, respectively. For countries in the control group, $X_{i,post}$ and $X_{i,pre}$ are set according to the average year of reforms of the treatment sample. We focus on the sign and significance of the dummy's coefficient, α_1. Table G2 indicates that reforms in conscription increased GDP and the government wage bill significantly, while they did not have a significant effect on the real wage. The coefficient on the dummy is statistically significant and positive when X_i is GDP or the government wage bill, while it is not statistically significant when the real wage is the dependent variable. Hence, the increase in the public wage bill follows the increase in public employment, which subsequently increases output. Interestingly, the initial conditions never turn out significant for those variables suggesting that reforms were exogenous to the macroeconomic conditions

[1] We tried to identify similar episodes for government wage bill reforms with little success.

[2] Conscription is the compulsory enlistment of people in some sort of national service, most often military service.

prevailing in these economies.[3] We take the results of Table G2 as additional evidence suggesting that government vacancy shocks have large and significant effects on output.

Table G1: Changes in conscription		
Countries with changes in conscription	Date	Countries with no changes in conscription
Belgium	March 1995	Austria
Bosnia Herzegovina	January 2007	Belarus
Bulgaria	November 2007	Denmark
Czech Republic	December 2004	Finland
France	1996	Moldova
Hungary	November 2004	Germany (suspended November 2010)
Italy	December 2004	Greece
Latvia	January 2007	Lithuania
FYROM	Octber 2006	Norway
Montenegro	August 2006	Switzerland
Netherlands	1996	Ukraine
Poland	December 2008	Sweden (suspended July 2010)
Portugal	November 2004	
Romania	October 2006	
Slovakia	January 2006	
Slovenia	September 2003	
Spain	2001	
data source: Wikipedia		

Table G2: Effects of conscription reforms	
GDP	$a_1 = 780$ (0.006)
$w_t N_t^g$	$a_1 = 2.32$ (0.08)
w_t	$a_1 = 289$ (0.31)
Note: p-values are in parenthesis	

[3] We have also run regressions controlling for the terminal condition to examine whether changes in conscription take place because policymakers expect high output growth. The terminal condition is never significant.

References

[1] Barnichon, R. and A. Figura, "What drives matching efficiency? A tale of composition and dispersion," Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series, No 2011-10, (2011).

[2] Brückner, M. and E. Pappa, "Fiscal expansions, unemployment, and labor force participation: Theory and evidence", *International Economic Review*, 53(4) (2012), 1205-1228.

[3] Domeij, D. and M. Floden, "The labor-supply elasticity and borrowing constraints: Why estimates are biased," *Review of Economic Dynamics*, 2 (2006), 242-262.

[4] Galí, J., "The return of the wage Phillips curve," *Journal of the European Economic Association*, 9(3) (2011), 436-461.

[5] Hagedorn, M. and L. Manovskii, "The cyclical behaviour of unemployment and vacancies revisited," *American Economic Review*, 98(4) (2008), 1692-1706.

[6] Kamps, C., "New estimates of government net capital stocks for 22 OECD countries, 1960-2001," IMF Staff Papers, Palgrave Macmillan, 53(1) (2006), pages 6.

[7] Petrongolo, B. and C.A. Pissarides, "Looking into the black box: A survey of the matching function," *Journal of Economic Literature,* 39(2) (2001), 390-431.