Fiscal Consolidation in a Low Inflation Environment: Pay Cuts versus Lost Jobs*

Guilherme Bandeira† Evi Pappa‡ Rana Sajedi§ Eugenia Vella¶

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Abstract

We construct a model of a monetary union to study fiscal consolidation in the Periphery of the euro area, through cuts in public sector wages or hiring when the nominal interest rate is constrained at its lower bound. Consolidation induces a positive wealth effect that increases demand, and a reallocation of workers towards the private sector, which together boost private activity. However, in a low inflation environment, demand is suppressed and the private sector is not able to absorb the additional workers. Comparing the two instruments, cuts in public hiring increase unemployment persistently in this environment, while wage cuts reduce it. Regions with higher mobility of labor between the two sectors are able to consolidate more effectively. Price flexibility is also key at the zero lower bound: for a higher degree of price rigidity in the Periphery, consolidation becomes harder to achieve. Consolidations can be self-defeating when the public good is productive, or a complement to private consumption.

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†*Department of Economics, European University Institute. e-mail: dealmeida.bandeira@gmail.com*
‡Corresponding author: *Department of Economics, European University Institute, Via della Piazzuola 43, 50133 Florence, Italy, Tel: (+39) 055 4685 908, e-mail: evi.pappa@eui.eu*
§*Bank of England. e-mail: rana.sajedi@bankofengland.co.uk*
¶*Department of Economics, University of Sheffield. e-mail:e.vella@sheffield.ac.uk*

1 Introduction

Fiscal consolidation policies implemented in the euro area in recent years have placed special emphasis on reducing the public wage bill, which represents a sizable component of the government budget.[1] The fall in the nominal government wage bill has been particularly pronounced in Periphery countries of the euro area, such as Ireland, Greece and Portugal (see Figure 1), and has come from cuts in both wages and the number of employees in the public sector (see Figure 2).[2] At the same time, the euro area has been experiencing a prolonged period of inflation uncertainty: with monetary policy constrained by the zero lower bound (ZLB henceforth), inflation has remained below the ECB's medium run objective for some time. This environment of low inflation has important implications for the design and implementation of fiscal policy. This paper offers a positive analysis of the relative effectiveness of cutting wages versus cutting hiring for reducing the public wage bill in a monetary union when inflation is low.

Historically, periods of high inflation have been used to reduce debt-to-GDP ratios, for example in many western countries following both the First and Second World War (Reinhart et al. 2015). On the contrary, low inflation, all else equal, raises deficit- and debt-to-GDP ratios by reducing the growth in nominal GDP. Debt dynamics would be left unchanged if nominal interest rates adjust by the same magnitude as inflation, thus leaving real rates unchanged. Instead, when nominal rates have hit the ZLB, falling inflation leads to rising real interest rates, making it more difficult to reduce government debt-to-GDP ratios.

Recent studies, both theoretical and empirical, have looked at a less direct effect of low inflation on fiscal policy, namely the impact of the ZLB on fiscal multipliers. Much of the literature has found that fiscal multipliers are higher when monetary policy is constrained.[3]

[1] According to data reported by Holm-Hadulla et al. (2010), before the crisis the government wage bill accounted, on average, for almost a quarter of total public spending and more than 10% of GDP. On average, almost 15% of the labor force in the euro area was employed in the public sector.

[2] These policies have been implemented through reducing overtime pay, retrenching specific indemnities or benefits, implementing attrition rules to reduce new hiring or simply by outright lay-offs and pay cuts. In Greece, for example, a 10% cut across all public sector wages was legislated in 2010, followed by further cuts. In Spain, the attrition rule allowed a new hire for every 10 exits.

[3] Eggertsson (2011), Christiano et al. (2011), Coenen et al. (2012) and De Long and Summers (2012) find

Based on this principle, several papers discuss the potential role of fiscal stimulus in alleviating a ZLB crisis: Correia et al. (2013) suggest an alternative stimulus strategy to the use of government spending, based on consumption taxation, and Rendahl (2016) focuses on how expansionary fiscal policy can best exploit the amplification of labor market movements at the ZLB. The converse of these arguments is that attempting to carry out fiscal consolidation in a liquidity trap can be very costly, and even self-defeating.

Another important aspect is the fact that inflation can have a different impact, both in terms of size and timing, across different components of public expenditure and revenue. Jalil (2012) shows that the differences between the estimated multipliers of government spending and taxation can be explained by the differential response of monetary policy. Erceg and Linde (2013) find that, at the ZLB, a tax-based consolidation is less costly in the short run than a spending-based consolidation, while the opposite is true when monetary policy is unconstrained. McManus et al. (2014) demonstrate that the ZLB has different effects on different fiscal consolidation instruments, and should therefore be considered when designing fiscal policy. We extend this literature by comparing the effectiveness of two different instruments for reducing the public wage bill as a means to achieve fiscal consolidation at the ZLB.

We consider a New Keynesian model of a two-block monetary union, calibrated for the Periphery and Core of the euro area. In order to build a complete model of the labor market, we incorporate both search and matching frictions, leading to involuntary unemployment, and an endogenous labor force participation decision, leading to voluntary unemployment. We allow the government to hire public employees to produce a public good that is used in private production. Following Erceg and Linde (2013) and Pappa et al. (2015), we compare a given public debt consolidation through two alternative fiscal instruments, namely public wage cuts and public vacancy cuts, in normal times and in a low inflation environment.

that the government spending multiplier increases significantly at the ZLB. Erceg and Linde (2013) show that the magnitude of the output contraction induced by spending-based consolidation is roughly three times larger when monetary policy is constrained by the ZLB. Ilzetzki et al. (2013) report substantially higher multipliers in countries operating under fixed exchange rates, which is another form of constrained monetary policy.

In normal times, cuts in the public wage bill using either instrument cause a reallocation of labor towards the private sector, facilitating hiring and reducing the private wage. This induces an internal devaluation: by increasing the competitiveness of the Periphery, the consolidation leads to a depreciation of the real exchange rate. Together with the positive wealth effect of the cut in government spending, this boosts private output. However, we find that the two instruments differ in terms of their effect on unemployment: public wage cuts lead to a fall in unemployment as the private sector quickly absorbs the increased share of jobseekers, while public vacancy cuts lead to a more sluggish adjustment in the labor market, such that unemployment moves very little. In a low inflation environment, induced by negative demand shocks and a ZLB constraint on monetary policy, the government debt-to-GDP ratio rises, and, hence, a significantly larger cut in the public wage bill is required. The differences in the response of unemployment between the two instruments now appear more pronounced: although the fall in unemployment following public wage cuts is mitigated, public vacancy cuts induce a substantial and persistent rise in unemployment.

We run a series of alternative simulations to investigate the mechanisms at play in our model. We find that the ability of jobseekers to reallocate their search is of key importance: rigidities in the mobility of labor between the public and private sectors mitigate the positive effects of the fiscal consolidation on private employment, making consolidation itself more difficult to achieve. Wage stickiness, instead, induces a positive effect on private sector hirings, as the private firm's share of the surplus increases in response to the negative fiscal shock, reinforcing the positive effects from the consolidation. Price flexibility is crucial for the success of the fiscal consolidation at the ZLB since it reinforces the expansionary effects of the cut in the public wage bill. In particular, when the degree of price stickiness in the Periphery is assumed to be higher than in the Core, the internal devaluation channel is reversed, making the consolidation harder to achieve. Finally, looking at different assumptions on the role of the public good in the economy, we find that consolidation in a low inflation environment is easier if the public good is unproductive, such that public sector output does not affect private

labor productivity. Assuming that the public good is a complement to private consumption in the utility function slows down the recovery.

Our work is related to a few recent articles. Bradley et al. (2016) estimate a structural model with a public sector and a labor market with search and matching frictions, using UK data. The authors run simulations of austerity measures, such as a reduction in public sector hiring, an increase in public sector lay-offs, and progressive and proportional cuts to the distribution of wages in the public sector, that were implemented after the 2008 recession. In line with our results, they find that all policies increase hiring and turnover in the private sector. In an earlier contribution, Demekas and Kontolemis (2000) developed a simple two-sector model of the labor market with endogenous unemployment, but without explicit dynamics, showing that increases in government wages lead to increases in private sector wages and higher unemployment, while increases in government employment do not have a significant impact on unemployment. Similarly, Ardagna (2007) has shown that, in a DSGE model with a unionized labor market, unions demand higher wages in response to a debt-financed increase in public sector employment and wages, which leads to a fall in private sector employment and a contraction in the economy. We extend the existing literature by considering a DSGE model of a monetary union, and by explicitly incorporating the ZLB and analyzing its consequences for the effects of cuts in the public wage bill.

The remainder of the paper is organized follows. In Section 2, we provide the details of the model. Section 3 discusses the results of the different policy experiments and Section 4 provides extensive sensitivity analysis. Section 5 concludes.

2 The Model

We consider a two-country DSGE model of a monetary union with search and matching frictions, endogenous labor force participation, and sticky prices in the short run. The two countries, labeled Home and Foreign, are of sizes n and $1-n$, respectively. The following subsections describe the Home economy in more detail: the structure of the Foreign economy

is analogous. All variables are in *per capita* terms. Where necessary, the conventional $\star$ denotes foreign variables or parameters, and the subscripts h and f denote goods produced in the Home and Foreign country and their respective prices.

There are four types of firms in each country: (i) a public firm that produces a good used in private production, (ii) private competitive firms that use labor, capital and the public good to produce a non-tradable intermediate good, (iii) monopolistic retailers that transform the intermediate good into a tradable good, and (iv) competitive final goods producers that use domestic and foreign produced retail goods to produce a final, non-tradable good which is used for investment and consumption. Price rigidities arise at the retail level, while labor market frictions occur in the intermediate goods sector. The representative household consists of private and public employees, unemployed, and labor force non-participants. The government collects taxes and uses revenues to finance the wages of public employees, the cost of opening new vacancies in the public sector and the provision of unemployment benefits.

2.1 Labor markets

We consider search and matching frictions in both the private and public labor markets. In each period, jobs in each sector, $j = p, g$, are destroyed at a constant fraction σ^j and a measure m^j of new matches are formed. The evolution of employment in each sector is thus given by:

$$n_{t+1}^j = (1 - \sigma^j) n_t^j + m_t^j \tag{1}$$

We assume that $\sigma^p > \sigma^g$ in order to capture the fact that, in general, public employment is more permanent than private employment.[4]

The new matches are given by:

$$m_t^j = \rho_m^j (v_t^j)^\alpha (u_t^j)^{1-\alpha} \tag{2}$$

[4]For example, Albrecht et al. (2015) and Gomes (2015) find empirical evidence that separation rates in the public sector are lower than the private sector in the UK, US and Colombia respectively.

where the matching efficiency, ρ_m^j, can differ in the two sectors. From the matching functions specified above we can define, for each sector j, the probability of a jobseeker being hired, ψ_t^{hj}, and of a vacancy being filled, ψ_t^{fj}:

$$\psi_t^{hj} \equiv \frac{m_t^j}{u_t^j} \tag{3}$$

$$\psi_t^{fj} \equiv \frac{m_t^j}{v_t^j} \tag{4}$$

2.2 Households

The representative household consists of a continuum of infinitely lived agents. The members of the household derive utility from leisure, which corresponds to the fraction of members that are out of the labor force, l_t, and a consumption bundle, c_t. Following Neiss and Pappa (2005), we also allow for variable labor effort, x_t, which leads to separable disutility. The instantaneous utility function is, thus, given by:

$$U(c_t, l_t, x_t) = \frac{(c_t - h_b c_{t-1})^{1-\eta}}{1-\eta} + \Phi \frac{l_t^{1-\varphi}}{1-\varphi} - \Upsilon \frac{x_t^{1+\xi}}{1+\xi} \tag{5}$$

where η is the inverse of the intertemporal elasticity of substitution, h_b is the parameter determining habits in consumption, $\Phi > 0$ is the relative preference for leisure, φ is the inverse of the Frisch elasticity of labor supply, and $\Upsilon > 0$ and ξ are the utility parameters for variable labor effort in the private sector.[5]

At any point in time, a fraction n_t^p (n_t^g) of the household members are private (public) employees. Bruckner and Pappa (2012) and Campolmi and Gnocchi (2016) have added a labor force participation choice in New Keynesian models of equilibrium unemployment. Following Ravn (2008), the participation choice is modeled as a trade-off between the cost of

[5]For simplicity, we will abstract from variable labor effort in the public sector. Essentially, the way we model effort is in line with the performance-pay scheme approach in Champagne (2015), which "resembles a right-to-manage assumption, where workers have the right to manage their effort as a function of the bargained wage". Hence, while wages in the public sector are assumed to be fixed, the efficient wage per worker in the private sector adjusts to exerted effort.

giving up leisure and the prospect of finding a job. In particular, the household chooses the fraction of the unemployed actively searching for a job, u_t, and the fraction which are out of the labor force and enjoying leisure, l_t, so that:

$$n_t^p + n_t^g + u_t + l_t = 1 \tag{6}$$

The household chooses the fraction of jobseekers searching in each sector: a share s_t of jobseekers look for a job in the public sector, while the remainder, $(1 - s_t)$, seek employment in the private sector. That is, $u_t^g \equiv s_t u_t$ and $u_t^p \equiv (1 - s_t)u_t$.

The household owns the private capital stock, which evolves according to:

$$k_{t+1}^p = \left[1 - \frac{\omega}{2}\left(\frac{i_t^p}{i_{t-1}^p} - 1\right)^2\right] i_t^p + (1 - \delta^p)\, k_t^p \tag{7}$$

where i_t^p is private investment, δ^p is a constant depreciation rate and ω dictates the size of investment adjustment costs.

The budget constraint, in real terms, is given by

$$\begin{aligned}(1 + \tau_c)\, c_t + i_t^p + b_{g,t+1} + e_t r_{f,t-1} b_{f,t} \;&\leq\; \left[r_t^p - \tau_k\left(r_t^p - \delta^p\right)\right] k_t^p + r_{t-1} b_{g,t} + e_t b_{f,t+1} \\ &+\; (1 - \tau_n)\left(w_t^p n_t^p x_t + w_t^g n_t^g\right) + \mathrm{b} u_t + \Pi_t^p + T_t\end{aligned} \tag{8}$$

where w_t^j, $j = g, p$, are the real wages in the two sectors, r_t^p is the real return on capital, b denotes unemployment benefits, Π_t^p are the profits of the monopolistic retailers, discussed below, and τ_c, τ_k, τ_n, and T_t represent taxes on private consumption, private capital, labor income and lump-sum transfers, respectively. Government bonds are denoted by $b_{g,t}$, and pay the real return r_{t-1}, while $b_{f,t}$ denote liabilities with the Foreign country.[6] Although the nominal exchange rate in fixed, the interest rate on foreign assets, $r_{f,t}$, is still affected by

[6] Assuming government debt is only held by local households captures well the case of Periphery countries like Italy and Spain, where the largest fraction of public debt is held domestically. An interesting extension would be to allow for public debt to also be held externally.

consumer inflation differentials between the two countries, which are captured by the real exchange rate, e_t. In fact, we can define the gross nominal interest rate at Home, R_t, through the Fisher equation:

$$r_t = \frac{R_t}{\mathrm{E}_t \pi_{t+1}} \tag{9}$$

where π_t is the gross consumer inflation rate.

Thus the problem of the household is to choose c_t, u_t, s_t, n^p_{t+1}, n^g_{t+1}, x_t, i^p_t, k^p_{t+1}, $b_{g,t+1}$, $b_{f,t+1}$ to maximize lifetime utility subject to the budget constraint, (8), the law of motion of employment in each sector, (1), the law of motion of capital, (7), and the composition of the household, (6). The resulting first order conditions are provided in an online appendix.[7]

For clarity, we derive the marginal value of an additional private sector employee as:

$$\begin{aligned} V^H_{n^p t} &= \lambda_{ct} w^p_t x_t (1-\tau_n) - \Phi l_t^{-\varphi} + (1-\sigma^p)\lambda_{n^p t} \\ &= \lambda_{ct} w^p_t x_t (1-\tau_n) - \Phi l_t^{-\varphi} + (1-\sigma^p)\beta \mathrm{E}_t(V^H_{n^p t+1}) \end{aligned} \tag{10}$$

where λ_{ct} and $\lambda_{n^p t}$ are the Lagrange multipliers on the budget constraint and the law of motion of private employment, respectively. Using (10) together with the equivalent expression for the value of an additional public sector employee, the definition of hiring rates (3), and the first order condition with respect to s_t, we obtain:

$$\mathrm{E}_t \left(V^H_{n^g,t+1} \right) \psi^{hg}_t = \mathrm{E}_t \left(V^H_{n^p,t+1} \right) \psi^{hp}_t \tag{11}$$

Hence, the decision regarding the fraction of jobseekers to search in a given sector will depend not only on the probability of finding a job in each sector, ψ^{hj}_t, but also on the expected utility

[7]The online appendix can be found at `https://me.eui.eu/evi-pappa/`

from searching in that sector. This, in turn, depends on the separation rate, σ^j, and the respective wage in each sector. In other words, a wage differential can arise between the two sectors in a non-degenerate equilibrium if there are differences in the number of vacancies, the matching efficiency, or the separation rate.

2.3 Production

2.3.1 Intermediate goods firms

Intermediate goods are produced with a Cobb-Douglas technology:

$$y_t^p = (A_t n_t^p x_t)^{1-\phi} (k_t^p)^{\phi} (y_t^g)^{\nu} \tag{12}$$

where A_t is a labor augmenting productivity factor, k_t^p and n_t^p are private capital and labor inputs, x_t is the effort intensity of labor. Following Barro (1990) and Turnovsky (1999), we allow the public good, y_t^g, to enter the production function, taken as exogenous by the firms. The parameter ν regulates how the public input affects private production: when ν is zero, the government good is unproductive.

Since current hires give future value to intermediate firms, the optimization problem is dynamic and, hence, firms maximize the discounted value of future profits. The number of workers currently employed, n_t^p, is taken as given and the employment decision concerns the number of vacancies posted in the current period, υ_t^p, so as to employ the desired number of workers next period, n_{t+1}^p. Firms also decide the amount of the private capital, k_t^p, to be rented from the household at rate r_t^p. The problem of an intermediate firm with n_t^p currently employed workers consists of choosing k_t^p and υ_t^p to maximize:

$$Q^p(n_t^p) = \max_{k_t^p, \upsilon_t^p} \left\{ p_{x,t} (A_t x_t n_t^p)^{1-\phi} (k_t^p)^{\phi} (y_t^g)^{\nu} - w_t^p n_t^p x_t - r_t^p k_t^p - \kappa \upsilon_t^p + E_t \left[\Lambda_{t,t+1} Q^p(n_{t+1}^p) \right] \right\} \tag{13}$$

where $p_{x,t}$ is the relative price of intermediate goods, κ is a utility cost associated with posting

a new vacancy, and $\Lambda_{t,t+1} = \beta\frac{\lambda_{ct+1}}{\lambda_{ct}}$ is the discount factor. The maximization takes place subject to the private employment transition equation, where the firm takes the probability of the vacancy being filled as given:

$$n^p_{t+1} = (1-\sigma^p)n^p_t + \psi^{fp}_t \upsilon^p_t \tag{14}$$

The first order conditions with respect to capital and vacancies are:

$$p_{x,t}\phi\frac{y^p_t}{k^p_t} = r^p_t \tag{15}$$

$$\frac{\kappa}{\psi^{fp}_t} = E_t\Lambda_{t,t+1}[p_{x,t+1}(1-\phi)\frac{y^p_{t+1}}{n^p_{t+1}} - w^p_{t+1}x_{t+1} + (1-\sigma^p)\frac{\kappa}{\psi^{fp}_{t+1}}] \tag{16}$$

According to (15) and (16) the value of the marginal product of private capital should equal the real rental rate and the marginal cost of opening a vacancy should equal the expected marginal benefit. The latter includes the marginal productivity of labor minus the wage plus the continuation value, knowing that with probability σ^p the match can be destroyed.

The expected value of the marginal job for the intermediate firm, $V^F_{n^pt}$ is:

$$V^F_{n^pt} \equiv \frac{\partial Q^p(n^p_t)}{\partial n^p_t} = p_{x,t}(1-\phi)\frac{y^p_t}{n^p_t} - w^p_t x_t + \frac{(1-\sigma^p)\kappa}{\psi^{fp}_t} \tag{17}$$

2.3.2 Retailers

There is a continuum of monopolistically competitive retailers indexed by i on the unit interval. Retailers buy intermediate goods and differentiate them with a technology that transforms one unit of intermediate goods into one unit of retail goods, and, thus, the relative price of intermediate goods, $p_{x,t}$, coincides with the real marginal cost faced by the retailers. Let y_{it} be the quantity of output sold by retailer i. The aggregate tradable good can be expressed as:

$$y^r_t = \left[\int_0^1 (y_{it})^{\frac{\epsilon-1}{\epsilon}} di\right]^{\frac{\epsilon}{\epsilon-1}}$$

where $\epsilon > 1$ is the constant elasticity of demand for each variety of retail goods. The aggregate tradable good is sold at a price $P_{h,t} = \left(\int (P_{i,h,t})^{\epsilon-1} di\right)^{\frac{1}{\epsilon-1}}$. The demand for each intermediate good depends on its relative price and on aggregate demand:

$$y_{i,t} = \left(\frac{P_{i,h,t}}{P_{h,t}}\right)^{-\epsilon} y_t^r \tag{18}$$

Following Calvo (1983), we assume that in any given period each retailer can reset its price with a fixed probability $(1-\chi)$. Firms that are able to reset their nominal price choose $P^*_{i,h,t}$ so as to maximize expected real profits given by:

$$\Pi_{\mathfrak{t}}(i) = \text{Max}_{P^*_{i,h,t}} \mathrm{E}_t \sum_{s=0}^{\infty} (\beta\chi)^s \Lambda_{t,t+s} \left(\left[\frac{P_{i,h,t}}{p_{t+s}} - p_{x,t+s} \right] y_{i,t+s} \right)$$

subject to the demand schedule (18), in each period. Since all firms are ex-ante identical, $P^*_{i,h,t} = P^*_{h,t}$ for all i. The resulting expression for the real price $p^*_{h,t} \equiv P^*_{h,t}/P_t$ is:

$$\frac{p^*_{h,t}}{p_{h,t}} = \frac{\epsilon}{(\epsilon-1)} \frac{\mathcal{N}_t}{\mathcal{D}_t} \tag{19}$$

where:

$$\mathcal{N}_t = p_{x,t} y_t^r + \beta\chi \mathrm{E}_t \Lambda_{t,t+1} (\pi_{h,t+1})^{\epsilon} \mathcal{N}_{t+1} \tag{20}$$

$$\mathcal{D}_t = p_{h,t} y_t^r + \beta\chi \mathrm{E}_t \Lambda_{t,t+1} (\pi_{h,t+1})^{\epsilon-1} \mathcal{D}_{t+1} \tag{21}$$

$p_{h,t} \equiv P_{h,t}/P_t$ is the real domestic price of y_t^r and $\pi_{h,t}$denotes producer inflation. Under the assumption of Calvo pricing, the price index, in nominal terms, is given by:

$$P_{h,t} = \chi (P_{h,t-1})^{\epsilon-1} + (1-\chi) \left(P^*_{h,t}\right)^{1-\epsilon} \tag{22}$$

The aggregate tradable good is sold domestically and abroad:

$$y_t^r = y_{h,t} + y_{h,t}^\star \tag{23}$$

where $y_{h,t}$ is the share of tradable goods sold domestically and $y_{h,t}^\star$ the quantity sold abroad, and we have assumed the law of one price holds

$$p_{h,t} = e_t p_{h,t}^\star \tag{24}$$

2.3.3 Final Goods Producer

Finally, in each country perfectly competitive firms produce a non-tradable final good by aggregating domestic and foreign aggregate retail goods using technology:

$$y_t = \left[(\varpi)^{\frac{1}{\gamma}} (y_{h,t})^{\frac{\gamma-1}{\gamma}} + (1-\varpi)^{\frac{1}{\gamma}} (\overline{\tau} y_{f,t})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}$$

where $\overline{\tau} \equiv (1-n)/n$ normalizes the amount of imported goods at Home to *per capita* terms. The home bias parameter ϖ denotes the fraction of goods produced at home that are used in the production of the final good. The elasticity of substitution between home-produced and imported goods is given by γ. Final good producers maximize profits $y_t - p_{h,t} y_{h,t} - p_{f,t} \overline{\tau} y_{f,t}$ each period. Solving for the optimal demand functions gives:

$$y_{h,t} = \varpi (p_{h,t})^{-\gamma} y_t \tag{25}$$

$$y_{f,t} = (1-\varpi) (p_{f,t})^{-\gamma} \frac{n}{1-n} y_t \tag{26}$$

The consumer price index, P_t, is defined by substituting out $y_{h,t}$ and $y_{f,t}$ in the CES above

by the respective demand curves, which yields:

$$P_t = \varpi \left(P_{h,t}\right)^{1-\gamma} + (1-\varpi)\left(P_{f,t}\right)^{1-\gamma} \tag{27}$$

2.4 Government

The government sector produces the public good using public capital and labor:

$$y_t^g = (A_t n_t^g)^{1-\mu} (\bar{k^g})^{\mu} \tag{28}$$

where we assume that productivity, A_t, is not sector specific and μ is the share of public capital, $\bar{k^g}$, which is assumed fixed. The public good, which is granted for free, provides productivity enhancing services. Government expenditure consists of public wages, public vacancy costs, unemployment benefits and lump-sum transfers, while revenues come from the consumption, capital income and labor income. The government deficit is, therefore, defined by:

$$DF_t = w_t^g n_t^g + \kappa v_t^g + \mathrm{b}u_t + T_t - TR_t$$

where $TR_t \equiv \tau_n(w_t^p n_t^p x_t + w_t^g n_t^g) + \tau_k(r_t^p - \delta^p)k_t^p + \tau_c c_t$ denotes tax revenues.

The government budget constraint is given by:

$$b_{g,t} + DF_t = \frac{b_{g,t+1}}{r_t} \tag{29}$$

We assume that tax rates are constant and fixed at their steady state levels, and we do not consider them as active instruments for fiscal consolidation in order to focus on public wage bill cuts. Thus, the government has two potential fiscal instruments, v_g and w_g. We consider each instrument separately, assuming that if one is active, the other remains fixed at its steady state value. For $\Psi \in \{v_g, w_g\}$, we assume fiscal rules of the form, following Erceg

and Linde (2013) and Pappa et al. (2015):

$$\Psi_t = \Psi^{(1-\beta_{\Psi 0})}\ \Psi_{t-1}^{\beta_{\Psi 0}} \left[\left(\frac{\tilde{b}_{g,t}}{b^*_{g,t}} \right)^{\beta_{\Psi 1}} \left(\frac{\Delta \tilde{b}_{g,t+1}}{\Delta b^*_{g,t+1}} \right)^{\beta_{\Psi 2}} \right]^{(1-\beta_{\Psi 0})} \tag{30}$$

where $\tilde{b}_{g,t} \equiv \frac{b_{g,t}}{rgdp_t}$ is the debt-to-GDP ratio and $b^*_{g,t}$ is the target debt-to-GDP ratio, given by the AR(2) process:

$$\log b^*_{g,t} - \log b^*_{g,t-1} = \mu_b + \rho_1(\log b^*_{g,t-1} - \log b^*_{g,t-2}) - \rho_2 \log b^*_{g,t-1} - \varepsilon^b_t$$

where ε^b_t is a white noise shock representing a fiscal consolidation.

2.5 Closing the model

2.5.1 Monetary policy

There is a single independent monetary authority that sets the gross nominal interest rate to target zero net inflation, subject to the ZLB:

$$R^\star_t \quad = \quad \text{Max}\left\{1, \rho R^\star_{t-1} + (1-\rho)\,\rho_\pi \tilde{\pi}_t\right\} \tag{31}$$

where $\tilde{\pi}_t$ is the sum of national gross consumer price inflations, weighted by population sizes, $n\pi_t + (1-n)\,\pi^\star_t$. For the Home, consumer price inflation is defined as:

$$\frac{\pi_{h,t}}{\pi_t} \quad = \quad \frac{p_{h,t}}{p_{h,t-1}} \tag{32}$$

With fixed nominal exchange rates, the real exchange rate equals the ratio of consumer prices:

$$\frac{e_t}{e_{t-1}} \quad = \quad \frac{\pi^\star_t}{\pi_t} \tag{33}$$

Finally, and to render the model stationary, we introduce a risk premium charged to Home households depending on the relative size of net-foreign-liabilities to total output:

$$r_{f,t} = r_t^{\star} exp\left\{\Gamma e_t \frac{b_{f,t+1}}{rgdp_t}\right\} \tag{34}$$

where Γ is the elasticity of the risk premium with respect to the liabilities.

2.5.2 Resource constraint

The non-tradable domestic final good is sold for consumption and for investment:

$$y_t = c_t + i_t^p + \kappa(v_t^p + v_t^g) \tag{35}$$

where it is clear that the costs of vacancy posting entail real losses. In turn, following the national accounting identity, total output is defined as tradable output plus the government wage bill:

$$rgdp_t = p_{h,t} y_t^r + w_t^g n_t^g \tag{36}$$

Aggregating the budget constraint of households using the market clearing conditions, the budget constraint of the government, and aggregate profits $V_t = \int_i \Pi_{\mathrm{R}}(i)\, di$, we obtain the law of motion for net foreign assets, which is given by:

$$e_t \left(r_{f,t-1} b_{f,t} - b_{f,t+1}\right) = nx_t \tag{37}$$

and where nx_t are net exports defined as:

$$nx_t = p_{h,t} y_{h,t}^{\star} - p_{f,t} \overline{\tau} y_{f,t} \tag{38}$$

2.5.3 Wage bargaining

Private sector wages are determined by ex post (after matching) Nash bargaining. Workers and firms split rents and the part of the surplus they receive depends on their bargaining power. If we denote by $\vartheta \in (0,1)$ the firms' bargaining power, the Nash bargaining problem is to maximize the weighted sum of log surpluses:

$$\max_{w_t^p} \left\{ (1-\vartheta) \ln V_{n^p t}^H + \vartheta \ln V_{n^p t}^F \right\}$$

where $V_{n^p t}^H$ and $V_{n^p t}^F$ are given by 10 and 17, respectively. The optimization problem leads to the following solution for w_t^p:

$$w_t^p = (1-\vartheta) p_{x,t} (1-\phi) \frac{y_t^p}{n_t^p x_t} + \frac{\vartheta}{(1-\tau_n) x_t \lambda_{c,t}} \Phi l_t^{-\varphi} \tag{39}$$

Hence, the equilibrium wage is a weighted average of the marginal product of employment and the disutility from labor, with the weights given by the firm and household's bargaining power, respectively.

2.6 Model Solution and Calibration

We solve the model by linearizing the equilibrium conditions around a non-stochastic steady state in which all prices are flexible, the price of the private good is normalized to unity, and inflation is zero. To account for the ZLB, which is a non-linear constraint, we use the Occbin toolkit provided by Guerrieri and Iacoviello (2015). Following the literature, the low inflation environment is induced by assuming a shock to the household's discount rate, ϱ^β, in both countries. This shock contracts demand and causes inflation to fall across the monetary union, driving the common nominal interest rate to its lower bound. By raising the household's propensity to save, the discount factor shock by itself induces a rise in investment. To avoid this counterfactual behavior for investment, we also introduce a shock to the price

of investment, ϱ^i, that leads to a fall in investment.[8]

The stochastic processes for these fluctuations are as follows:

$$\varrho_t^\beta = (1-\rho_\beta)\varrho^\beta + \rho_\beta \varrho_{t-1}^\beta + \epsilon_t^\beta$$
$$\varrho_t^i = (1-\rho_i)\varrho^i + \rho_i \varrho_{t-1}^i + \epsilon_t^i$$

where we set $\rho_\beta = 0.825$ and $\rho_i = 0.85$.

Table 1 shows the key parameters and steady state values targeted in our calibration. We calibrate the model at a quarterly frequency and consider the Home country to represent the Periphery of the euro area, consisting of Greece, Ireland, Italy, Portugal and Spain. We follow Erceg and Linde (2013) and assume symmetry across the two countries for most parameters. However, because we set $n = 0.3$ and assume zero net foreign assets in the steady state, the two countries necessarily differ in the degree of home bias, ϖ and $\varpi^\star$, which is set to 0.85 in the Periphery and 0.94 in the Core. Again following Erceg and Linde (2013), we set the elasticity between domestic and foreign consumption goods to 1.5, and set private output, y^p, to represent 77% of GDP. We choose an annual government debt-to-GDP ratio of 80%, significantly above the Maastricht limit and, therefore, consistent with an environment in which fiscal consolidation is deemed necessary.

The rest of the utility function parameters are standard. The intertemporal elasticity of substitution is set to 1 and the habit parameter is set equal to 0.75 in order to increase persistence and the duration of the lower bound. We assume a Frisch elasticity of labor equal to 0.25, while the labor effort elasticity is set to 0.5. The value of these parameters is not inconsequential, the size of both elasticities affect the reaction of labor force participation, and, as a result, the responses of unemployment to the fiscal shock. Moreover, the elasticity of labor effort affects the speed of recovery since it allows for more flexibility in terms of the labor input in the private sector.

We set the labor force participation rate to 65%, assume that 20% of jobseekers are

[8]Responses for the low inflation environment without the investment shock are shown in the online appendix. The responses of variables other than investment are not qualitatively affected by this shock.

Table 1: Calibration of Parameters and Steady State Values

Parameter/Variable	Value	Description
Preferences:		
β	0.99	discount factor
η	1.00	intertemporal elasticity of substitution
h_b	0.75	habits in consumption
φ	4.00	inverse Frisch elasticity of labor
ξ	0.50	elasticity of variable labor effort
ϖ	0.85	home bias in the Periphery
γ	1.50	elasticity of substitution between home and foreign goods
Ratios:		
n	30%	relative size of Periphery
$y^p/rgdp$	77%	private output to GDP
$B_g/rgdp$	80%	annual public debt to GDP
Labor Market:		
$(1-l)$	65%	labor force participation
$u/(1-l)$	12%	unemployment rate
u^g/u	20%	share of jobseekers in the public sector
n^g/n	18%	share of public employment
$b/(1-\tau_n)w^p$	52.3%	net replacement rate
κ/w^p	7.29%	vacancy costs as a share of wages
ψ^{fp}, ψ^{fg}	7%	probability of vacancy filling (private, public)
σ^p	4.18%	private job destruction rate
σ^g	$0.95\times\sigma^p$	public job destruction rate
α	0.50	elasticity of matching wrt vacancies
Production:		
ω	4	investment adjustment costs
δ^p	2%	depreciation rate
ϕ, μ	36%	capital share (private, public)
ν	5%	productivity of public good in private production
ϵ	1.1	markup
χ	0.85	Calvo lottery
Policy:		
ρ	0.85	interest rate inertia
ρ^π	2.50	Taylor rule inflation targeting
ρ_1 , ρ_2	0.79, 0.0001	persistence debt target
β_{ψ^0}, β_{ψ^1},β_{ψ^2}	0.5 (0.1), 5.3 (1), 20 (1.9)	fiscal rule parameters for vacancy (wage) cuts

Unless otherwise stated, parameter values are equal for both countries.

searching in the public sector, and that 18% of employed workers are working for the government. For the remaining labor market parameters, we follow Moyen et al. (2016), who calibrate a model for the euro area with one block matching the Periphery. As such, the unemployment rate is set to 12%, the net replacement rate to equal 52.3% and vacancy costs

to represent 7.29% of private wages. We assume equal probabilities of a vacancy to be filled in both sectors, $\psi^{fp} = \psi^{fg} = 7\%$. As discussed above, we assume that the average duration of employment is shorter in the private sector, and therefore set the separation rate in the public sector 5% lower than in the private sector.

The parameters in the production function are standard: the capital share is set to 0.36 in both sectors. The depreciation rate implies an annual depreciation of 10% and the capital adjustment costs are set to 4.[9] For the productivity of public good we assume a low value for ν and investigate the sensitivity of results to this parameter value in the subsequent sessions. Finally, we assume prices are sticky for more than a year and that the central bank reacts strongly to deviations of inflation.

For the parameters governing fiscal policy, we set ρ_1 and ρ_2, which govern the path of the debt-to-GDP target, such that any change in the target is observed fully after twenty five quarters and lasts for an arbitrarily long period of time, beyond the relevant policy horizon. Finally, we set the parameters governing the fiscal instruments in equation (30) such that, in normal times, the actual debt-to-GDP ratio meets the target after 25 quarters for both instruments.

3 Fiscal Consolidation through the Wage Bill

We consider a shock which drives the debt-to-GDP target around 10% below its steady state. We simulate the responses to this shock with either public vacancies, v^g, or public wages, w^g, adjusting to achieve fiscal consolidation, and compare the effects of the consolidation under the two alternative instruments. We first look at the effects of this shock in normal times, and then compare these results to when the consolidation is implemented in a low inflation environment.

[9] We have investigated the sensitivity of our results to changes in this parameter. Lower values of ω imply a higher initial drop in investment after the shock to its price and makes this consolidation tougher for both instruments.

3.1 Consolidation in Normal Times

Figure 3 presents the comparison between cutting public vacancies and cutting public wages to meet the new debt-to-GDP target, when the economy is not subject to the demand shocks.[10]

For both instruments, the consolidation induces a gradual fall in the public wage bill, and a contraction in public employment and hence public output.[11] In the case of public vacancies, the reduction in the public wage bill has a slight lag relative to the wage cuts, due to the lag in the adjustment of public employment. Crucially, for both instruments, the share of public sector jobseekers in total jobseekers falls. In the case of public vacancy cuts, there is a fall in the number of matches, and hence the probability of finding a job in the public sector. The public wage cuts cause the value of the public sector job, in the case of a match, to fall. As a result, in both cases, the expected value of searching for a job in the public sector is reduced. Since agents redirect their search until the expected value of searching in each sector is equalized, this leads to a reallocation of jobseekers towards the private sector.[12] With public wages as the active instrument, this mechanism induces an endogenous reduction in public employment, which further aids the consolidation. On the contrary, public vacancies need to adjust a lot more to achieve a similar fall in the public wage bill since, in this case, public wages are assumed to be fixed.

The rise in the supply of labor in the private sector leads to the reduction of private wages. Hence we see that the consolidation induces an internal devaluation, increasing competitiveness within the monetary union, and so implying a depreciation of the real exchange rate, and the eventual rise in net exports. At the same time, the reduction in expenditure on the public wage bill creates a positive wealth effect for the household, further boosting demand in the private sector. This raises labor demand in this sector, translating to higher

[10] All responses are in percent deviations from steady state, except for interest rates and inflation, which are shown in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which is shown in levels.

[11] Recall that the dynamics of public output are exactly the same as public employment.

[12] Note that, in equilibrium, the expected value of searching for a job will be lower in both sectors.

private vacancies. The expansion of both the demand and supply of private labor raises private employment. As a result, tradable output rises, more so in the long run as investment also picks up. This response is slower in the case of vacancy cuts, given, in particular, that investment takes time to rise. Note that the rise in tradable output occurs despite the fall in public output, which also serves as an input in private production.[13]

Recalling the definition of GDP as the sum of private and public output, with the latter measured by the public wage bill, we can see that the consolidation process depresses GDP for many periods. In the short to medium run, this effect is somewhat bigger for wage cuts, despite a slightly larger increase in tradable output. The long run effect on tradable output is higher for vacancy cuts, yet the disproportionate cut in public employment in this case makes the recovery in real GDP slower.

One variable that stands out as behaving very differently under the alternative instruments is the unemployment rate. Given the positive wealth effect from the consolidation, as well as the reduction in the expected value of searching for a job, jobseekers leave the labor force, and labor force participation falls for both instruments. As the labor markets adjust, the faster response of private employment in the case of public wage cuts means that remaining jobseekers are absorbed into private employees, and unemployment continues to fall. On the other hand, in the case of vacancy cuts, the sluggish response of the private sector labor market means that jobseekers remain unemployed for longer. Along with the fact that public employment falls by much more in the medium to long run, this implies that the unemployment rate fluctuates only slightly around the initial steady state when vacancy cuts are the active instrument.[14]

Although our model differs substantially from Bradley et al. (2016), our general conclusions do not. In normal times, cuts in the public wage bill expand the private sector, both by raising demand and causing a reallocation of jobseekers to the private sector. We have

[13]Our results are consistent with the empirical findings of Cavallo (2005), who shows that hours, output, and investment in the private sector in the US decrease in response to an unanticipated increase in the government wage bill expenditure.

[14]Note that assuming a higher Frisch elasticity would imply a much larger fall in labor force participation, and would therefore lead to a fall in the unemployment rate for the vacancy cuts case as well.

also underlined an additional mechanism not considered in Bradley et al. (2016), namely that for both instruments the public wage bill cut in a monetary union induces an internal devaluation, therefore aiding the recovery by raising external demand. Comparing the two instruments, cutting public wages implies a faster expansion in the private sector, and hence a fall in unemployment. Public vacancy cuts, on the other hand, imply an overall larger cut in public employment and a significantly more sluggish response of workers, such that the positive effects in the private sector take longer to materialize, and the unemployment rate does not respond significantly.

3.2 Consolidation in a Low Inflation Environment

We now turn to the case where the consolidation occurs while monetary policy is constrained at the ZLB and inflation is stuck below steady state. Figures 4 and 5 plot the IRFs for vacancy cuts and wage cuts, respectively. In each, to aid comparison, we again plot the baseline consolidation in normal times in the blue solid lines, as in Figure 3.

For completeness, we also plot the case where the economy is hit by the negative demand shocks but the ZLB constraint is not imposed: these are the green dashed lines. In both Figures, in this unconstrained case the net nominal interest rate becomes negative for around five quarters. This depresses the real interest rate, offsetting the effects of the demand shock and pushing up on inflation. It is interesting to note that the fall in the real interest rate is actually a boost to public finances, and the government's debt-to-GDP ratio quickly falls close to the target with only a smaller adjustment in the fiscal instruments needed.

Conversely, when the ZLB is imposed, shown by the red dash-dotted lines, the nominal rate remains at its lower bound for those five quarters: the real interest rate is higher than the unconstrained case and inflation falls by more. The contraction of tradable output, coupled with the fall in inflation, push the government's debt-to-GDP ratio in an upward trajectory, in spite of the consolidation. Hence we see that an important difference between the consolidation in normal times and the low inflation environment is that a much larger

adjustment of the fiscal instrument is needed in the latter case.

At the ZLB, with both consumption and investment contracting, the private sector is no longer able to absorb the increasing number of private jobseekers. This can be seen in the response of private vacancies, which fall during the liquidity trap. In addition, private wages fall by much more in the low inflation environment, leading to private employment actually contracting in the short run in the case of cuts to public vacancies. Along with the contraction in investment and the increasingly sluggish response of private employment, this implies that tradable output, and hence real GDP, fall sharply. In the case of vacancy cuts, the unemployment rate now rises significantly.

What does the low inflation environment imply about the comparison of the two instruments? In Figure 6 we plot together the IRFs when the ZLB constraint is binding for the two instruments. Compared to Figure 3, we see that the two responses are now relatively closer in general, and particularly for tradable output. This comes about because the relatively larger size of the demand shocks dominate the shape of most responses. As before, however, the most striking difference is in unemployment, which again falls in the case of wage cuts, but now rises significantly in the case of vacancy cuts. This difference stems mainly from the weaker performance of private employment during the liquidity trap period.[15] Hence, on balance and in terms of the response of unemployment and the private sector, public wage cuts remain less adverse than vacancy cuts.

3.3 The Role of the Consolidation Shock

Since we are considering simultaneous shocks, it is useful to separate their effects. To this end, we now compare the IRFs for the consolidation shock at the ZLB, discussed above, to a case where the economy hits the ZLB but the public debt target is held constant. The comparison is shown in Figures 7a and 7b for vacancy cuts and wage cuts, respectively, with

[15] In exercises we do not show here for economy of space, we find that the increase in unemployment following vacancy cuts can be mitigated by assuming a lower Frish elasticity. Nonetheless these results are robust for reasonable values, $0.1 \leq \frac{1}{\varphi} \leq 1$.

the blue solid lines reporting the scenario with the consolidation shock and the green dashed lines the one without.

For both policy instruments, consolidation is in fact induced by the negative demand shocks alone. As discussed above, by inducing a fall in inflation and a contraction in the private sector, the discount factor shock increases the debt-to-GDP ratio above the target. As a result, and according to the fiscal rule specified in equation (30), public vacancies or wages are automatically cut, even without the consolidation shock. Nonetheless, these effects are smaller compared to the scenario with the consolidation shock. Importantly, this means that there is a smaller reallocation of jobseekers to the private sector. In fact, due to the drop in private demand, households initially reallocate jobseekers towards the public sector. This leads to a smaller depreciation of the real exchange rate, and a bigger fall in private consumption. The recovery in investment is also noticably slower. All of these lead to a bigger contraction in private vacancies, and private employment now falls persistently. Along with the smaller drop in labor force participation, this means that the unemployment rate rises now for both instruments.

4 Sensitivity Analysis

We now perform different exercises to investigate how the mechanisms of the model affect our results. First, we explore the role of labor market rigidities, considering two distinct scenarios: one in which real wages are sticky in the private sector and one in which we assume that the share of jobseekers searching in each sector is held fixed. Second, we investigate the importance of price rigidities in inducing the expansionary effects of fiscal consolidation at the ZLB. Finally, we look at the role of the productivity of the public good, and also consider an alternative scenario in which the public good is utility-enhancing.[16]

[16]We plot only the responses of consolidation in the low inflation environment here; responses for these sensitivity exercises in normal times are provided in the online appendix. The appendix also includes further sensitivity results varying the parameters that determine the openness of the economy, such as the degree of home bias, the elasticity of trade and the relative size of the Periphery. These results illustrate that the open economy dimension plays an important role in determining the size of the internal devaluation and affects the

4.1 Labor Market Rigidities

Our analysis has highlighted the role of the labor market channels in driving the effects of fiscal consolidation through public wage bill cuts. We now explore the extent to which modeling sticky wages in the private sector, or muting the reallocation of unemployed jobseekers between the two sectors, affects our main findings.

4.1.1 Sticky Wages

Since households and firms are price takers, private sector wages are an important input in their decisions regarding the numbers of jobseekers and vacancies. It is therefore important to test whether alternative assumptions about wage setting alter the results presented above. The rather strong assumption that wages are renegotiated every period is one that warrants particular attention. As an alternative, we introduce wage rigidity in the private sector in a similar fashion to Monacelli et al. (2010), assuming that private real wages evolve according to the following rule:

$$w_t^p = \rho_w w_{t-1}^p + (1-\rho_w)\left\{\left((1-\vartheta)p_{x,t}(1-\phi)\frac{y_t^p}{n_t^p x_t} + \frac{\vartheta}{(1-\tau_n)x_t\lambda_{c,t}}\Phi l_t^{-\varphi}\right)\right\} \tag{40}$$

In other words, the real wage is a weighted average of last period's wage and the outcome of Nash bargaining this period. We set ρ_w, the degree of real wage rigidity, to 0.75.[17]

The resulting IRFs are depicted by the green dashed lines in Figures 8a and 8b. By definition, when private wages are sticky they move less in response to the shocks. As discussed by Monacelli et al. (2010), wage rigidity affects the rate at which firms post vacancies, since it influences firms' expected gains from hiring. The authors show that when the real wage is fixed, the firm's share of the surplus increases in response to negative government

behavior of net exports, but since the effect of the fiscal consolidation on trade is small, this only marginally affects the baseline results.

[17] Gali (2011) highlights the importance of nominal wage stickiness in a similar environment. Introducing nominal wage stickiness within a search and matching framework where wages are the result of bargaining between households and firms who behave optimally is not trivial and is beyond the scope of our paper. Thomas (2008), Gertler and Trigari (2009) and references therein provide a complete discussion and implementation of nominal wage rigidities in a search and matching model.

shocks, thereby encouraging hiring. Indeed, this is what we observe here: private vacancies now increase during the liquidity trap for wage cuts, and fall by less than the baseline in the case of vacancy cuts. For both instruments this pushes down on the unemployment rate relative to the baseline. Hence, by boosting labor demand, real wage rigidities increase the expansionary effects of consolidation for the private sector at the ZLB.

4.1.2 Fixed Allocation of Jobseekers

Letting households choose the fraction of unemployed workers that look for a job in each of the two sectors is important for the dynamics of our model. This assumption implies that jobseekers can costlessly optimize their search between sectors in each period. However, in reality, human capital derived from learned skills, past experience and in-job networking introduce an asymmetry to the mobility of workers. Hence jobseekers with previous experience in one sector would find it more difficult to be hired in the other. To explore the consequences of imperfect mobility, we impose that the fraction of jobseekers in the public sector is fixed, that is $s_t = \bar{s}$. Hence, although the number of workers employed in each sector can evolve separately through the dynamics of vacancy postings and labor force participation, households cannot freely decide to reallocate jobseekers to one particular sector.

The red dash-dotted lines in Figures 8a and 8b depict the IRFs under this scenario. With no reallocation of jobseekers to the private sector, the recovery is now much slower. Firstly, as debt-to-GDP falls more slowly after the liquidity trap, larger and more persistent cuts in public vacancies are needed for consolidation. In fact, keeping the parameters of the fiscal rule, equation (30), the same, the target now takes significantly longer to be met. Output and unemployment effects become more pronounced. In the case of wage cuts, the endogenous reduction in public employment is now switched off, and as a result private employment falls throughout the consolidation. The unemployment rate continues to fall, however, as jobseekers leave the labor force, and the persistence of the fall in the public wage means that this fall is also more persistent.

Overall, rigidities in the reallocation of jobseekers from the public to the private sector imply that fiscal consolidation through cuts in the public wage bill is substantially more difficult to implement and, in particular for the case of vacancy cuts, comes at the cost of higher unemployment. Consolidation in this scenario also generates a negative response of private employment during the liquidity trap, for both fiscal instruments, which could be in line with the recent experience of member countries in the Periphery of the euro area.

4.2 Price Rigidities

The changes in relative prices induced by the fiscal consolidation in the monetary union (i.e. inflation differentials) are key for the success of the fiscal consolidation in the Periphery. The price stickiness assumption, under a fixed exchange rate regime and at the ZLB, affects the speed of the relative price movements and, as a result, can be crucial for the reallocation of resources within the monetary union. In this subsection we analyse how important is the assumption of price stickiness. In experiments we do not present here for economy of space we show that the degree of price stickiness is inconsequential during normal times, as the monetary policy will always react to undo possible rigidities stemming from price dispersion.

However, at the ZLB monetary policy cannot undo changes in relative prices induced by asymmetric fiscal shocks and, as a result, the degree of price stickiness becomes key for the effects of fiscal consolidation. The green dashed lines in Figures 9a and 9b depict the responses when we assume that the degree of price rigidities increases for both regions by setting $\chi = 0.9$. As it is clear from the figure, price rigidities matter for the success of the consolidation at the ZLB. The larger the share of firms that cannot change their prices on impact, the stronger the negative effects of the demand shocks and the deeper the needed consolidation. The red dotted lines in Figures 9a and 9b depict the responses when we assume that the degree of price rigidities increases only in the Periphery. In this case, consolidation becomes self-defeating as the price stickiness in the Periphery implies larger effects from the negative demand shocks, that consolidation cannot overcome. The inability of prices to

adjust induces a reversal of the internal devaluation and leads to more pronounced effects from the demand shocks. This is an important note to take for policy analysis, since it highlights that consolidation alone without structural reforms in the Periphery might have detrimental effects for the economies involved.[18]

4.3 The Public Good

In this final section we examine the sensitivity of our results to different assumptions about the role of the public good in the economy.

4.3.1 The Productivity of Public Output

We start with a focus on the parameter governing the productivity of the public good, ν, which is crucial in determining the effects of consolidation, even in the baseline model when the ZLB does not bind. Notice that in our economy output is demand determined and, as a result, the negative demand shocks push output down and induce firms to reduce their labor demand. When $\nu > 0$, fiscal consolidation in this environment further reduces the productive capacity of the firms by reducing the public good, but at the same time mitigates the negative demand effects by inducing a positive wealth effect. Hence, ν is at the center of the balance between two opposite effects on private production.

The green dashed lines in Figures 10a and 10b depict the responses when we assume that $\nu = 0.25$ instead of $\nu = 0.05$ as in the baseline. When the public good is more productive, the reduction in the public wage bill implies a bigger drop in the marginal product of labor, and this leads to a bigger fall in private vacancies and private wages. In the case of vacancy cuts, where public employment, and hence public output, falls more significantly, the differences are much starker. In this case, the reallocation of jobseekers towards the private sector is small and short-lived. This implies, firstly, that public employment does not fall as much as in the baseline, so that larger cuts to public vacancies are needed and the consolidation is

[18] In the online appendix we show that asymmetries in wage stickiness, or in the mobility of jobseekers across sectors, are less important for our results.

less successful, and, secondly, that the expansionary effects of the consolidation in terms of boosting private activity are mitigated. For both instruments, there is a bigger contraction in household consumption and investment, and ultimately a much larger and persistent drop in tradable output. For the case of public vacancy cuts in particular, the initial drop in private employment is larger and its subsequent evolution is always below baseline, raising the unemployment rate considerably and persistently.

The fact that the consolidation does not lead to a boost in private activity also implies that there is no internal devaluation: the real exchange rate even appreciates after the liquidity trap. On the other hand, with public wage cuts, and since public employment does not fall by as much when compared to the case of vacancy cuts, this channel of amplification through the productivity of the public good is less important. Hence, we see that the differences between the case with and without the public good in the private production function are relatively smaller.

4.3.2 A Utility-Enhancing Public Good

An alternative to the assumption of a productive public good would be to assume that it provides utility-enhancing services by being, for instance, a complement to private consumption. To investigate how this would affect our results, we assume that the final consumption bundle, which enters the utility function shown in equation (5), is a CES aggregation of private consumption and the public good

$$C_t = \left[\alpha_1 \left(c_t\right)^{\frac{\alpha_2-1}{\alpha_2}} + \left(1-\alpha_1\right)\left(y_t^g\right)^{\frac{\alpha_2-1}{\alpha_2}}\right]^{\frac{\alpha_2}{\alpha_2-1}}$$

We set $\alpha_1 = 0.8$ and $\alpha_2 = -0.9$ so that the public good accounts for 20% of consumption, and the public and private good are complements. The red dash-dotted lines in Figures 10a and 10b show the results.[19]

[19]Here we show the results switching off the productivity of the public good, that is with $\nu = 0$, however this does not affect the results. According to research by Fiorito and Kollintzas (2004) with European data, examples of publicly provided goods that complement private consumption include health and education. Fève et al. (2013) emphasize the importance of complementarities between private consumption and govern-

Since public output does not fall immediately following the consolidation shock, assuming the public good is a complement to private consumption pushes up on private consumption in the short run. This means that the effects of the demand shocks are mitigated, consumption falls by less, raising tradable output. This pushes down on debt-to-GDP relative to the baseline, such that the fiscal adjustment required is also smaller. In the long run, however, the fall in the public good reinforces the drop in consumption of the private good. This exacerbates the drag in economic activity, in particular in private employment and output. In this case, private demand remains depressed, keeping tradable output lower, and therefore making consolidation more difficult. In the short run, the consolidation implies that private demand in the Periphery falls by more relative to the Core, reversing the internal devaluation leading to a fall in net exports. In the long run, the fiscal adjustment is stronger and does not translate to the same boost for the private sector.

5 Conclusions

5.1 Summary

In this paper, we have set up a DSGE model of a monetary union with search and matching frictions, nominal rigidities, and public employment, to study the effects of fiscal consolidation through cuts in the public wage bill in a low inflation environment. Our model allows us to study non-trivial reallocation of agents both in and out of the labor force and between the public and private sector. In normal times, a reduction in the government wage bill induces a reallocation of labor towards the private sector, due to the contraction in the public sector, and so pushes down on private wages. This leads to an internal devaluation within the monetary union, which, along with the positive wealth effect from the cut in government expenditure, raises aggregate demand and so implies an expansion in the private

ment spending in the utility function in determining the size of government spending multipliers. Assuming substitutability between private and public consumption goods instead, a channel also investigated in the literature, would yield straightforward results mirroring the analysis above.

sector. Despite these positive effects, the response of unemployment depends on the fiscal instrument chosen: if the reduction comes from a cut in public sector wages, the reallocation towards private employment is much faster and the unemployment rate falls, whereas if the reduction comes from a cut in public sector hiring, which leads to a slower adjustment of private employment, the unemployment rate moves very little.

In a low inflation environment, induced by negative demand shocks, the debt-to-GDP ratio rises, and so larger fiscal cuts are needed to meet the debt target. Given the expansionary effects this has for the private sector, our analysis suggests that consolidation helps the recovery of the economy in a liquidity trap in the medium to long run. Nonetheless, with the contraction in demand, the private sector is much more limited in its ability to absorb the workers leaving the public sector, and so the expansionary effects of the consolidation are contained. On the other had, the effects of consolidation on the unemployment rate remain dependent on the fiscal instrument used: while public wage cuts effectively reduce the unemployment rate in the short to medium run, preventing it from jumping during the liquidity trap, public vacancy cuts have only a marginal effect in mitigating the rise in the unemployment rate.

5.2 Policy Implications

Our findings can be used as a roadmap for successful fiscal consolidations through cuts in the public wage bill. We point to several factors that matter for the recovery from the low inflation environment. The most important are rigidities in the mobility of unemployed jobseekers between the public and private sectors and nominal price stickiness

Rigidities in the reallocation of workers between the two sectors make consolidation through cuts in the public wage bill more adverse and, especially for the case of vacancy cuts, at the cost of higher unemployment. In fact, one might argue that the behavior of private employment observed in our baseline results, and in particular for public wage cuts, diverges from the recent developments in countries in the Periphery of the euro area. In-

stead, the exercise with immobility of jobseekers generates a drop in private employment for both fiscal instruments, which is more in line with recent experiences. Hence, the presence of active labor market policies that can help channel workers from the public to the private sector are crucial for the success of fiscal consolidations like the ones considered in this paper. In a similar sense, relative price rigidities are also important: higher price stickiness in the Periphery reverses the internal devaluation and leads instead to an appreciation of the real exchange rate, which reinforces the negative effects of the demand shocks and makes consolidations harder to achieve. Also in this case, structural reforms that reduce those type of rigidities would ease consolidations in the Periphery.

On the other hand, real wage rigidities do not appear to be crucial for the effectiveness of fiscal consolidation. While rigidities in private wage setting can lower the unemployment rate during consolidation by boosting private hiring, the effects on output are negligible. The same mixed effects occur when we consider the public good to be a complement to private consumption. By reducing the provision of the public good, consolidation pushes down on private demand in the long run, and hence lowers tradable output, although these effects are small. Alternatively, when the public good which is being cut is a productive factor for the private sector, consolidation is more difficult since it reduces the marginal productivity of labor and so pushes down on firm's demand for labor. Hence, the nature of the public good which provision is being reduced can determine the effectiveness of fiscal consolidation through public wage bill cuts.

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Figures

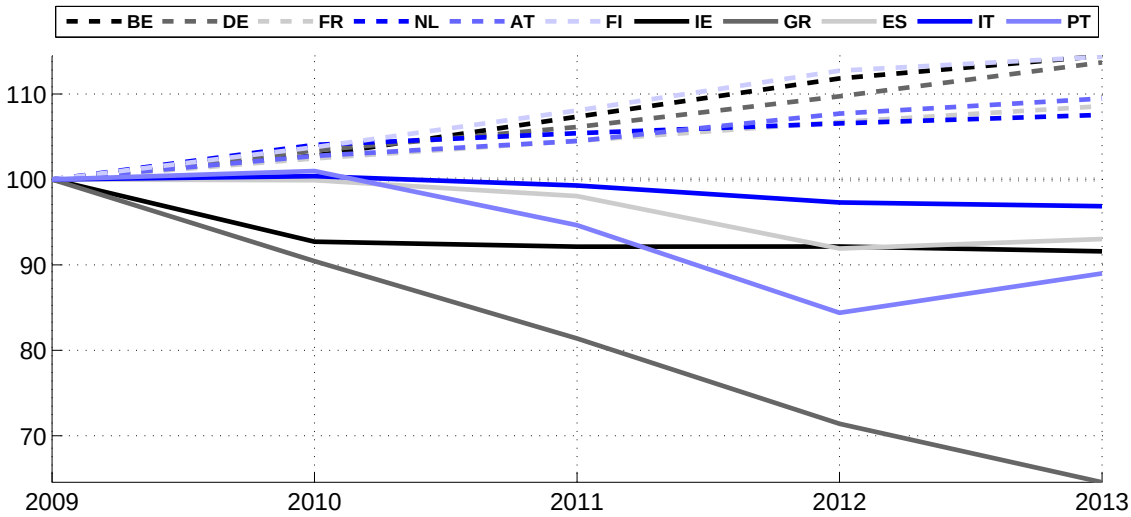
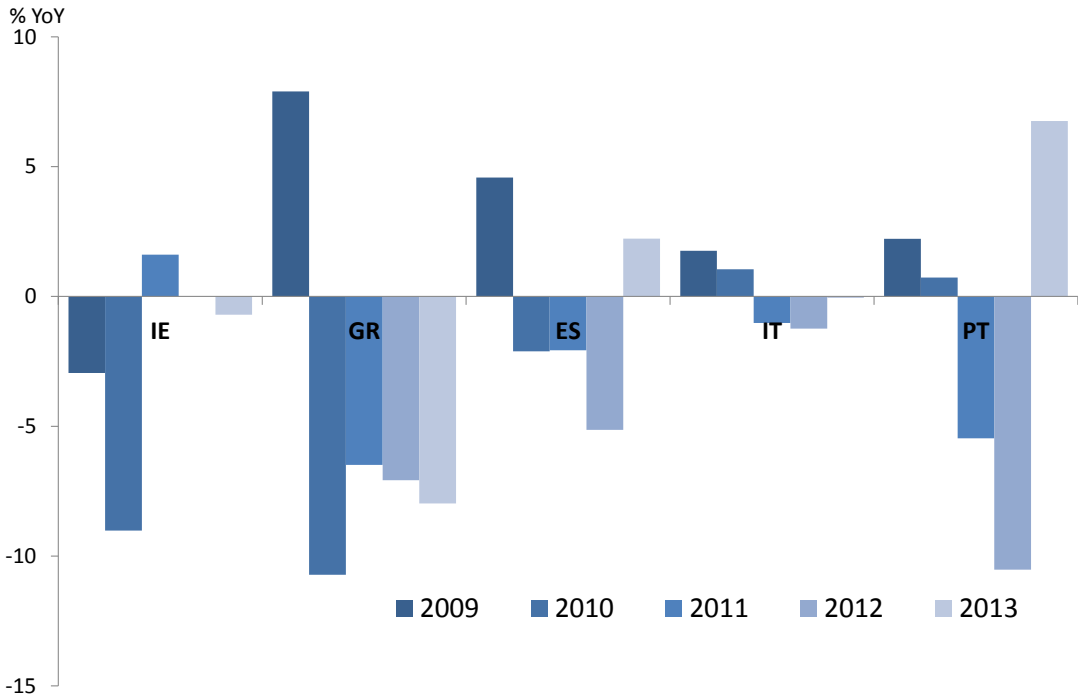
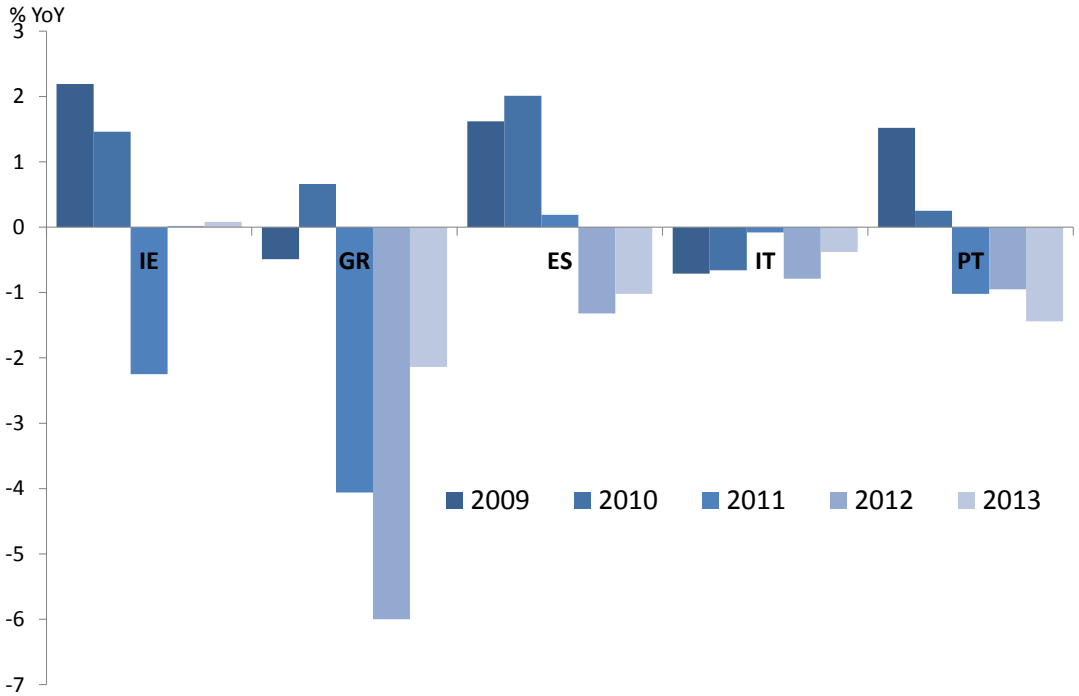


Figure 1: Evolution of the Public Wage Bill

Wages and salaries in the public sector, current prices. For comparability, country series have been normalized to 100 in 2009. *Source: Eurostat and authors' calculations.*



(a) Average Wage per Employee)



(b) Employment

Figure 2: Changes in Public Sector Wages and Employment

Source: Eurostat and authors' calculations.

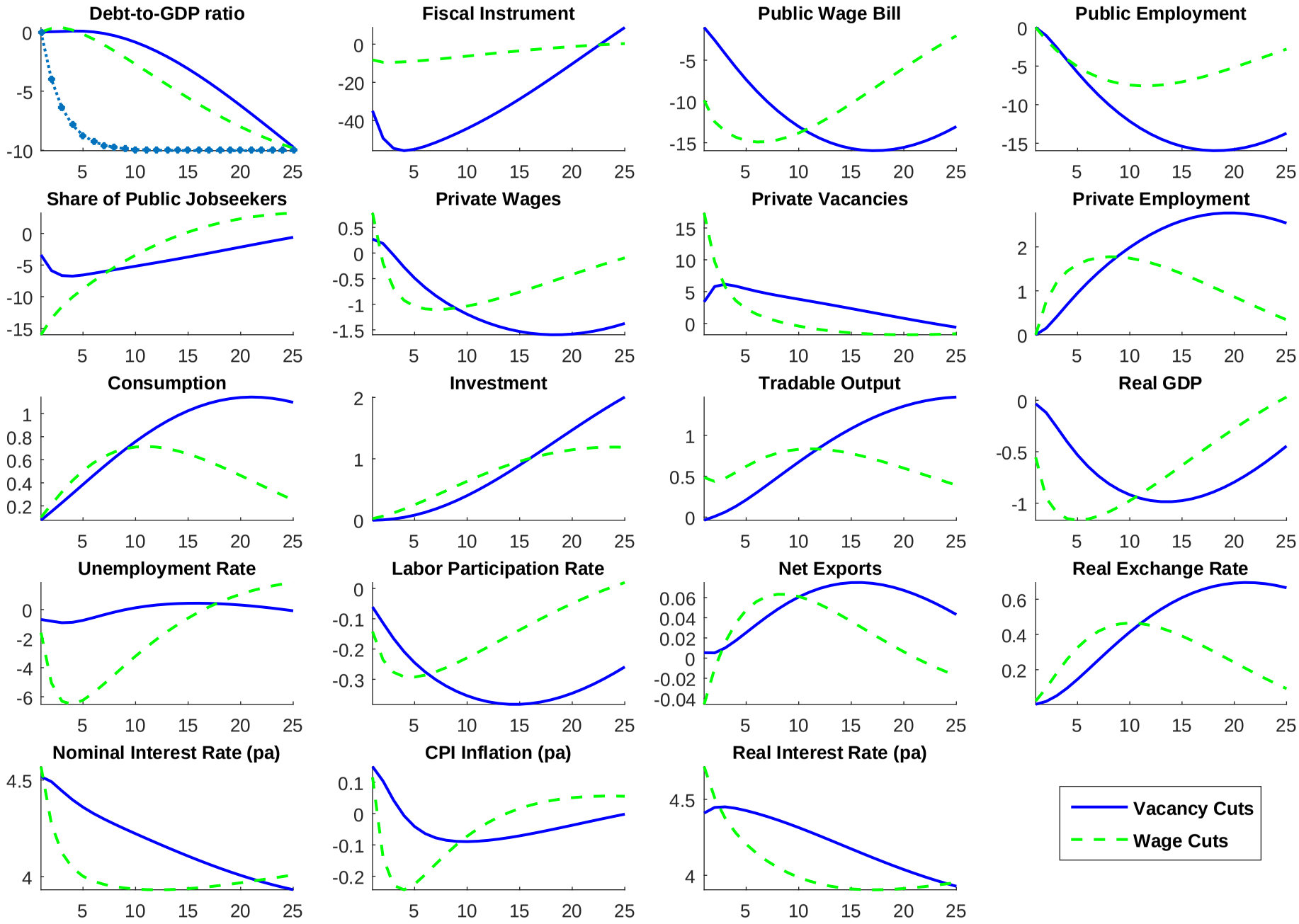


Figure 3: Normal Times: Public Vacancy Cuts vs. Public Wage Cuts

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.

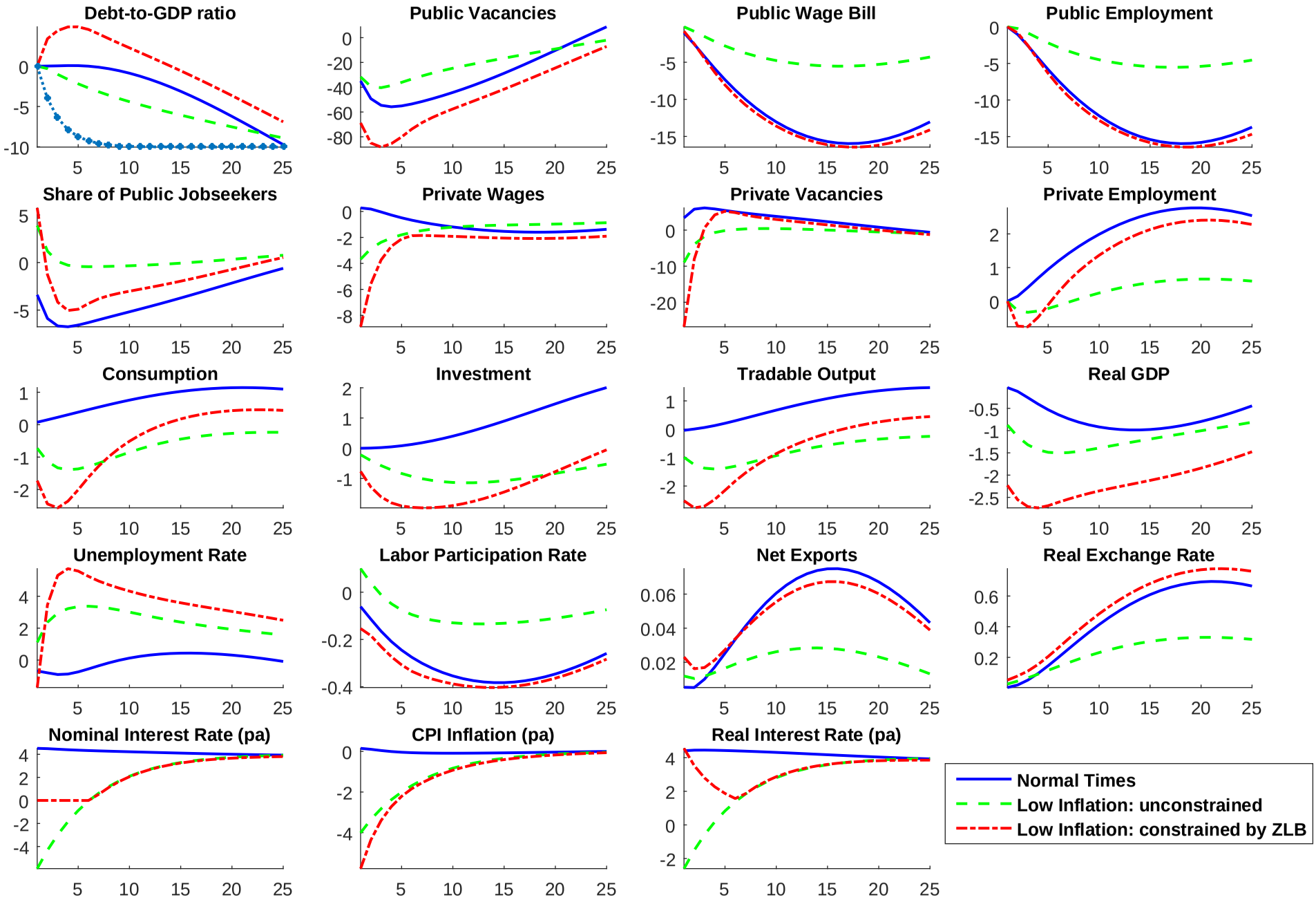


Figure 4: Normal Times vs. Low Inflation Environment: Public Vacancy Cuts

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.

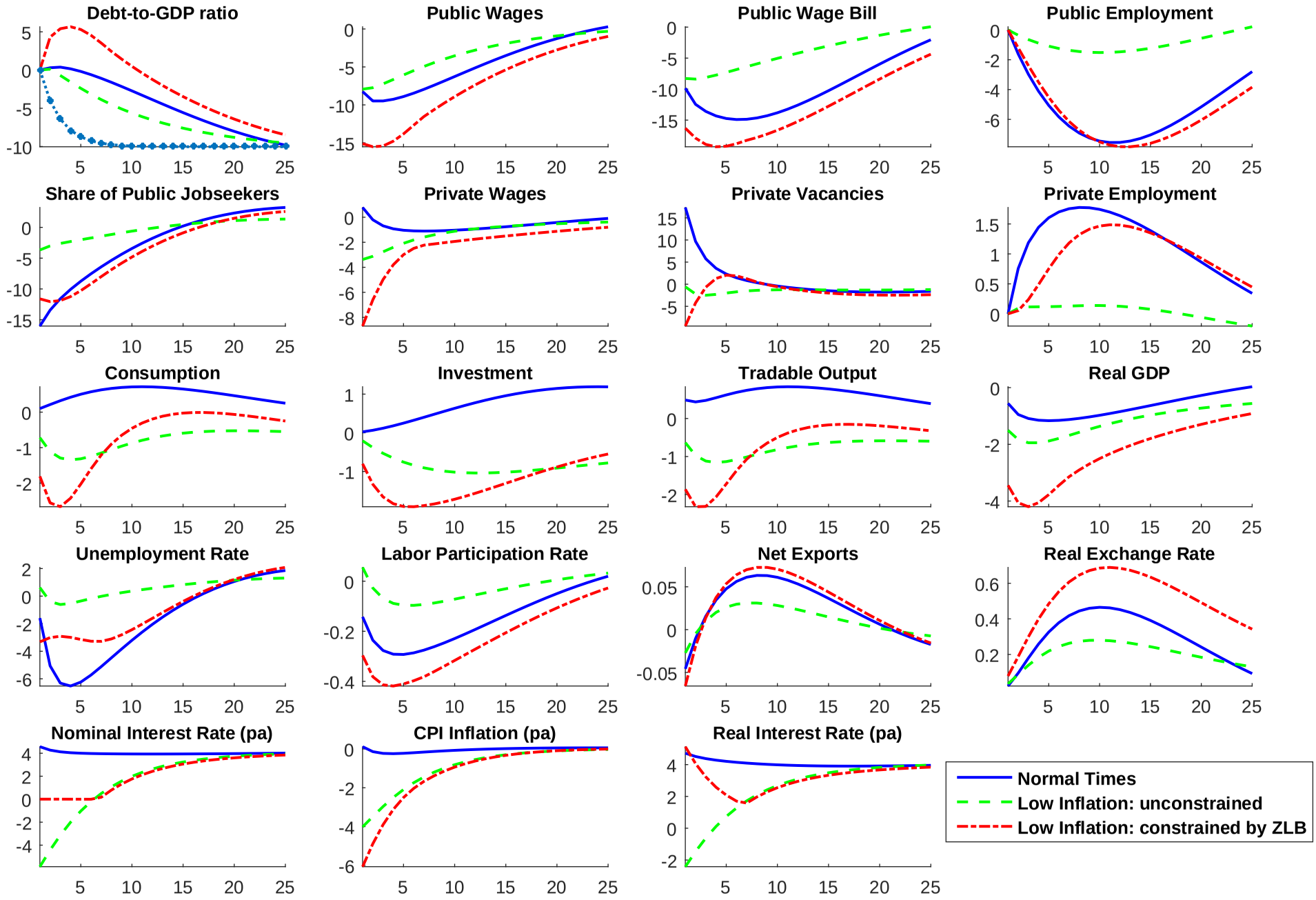


Figure 5: Normal Times vs. Low Inflation Environment: Public Wage Cuts

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.

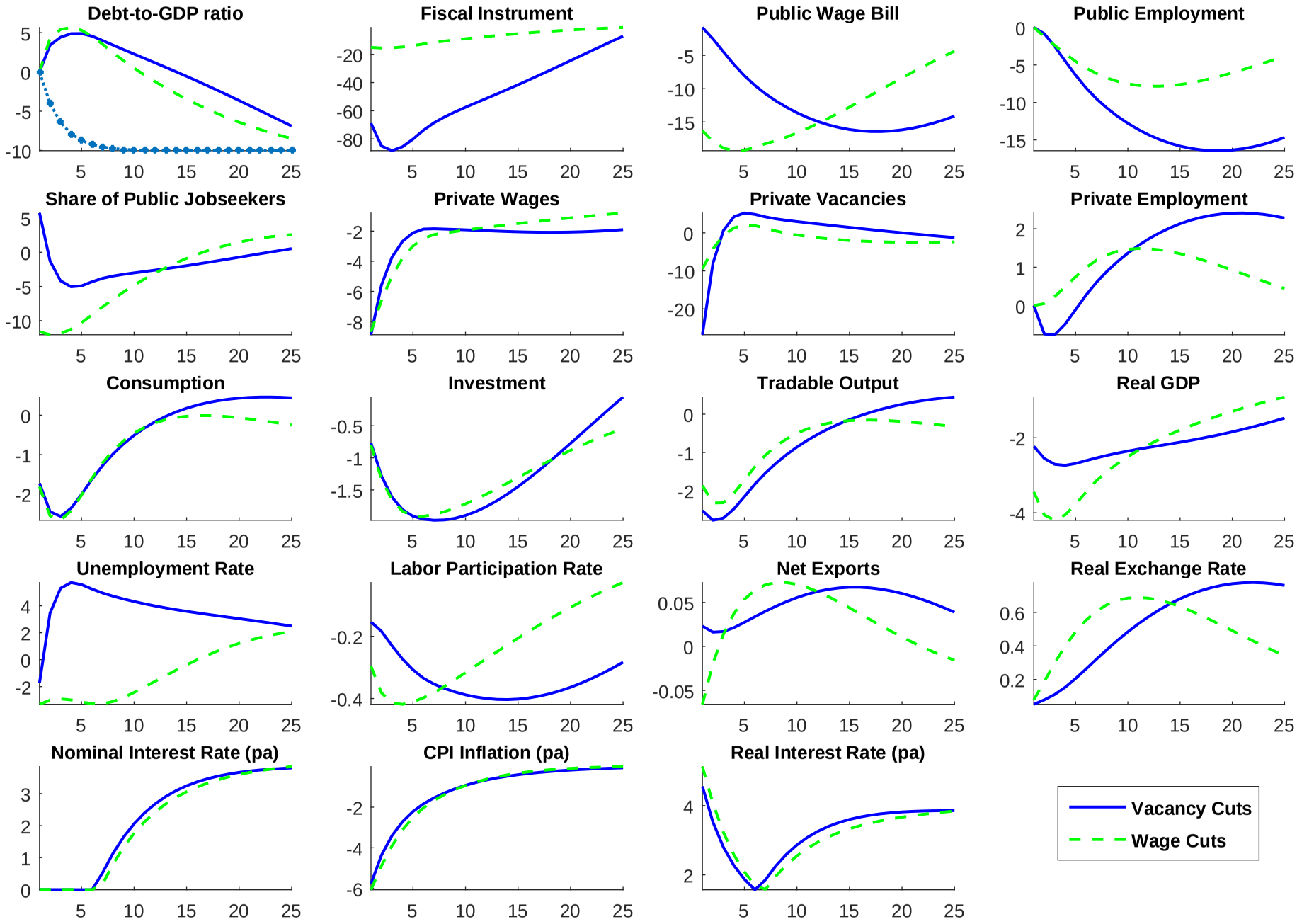
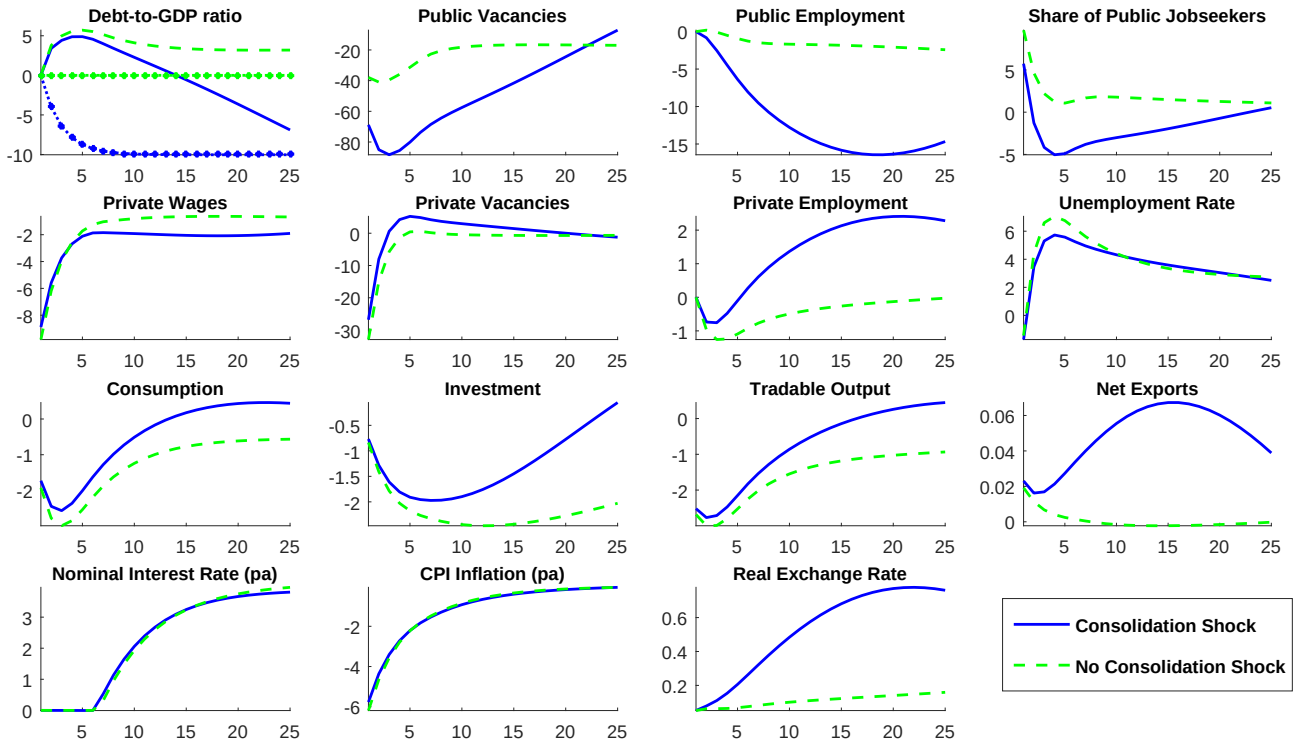
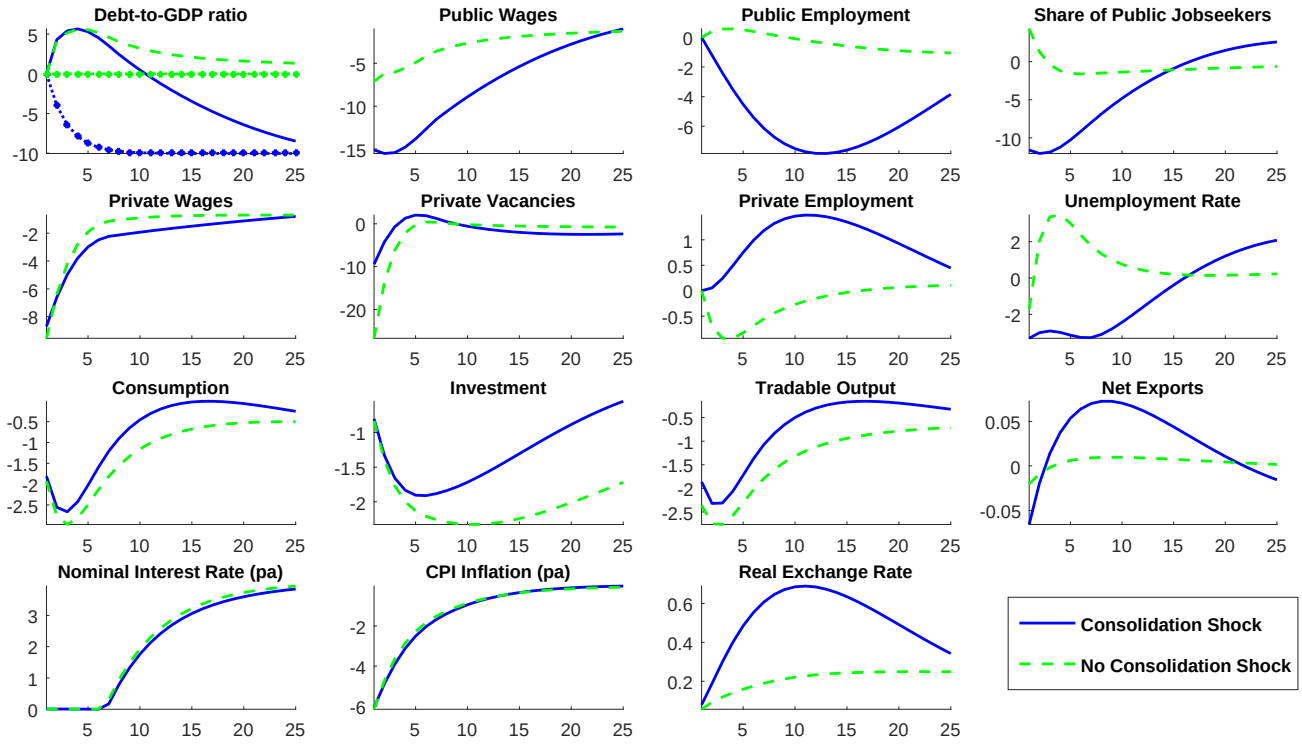


Figure 6: Low Inflation Environment: Public Vacancy Cuts vs. Public Wage Cuts

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.



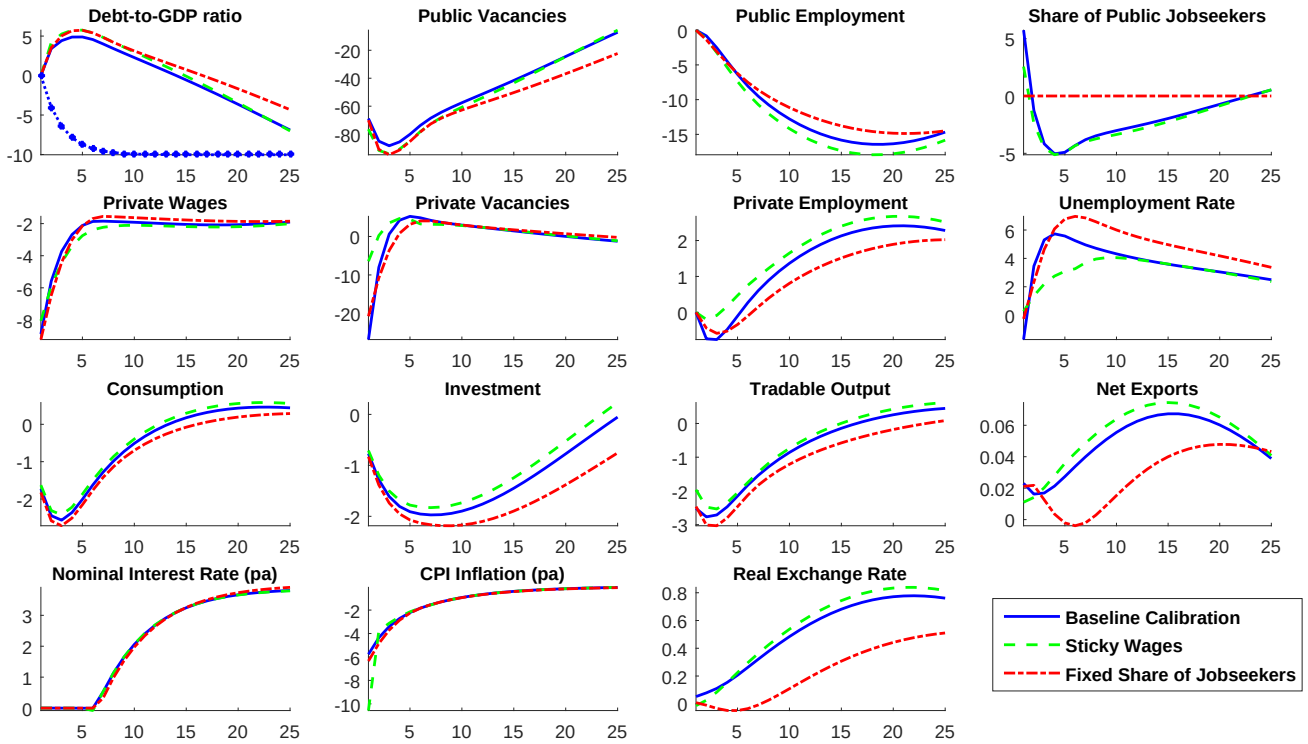
(a) Public Vacancy Cuts



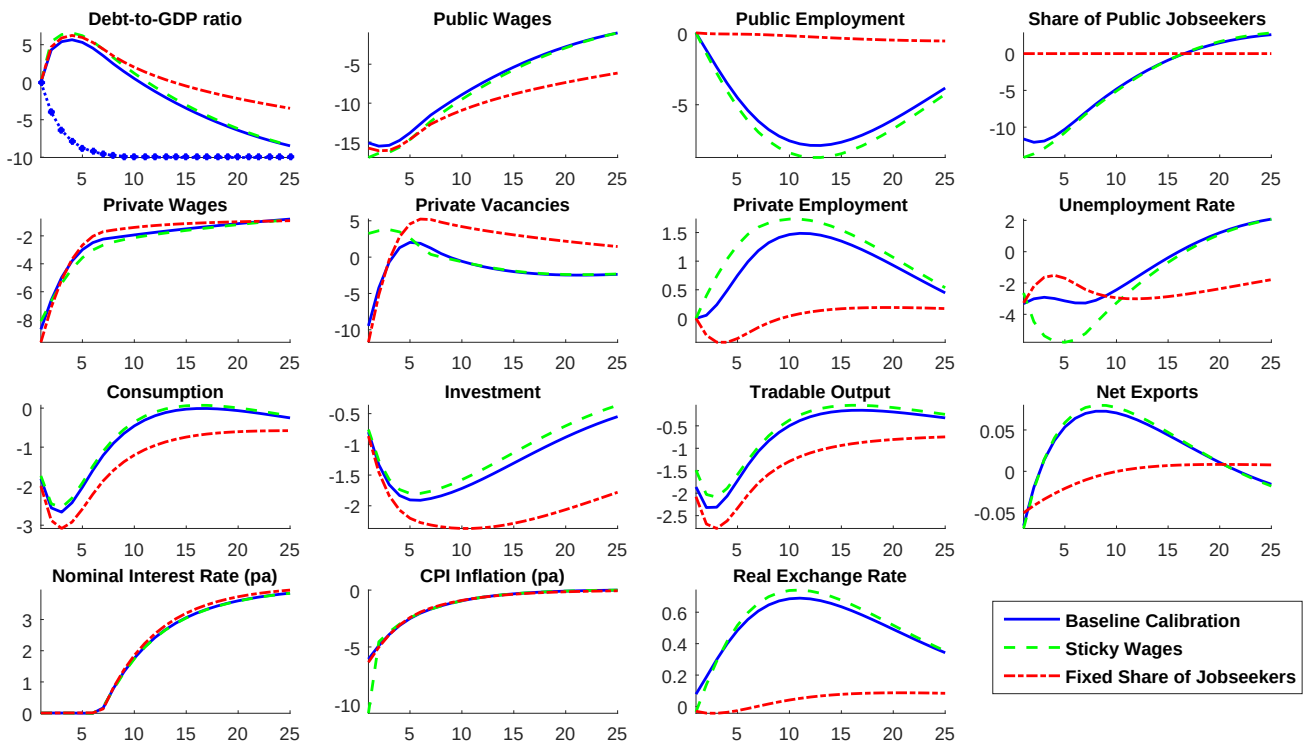
(b) Public Wage Cuts

Figure 7: The Role of Consolidation at the Zero Lower Bound

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.



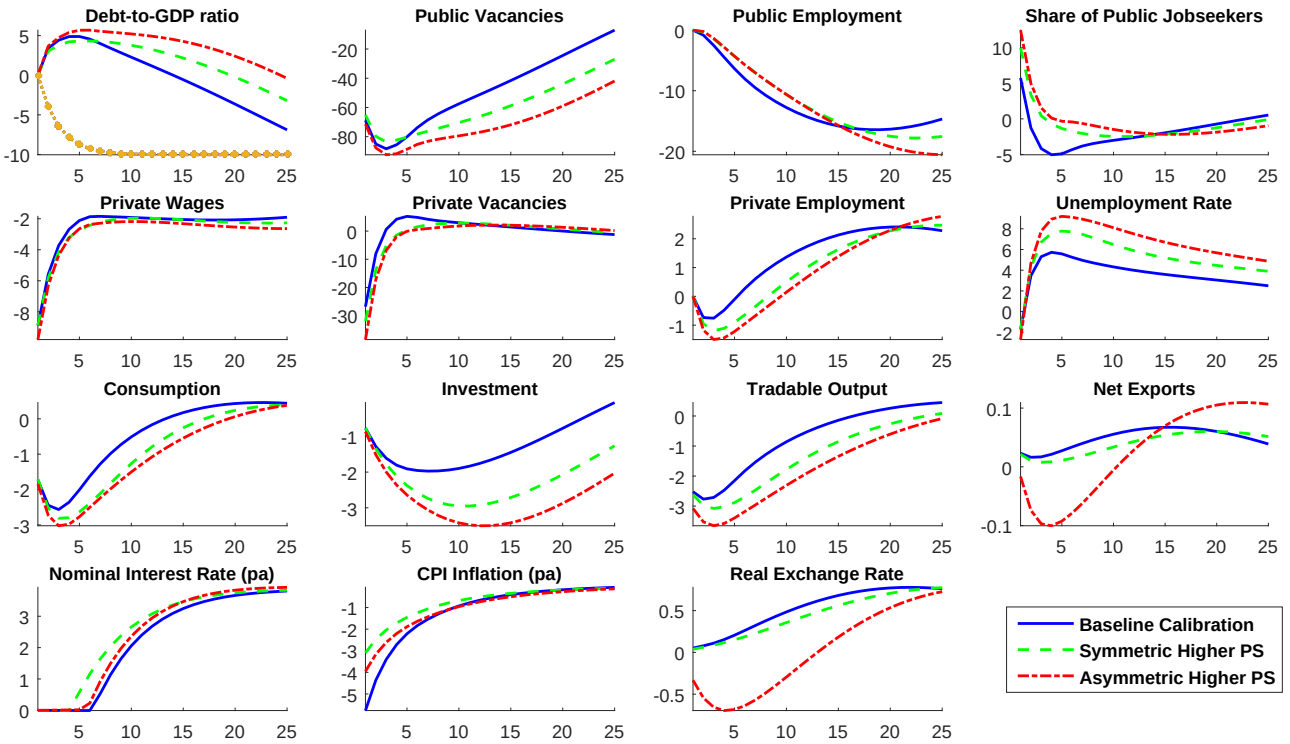
(a) Public Vacancy Cuts



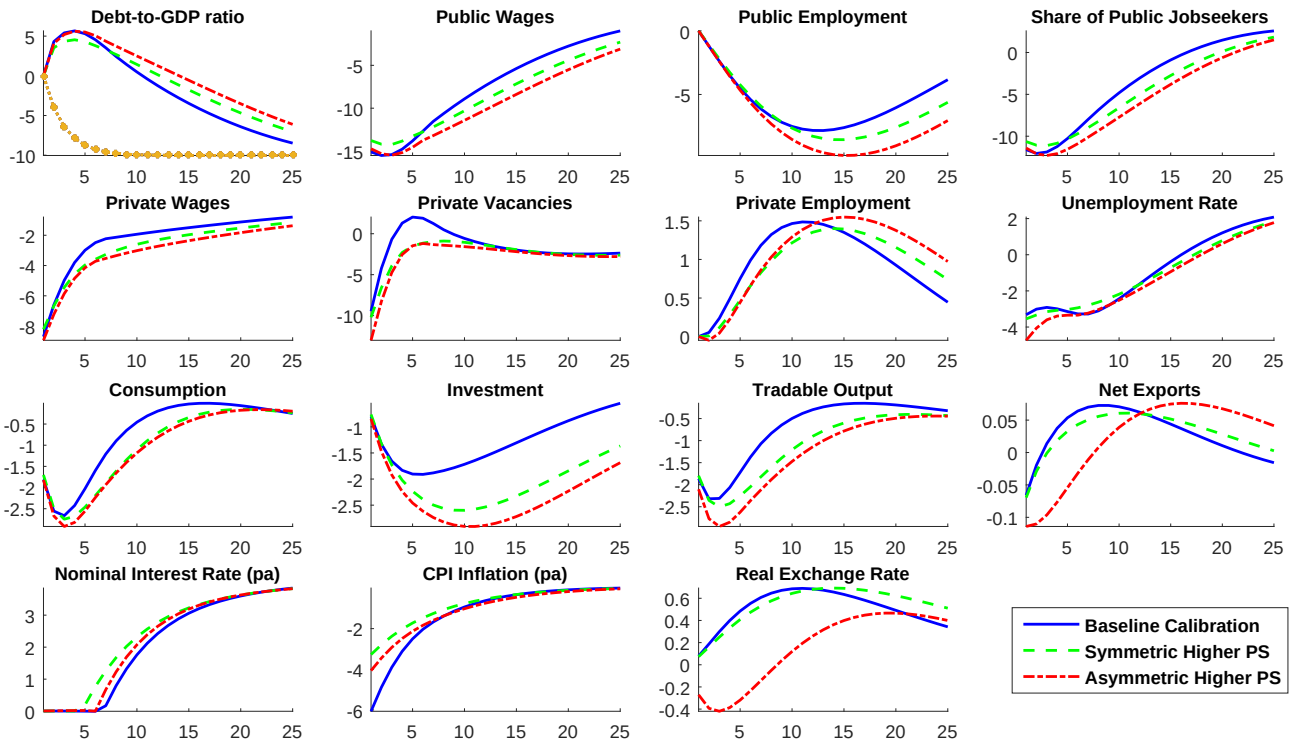
(b) Public Wage Cuts

Figure 8: Labor Market Rigidities at the Zero Lower Bound

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.



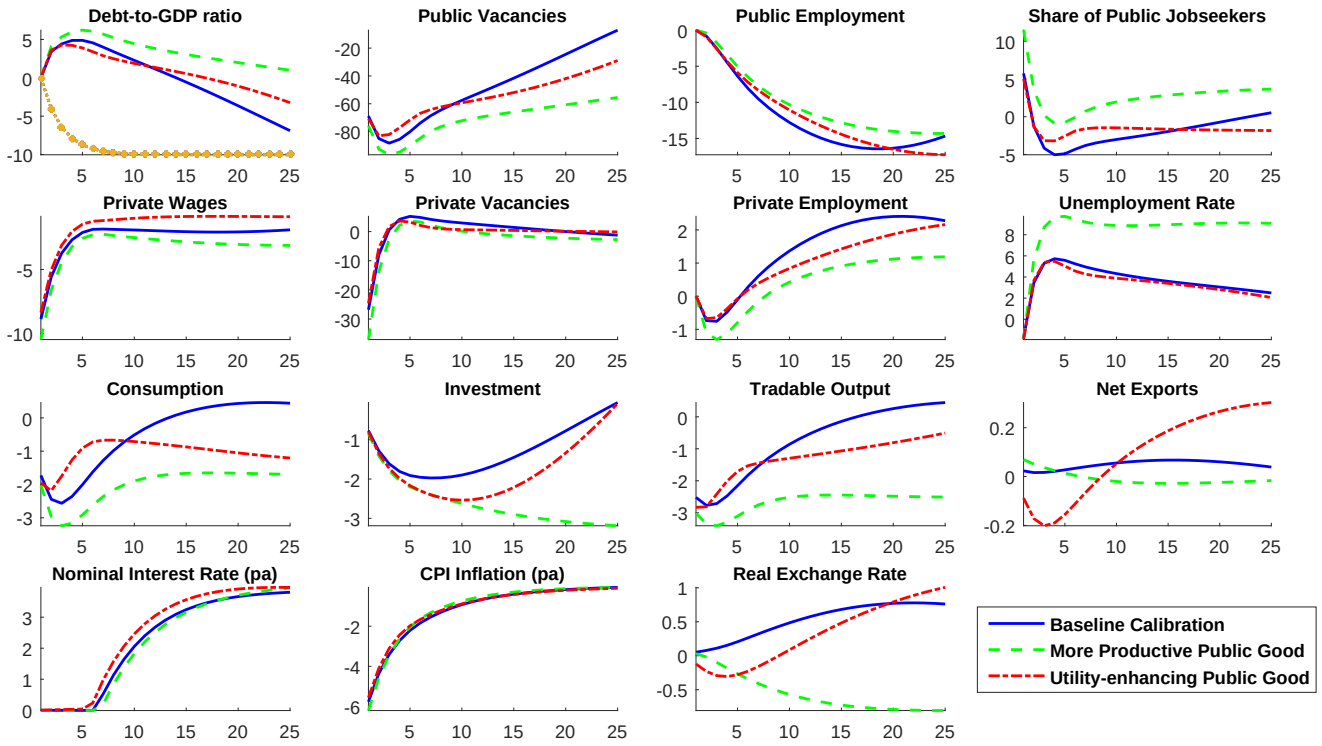
(a) Public Vacancy Cuts



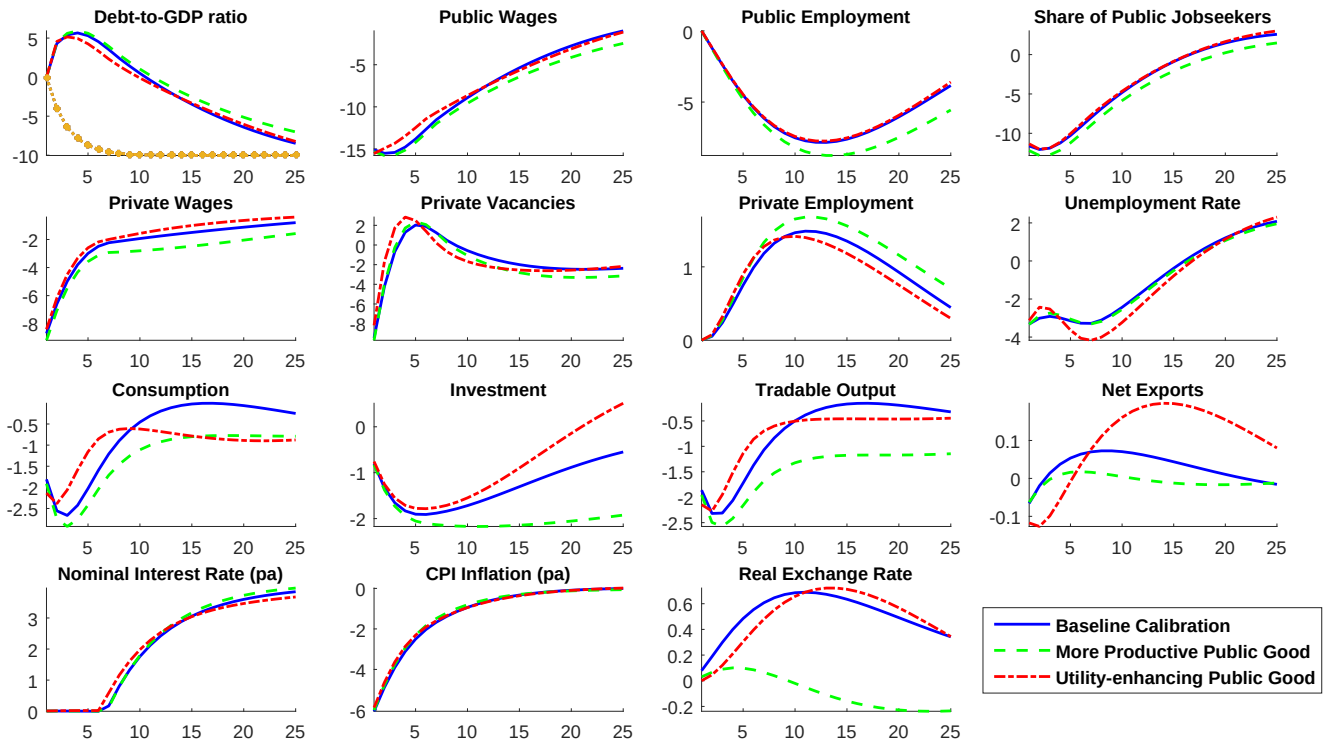
(b) Public Wage Cuts

Figure 9: Higher Price Stickiness (PS) at the Zero Lower Bound

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.



(a) Public Vacancy Cuts



(b) Public Wage Cuts

Figure 10: The Role of the Public Good at the Zero Lower Bound

Responses are in percent deviations from steady state, except for interest rates and inflation, which are in annualized levels, the share of public jobseekers, which is in percentage point deviation from steady state, and net exports, which are in levels.