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Abstract

In this paper, we study the aggregate and distributional implications of a smaller public sector in the euro area. By a smaller public sector, we mean a reduction in public debt and/or cuts in public spending, when such changes in fiscal policy are accommodated by adjustment in various taxes. Aggregate implications have to do with per capita output and welfare, while distribution refers to differences in income and welfare between private and public sector employees. We solve the model numerically using fiscal data from the euro area and then do a number of policy experiments. The general message is that the issue is not just a smaller public sector, but also the spending-tax mix chosen.

JEL-Code: H100, H300, H200.

Keywords: size of public sector, debt consolidation, taxation, reforms.

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1. Introduction

Given the sharp rise in public debt in most countries after the financial and economic crisis in 2008-09, there are calls for extra fiscal consolidation measures.[1] The latter are believed to be necessary because just improving the efficiency of the tax system, or waiting for growth to cyclically improve the debt dynamics, seems to be not enough. It is also believed that, especially in a period of protracted recession, consolidation measures should give a larger weight to spending cuts as opposed to tax increases.[2] Thus, although this is not always explicitly admitted, lower public spending seems inevitable.

In light of the above, in this paper, we study the aggregate and distributional implications of a smaller public sector. By a smaller public sector, we mean a reduction in public debt and/or cuts in public spending, when such changes in fiscal policy are accommodated by adjustment in various taxes. Aggregate implications have to do with per capita output and welfare, while distribution refers to differences in income and welfare between private and public employees. We choose to distinguish between private and public sector employees because the latter play a key role resisting most attempts to reform the public sector. It is thus important to look at the distributional implications of fiscal consolidation measures and, hopefully, find Pareto-improving ones. It is also important to find measures that reduce debt but do not endanger a macro recovery, at least in the medium- and long-run.

To study the above issues, we build a micro-founded dynamic general equilibrium model with two distinct groups of households: those that work in the private sector and those that are employed in the public sector. The latter (called public employees), together with goods purchased from the private sector, are used as inputs in the government production function (for similar models see e.g. Finn, 1998, Cavallo, 2005, Ardagna, 2007, Pappa, 2009, and Economides et al., 2011). We solve the model numerically using fiscal data from the euro area. Then, departing from this status quo equilibrium, we study a number of changes in fiscal policy, where the focus is on the aggregate and distributional implications of cuts in (various categories of) public spending and a declining share of public debt, and how these implications

[1] Fiscal consolidation means improvements in the budget balance through changes in fiscal policy.
[2] See European Commission (2011) for the current fiscal situation in Europe and fiscal consolidation measures taken.

depend on the public financing policy instrument. By public financing, we mean the tax instrument that adjusts to accommodate the exogenous changes in fiscal policy. We believe that these reforms can capture some of the main proposals currently under discussion in policy circles.

When we compare lifetime utility under the status quo to lifetime utilities under various fiscal reforms, our main results are as follows.

First, there is a policy mix that is Pareto superior to the status quo. In particular, both the aggregate economy and each social group can benefit relative to the status quo, if simultaneously: (a) we permanently reduce all categories of public spending as shares of output by 1%; (b) we gradually reduce public debt at 60% within a period of 10 to 15 years; and (c) we use the capital tax rate as the public financing instrument that accommodates these exogenous changes in fiscal policy. The latter means that capital tax rates increase in the short run during the debt consolidation phase but are reduced later on thanks to reduced spending and debt burden.

Second, although the above policy mix is Pareto superior relative to the status quo, there is a conflict of interests between private and public employees when we compare alternative reform mixes. In particular, concerning the aggregate economy and private employees, the above mix - that includes a permanent reduction in public spending - is better than a mix that is based on debt consolidation only. This happens because taxes need to rise by less when we both cut public spending and reduce debt relative to the case where we reduce debt only. Hence, the recessionary effects of debt consolidation become milder when we also cut spending at the same time. On the other hand, public employees would prefer debt consolidation only, since a cut in public spending hurts their wages directly. All this holds irrespectively of which tax rate is used to stabilize public debt over time.

Third, although the above mix is Pareto superior to the status quo during life time, it comes at a cost in the short-run. In particular, even if public spending is also cut permanently, reaction to debt imbalances necessitates higher taxes in the first 10-15 years of debt consolidation, which hits the real economy. As a result, the consumption of both private and public sector employees (especially, of the latter) fall during the debt consolidation phase. Thus, there will be no support for a smaller public sector if agents are short-sighted, and this applies even to private agents. Again

all this holds in all cases irrespectively of the tax instrument used to react to public debt imbalances over time.

Fourth, other things equal, it is better to use capital taxes rather than labour or consumption taxes to accommodate fiscal consolidation measures. This happens because when we use the capital tax rate to react to public debt imbalances in the short run, this works like an implicit tax or a capital levy on existing wealth. At the same time, public debt stabilization in the short run is translated into a reduced fiscal burden and expectations of lower capital taxes in the future, which in turn can stimulate investment. In other words, the standard capital levy mechanism of Judd (1985) and Chamley (1986) is important to both the efficiency and the long-run welfare gains from a smaller public sector (see also Altig et al., 2001, for the US).

Thus, the general message is that the issue is not just a smaller public sector (in the form of a lower debt burden, lower public spending, or both), but also the spending-tax mix. The benefits of a smaller public sector are higher, or the costs are lower, when they are used to finance a reduction in capital taxes in the medium- and long-run. The latter generates strong supply-side effects that strengthen the beneficial effects, or mitigate the adverse effects, of spending cuts.

Our work is related to several branches of the literature. First, it is related to the literature on debt consolidation (see e.g. Coenen et al., 2008, Forni et al., 2010, European Commission, 2010 and 2011, Papageorgiou, 2012, and Bi et al., 2012). This literature focuses on the best possible mix of spending cuts and tax rises. Here, instead, we take a smaller public sector as given, and study its aggregate and distributional implications. Second, our work is related to the more general literature on fiscal policy reforms. For instance, there is a rich literature on the implications of changes in the tax mix given spending (see e.g. Lucas, 1990, Cooley and Hansen, 1992, McGrattan, 1994, Altig et al., 2001, and House and Shapiro, 2006, for the US, and Angelopoulos et al., 2012, for the UK). Here, we focus on a smaller size of the public sector and the choice of the public financing instrument. Economides et al. (2011) study a different type of public sector reform, namely, the delegation of public good provision to private providers, while Economides and Philippopoulos (2012) study the implications of replacing consumption taxes with user prices.

The rest of the paper is organized as follows. Section 2 presents the model economy. Section 3 presents the status quo solution. Section 4 studies various reforms. Section 5 closes the paper.

2. The model economy

The model used is the "status quo" model in Economides et al. (2011). Consider a two-sector general equilibrium model in which private firms choose capital and labour supplied by private employees to produce a private good, while the government purchases part of the private good produced and hires public employees to produce a public good. The public good provides utility-enhancing services to all households. The private good is converted into the public good by a production function so that each is expressed in the same units. In order to finance total public spending, the government levies distorting taxes and issues bonds. Time is discrete and infinite.

The population size at time t, N_t, is exogenous. Among N_t, there are $p = 1, 2, ..., N_t^p$ identical households that work in the private sector and $b = 1, 2, ..., N_t^b$ identical households that work in the public sector, where $N_t^p + N_t^b = N_t$. There are also $f = 1, 2, ..., N_t^f$ identical private firms. Each household employed in the private sector owns one private firm. The fraction of public employees in population, $v_t^b \equiv \frac{N_t^b}{N_t}$, is exogenously set by the government.

2.1 Households working in the private sector

The lifetime utility of each household working in the private sector, $p = 1, 2, ..., N_t^p$, is:

$$\sum_{t=0}^{\infty} \beta^t u(c_t^p, e_t^p, \bar{Y}_t^g) \qquad (1)$$

where c_t^p and e_t^p are p's consumption and work hours respectively, $\bar{Y}_t^g$ is per capita public goods and services and $0<\beta<1$ is a time preference parameter. For our numerical solutions below, we use a period utility function of the form:

$$u(c_t^p, u_t^p, \bar{Y}_t^g) = \log(c_t^p + \psi \bar{Y}_t^g) - \mu \frac{(e_t^p)^{1+\xi}}{1+\xi} \tag{2}$$

where ψ, μ, ξ are preference parameters. Thus, $c_t^p + \psi \bar{Y}_t^g$ is composite consumption, where public goods and services influence private utility through the parameter ψ.

Each p enters period t with predetermined holdings of physical capital and government bonds, k_t^p and b_t^p, whose gross returns are r_t and ρ_t respectively. The within-period budget constraint of each p is:

$$(1+\tau_t^c)c_t^p + i_t^p + d_t^p = (1-\tau_t^k)(r_t\, k_t^p + \pi_t^p) + (1-\tau_t^l)w_t^p e_t^p + \rho_t b_t^p + \bar{G}_t^{tr,p} \tag{3a}$$

where i_t^p is savings in the form of physical capital, d_t^p is savings in the form of government bonds, π_t^p is dividends received from private firms, w_t^p is the wage rate in the private sector, $\bar{G}_t^{tr,p}$ is government transfers to each p and $0<\tau_t^k, \tau_t^l, \tau_t^c<1$ are tax rates on capital income, labor income and private consumption respectively.

The laws of motion of physical capital and government bonds for each p are:

$$k_{t+1}^p = (1-\delta)k_t^p + i_t^p - \frac{\varphi^{p,k}}{2}\left(\frac{k_t^p}{\bar{Y}_t}\right)^2 \tag{3b}$$

$$b_{t+1}^p = b_t^p + d_t^p - \frac{\varphi^{p,b}}{2}\left(\frac{b_t^p}{\bar{Y}_t}\right)^2 \tag{3c}$$

where $0<\delta<1$ is the capital depreciation rate, $\varphi^{p,k}, \varphi^{p,b} \geq 0$ capture the transaction costs paid by each p associated with participation in the capital and bond market respectively and $\bar{Y}_t$ denotes per capita output (see below). Regarding transaction

costs, similar quadratic cost functions have been used by e.g. Persson and Tabellini (1992).[3]

Each p chooses $\{c_t^p, k_{t+1}^p, b_{t+1}^p, e_t^p\}_{t=0}^{\infty}$ taking factor prices, economy-wide quantities and policy variables as given.

2.2 Households working in the public sector (public employees)

Public employees are modeled similarly to private employees. Thus, the lifetime utility of each household working in the public sector, $b = 1, 2, ..., N_t^b$, is:

$$\sum_{t=0}^{\infty} \beta^t u(c_t^b, e_t^b, \bar{Y}_t^g) \tag{4}$$

where

$$u(c_t^b, u_t^b, \bar{Y}_t^g) = \log(c_t^b + \psi \bar{Y}_t^g) - \mu \frac{(e_t^b)^{1+\xi}}{1+\xi} \tag{5}$$

The within-period budget constraint of each b is:

$$(1+\tau_t^c)c_t^b + i_t^b + d_t^b = (1-\tau_t^k) r_t k_t^b + (1-\tau_t^l) w_t^g e_t^b + \rho_t b_t^b + \bar{G}_t^{tr,b} \tag{6a}$$

where w_t^g is the wage rate in the public sector and $\bar{G}_t^{tr,b}$ is government transfers to each b.

The laws of motion of physical capital and government bonds for each b are:

$$k_{t+1}^b = (1-\delta)k_t^b + i_t^b - \frac{\varphi^{b,k}}{2}\left(\frac{k_t^b}{\bar{Y}_t}\right)^2 \tag{6b}$$

$$b_{t+1}^b = b_t^b + d_t^b - \frac{\varphi^{b,b}}{2}\left(\frac{b_t^b}{\bar{Y}_t}\right)^2 \tag{6c}$$

[3] These transaction costs help us to: (a) avoid unit root problems in the transition path and (b) get a well-defined solution for the portfolio share of each agent in the long run.

where $\varphi^{b,k}, \varphi^{b,b} \geq 0$ capture the transaction costs paid by each b associated with participation in the capital and bond market respectively.

Each b chooses $\{c_t^b, k_{t+1}^b, b_{t+1}^b, e_t^b\}_{t=0}^{\infty}$ taking factor prices, economy-wide quantities and policy variables as given.

2.3 Private firms producing the private good

In each period, each private firm $f = 1, 2, ..., N_t^f$ chooses capital and labor inputs, k_t^f and e_t^f, to maximize profits:

$$\pi_t^f = y_t^f - r_t\, k_t^f - w_t^p e_t^f \tag{7}$$

where, for our numerical solutions below, we use a production function of the form:

$$y_t^f = A(k_t^f)^{\alpha}(e_t^f)^{1-\alpha} \tag{8}$$

where $A > 0$ and $0 < \alpha < 1$ are technology parameters.

In each period, each f chooses k_t^f and e_t^f taking factor prices as given.

2.4 Public sector

We now present the public sector. We start with the government budget constraint and then specify the production function of public goods and services.

2.4.1 Government budget constraint

The period budget constraint of the government is (quantities are in aggregate terms are denoted by capital-letters):

$$G_t^g + G_t^w + G_t^{tr,p} + G_t^{tr,b} + (1+\rho_t)B_t = B_{t+1} + T_t \tag{9a}$$

where G_t^g is total public spending on goods and services purchased from the private sector; G_t^w is the total public wage bill; $G_t^{tr,p}$ and $G_t^{tr,b}$ are respectively transfers to

private and public employees; B_t is the beginning-of-period total stock of government bonds; and T_t denotes total tax revenues defined as:

$$T_t \equiv \tau_t^c (N_t^p c_t^p + N_t^b c_t^b) + \tau_t^k [N_t^p (r_t k_t^p + \pi_t^p) + N_t^b r_t k_t^b] + \tau_t^l (N_t^p w_t^p e_t^p + N_t^b w_t^g e_t^b) \qquad (9b)$$

Thus, as in Alesina et al. (2002), we include the three main types of government spending (purchases of goods and services from the private sector, public wages, and transfers to individuals). We also include the three main types of taxes (taxes on consumption, capital income and labor income).

Inspection of (9a-b) implies that, in each time period, there are nine policy instruments ($G_t^g, G_t^w, G_t^{tr,p}, G_t^{tr,b}$, $\tau_t^c, \tau_t^k, \tau_t^l$, B_{t+1}, N_t^b) out of which one needs to adjust to satisfy the government budget constraint. The choice of the adjusting public financing policy instrument is of key importance (see below). Following most of the related literature, we start by assuming that the adjusting instrument is the end-of-period total public debt, B_{t+1}, so that the other eight policy instruments can be set exogenously by the government.

For convenience, concerning spending policy instruments, we will work in terms of their GDP shares, $s_t^g \equiv \frac{G_t^g}{Y_t}$, $s_t^w \equiv \frac{G_t^w}{Y_t}$, $s_t^{tr,p} \equiv \frac{G_t^{tr,p}}{Y_t}$, $s_t^{tr,b} \equiv \frac{G_t^{tr,b}}{Y_t}$, where Y_t denotes total output (defined below). Similarly, concerning the number of public employees, we will work in terms of their population share, $v_t^b \equiv \frac{N_t^b}{N_t}$.

2.4.2 Production function of public goods and services

Following most of the related literature, we assume that total public goods and services, Y_t^g, are produced using goods purchased from the private sector, G_t^g, and public employment, L_t^g (where, in equilibrium, $L_t^g = N_t^b e_t^b$). In particular, following e.g. Linnemann (2009), for our numerical solutions, we use a Cobb-Douglas production function of the form:

$$Y_t^g = A(G_t^g)^\theta (L_t^g)^{1-\theta} \qquad (10)$$

where $0 \le \theta \le 1$ is a technology parameter. Notice that our modeling can nest most of the specifications used in the literature.[4] Also notice that both private and public good production face the same TFP; this is because we do not want our results to be driven by exogenous factors.

2.5 Decentralized competitive equilibrium (DCE) for any feasible policy

Combining the above, we now solve for a DCE for any feasible fiscal policy. In this DCE: (i) all households maximize utility acting competitively, (ii) all firms in the private sector maximize profits acting competitively, (iii) all markets clear and (iv) all constraints are satisfied. As we show in the Appendix, the DCE is summarized by 14 equilibrium equations. When $\{s_t^g, s_t^w, s_t^{tr,p}, s_t^{tr,b}, \tau_t^c, \tau_t^k, \tau_t^l, v_t^b\}_{t=0}^{\infty}$ are set by the government, the 14 endogenous variables are $\{c_t^p, c_t^b, k_{t+1}^p, k_{t+1}^b, b_{t+1}^p, b_{t+1}^b, e_t^p, e_t^b, \rho_t, y_t^f, \overline{Y}_t^g, r_t, w_t, w_t^g\}_{t=0}^{\infty}$.

To close the model, we need to specify the exogenously set policy instruments. Denoting them as $x_t \equiv (s_t^g, s_t^w, s_t^{tr,p}, s_t^{tr,b}, \tau_t^c, \tau_t^k, \tau_t^l, v_t^b)$, we will allow some of the policy instruments to respond systematically to debt imbalances (see also e.g. Forni et al., 2010, and many others, while a review of the literature on fiscal reaction functions can be found in European Commission, 2011). Thus, in general, we have:

$$x_t = x^{1-\rho^x} x_{t-1}^{\rho^x} \left(\frac{B_t / Y_t}{B / Y} \right)^{\gamma^x} \tag{11}$$

where x is the long-run value of the policy instrument, B_t / Y_t, is the beginning-of-period public debt-to-output ratio, B/Y is its long-run value,[5] $0 \le \rho^x \le 1$ is an autoregressive parameter and γ^x is a feedback policy coefficient, which is positive if the policy instrument describes a tax rate and negative if the policy instrument describes public spending. Further details for each tax-spending policy instrument are provided below.[6]

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[4] For details and comparison to the literature, see Economides et al. (2011). Our qualitative results are not affected by the functional form used.

[5] When we study the transition to a reformed economy, these long-run values will be the reformed or targeted values, not the ones in the data; the latter will be the pre-reform or departing values. See below.

[6] The fraction of public employees, v_t^b, will be kept constant at its average value in the data.

3. Parameterization, data and the status quo solution

We present parameterization and then the long-run solution of the model economy above.

3.1 Parameter values and policy instruments

Table 1 reports the baseline parameter values for technology and preference, as well as the values of the exogenously set policy instruments, used to solve the model economy developed in section 2. The time unit is meant to be a year. Regarding parameters for technology and preference, we use relatively standard values used by the business cycle literature. Regarding fiscal policy variables, we use data averages of the Eurozone.

Table 1 around here

Let us briefly discuss the parameter and policy values summarized in Table 1. The labour share in the private production function, $1-\alpha$, is set at 0.601. The scale parameter in the technology function, A, is set at 1. The time preference rate, β, is set at 0.96. The weight given to public goods and services in composite consumption, ψ, is set at 0.1, as is usually the case in similar studies. The other preference parameters related to hours of work, μ and ξ, are calibrated at 5 and 1 respectively; these parameter values imply hours of work within usual ranges. The capital depreciation rate, δ, is set at 0.05. The transaction cost parameter associated with participation in asset markets is set at $\varphi^{p,k} = \varphi^{p,b} = \varphi^{b,k} = \varphi^{b,b} = 0.002$ across both agents and both assets. We report that our results are robust to changes in these parameter values.

In the baseline parameterization, the productivity of public employment vis-à-vis the productivity of goods purchased from the private sector, in the public sector production function, $1-\theta$, is set at 0.465. This value is the sample average of public wage payments, as share of total public spending on inputs used in the production of public goods (see also e.g. Linnemann, 2009, and Economides et al., 2011).

Public employees as a share of total population, ν^b, are set at 0.1602, which is the average data in the Eurozone over 1990-2008. The output shares of public spending on wage payments, s_t^w, and on goods and services purchased from the private sector, s_t^g, are respectively 0.1067 and 0.1224, again as implied by the data over the same period as above.[7] The effective tax rates on consumption, capital and labor, τ_t^c, τ_t^k and τ_t^l, are respectively 0.1936, 0.2882 and 0.3882, as in the average data for the euro zone over 1995-2008.[8]

Total government transfers as a share of output, s_t^{tr}, are allowed to follow residually in the long run of the status quo economy so as to match the spending-tax data above and a public debt-to-output ratio, B/Y, at 0.8; the latter is the average value in the data over the sample period. Regarding the allocation of total government transfers between the two population groups, we assume that they are allocated between private and public sector employees so as to match the observed in the data wage premium of public vis-à-vis private employees. According to recent empirical studies (see e.g. Giordano et al., 2011, Holm-Hadula et al., 2010, and Lamo et al., 2008), this premium is considered to be on average around 10%. The same value has also been used by Ardagna (2007). As reported in Table 3 below, this 10% public wage premium, can happen when public employees enjoy a larger share of transfers than their fraction in population.

Concerning the autoregressive policy parameters, $0 \leq \rho^x < 1$, in the policy rules (11), their values depend on whether the particular policy instrument x reacts to debt imbalances along the transition to the long run, namely, whether γ^x is nonzero or zero. If a policy instrument reacts to debt imbalances along the transition (i.e. $\gamma^x \neq 0$), so there is also an endogenous feedback component in (11), our simulations imply that the value of ρ^x needs to be relatively small to get local determinacy. In that case, we simply choose to set it at zero (we report however that our results do not change if we assume a low positive value of persistence). If, on the other hand, a policy instrument does not react to debt imbalances (i.e. $\gamma^x = 0$), the value of ρ^x can

[7] The data on public employees and various categories of public spending are from OECD Economic Outlook, vol. 90, 2011, and cover the period 1990 to 2008.
[8] The data on effective tax rates are from the database of Eurostat and cover the period 1995 to 2008.

take any value between 0 and 1 without creating indeterminacy problems. In particular, in our policy experiments below, reaction to debt imbalances over time takes place through adjustments in tax rates (interestingly, a similar reaction to debt through adjustment in the output share of public spending creates indeterminacy problems). Hence, concerning tax rates, we set $\rho^x = 0$ in (11), while the value of the feedback policy coefficient, γ^x, is set so as to allow the reformed economy to approach the new long-run equilibrium public debt ratio within a period of 10-15 periods or years. Concerning public spending shares, we set $\gamma^x = 0$ in (11), while the value of ρ^x depends on the type of reform we study. In the case of immediate and permanent spending cuts, we set $\rho^x = 0$ in (11). In the case of gradual spending cuts, we choose to set $\rho^x = 0.6$. See below for further details.

3.2 The status quo, or benchmark, equilibrium

Given the parameter and policy values in Table 1, the steady state solution of the model economy, called status quo, is reported in the first row of Table 3. Notice that the solution is well defined and the key ratios, like consumption and capital as shares of output, are close to their respective values in the data.

In what follows, departing from this status quo steady state solution, we study the implications of various exogenous changes in fiscal policy.

4. Fiscal policy reforms

We now study fiscal policy reforms. The aim is to study the aggregate and distributional implications of a smaller public sector.

4.1 Reforms studied

We find it convenient to work in two steps. The first step studies debt consolidation only. In particular, we reduce the output share of public debt at 0.60 at some point in time, say, in 10-15 periods after departing from the status quo (we choose the value of 0.60 simply because it has been the reference value of the initial Maastricht Treaty). In turn, in the second step, we examine the more interesting case in which the same reduction in public debt is combined with a reduction in public spending. In

particular, each category of public spending is exogenously reduced by 1 percentage point of GDP vis-à-vis its average value in the data. Recall that here we employ three categories of public spending, namely, spending on public wages, on goods purchased from the private sector and on government transfers. In other words, total public spending as a share of output is cut by 3 percentage points. Actually, we will study two ways of spending cuts: a case in which these cuts take place immediately and permanently (known as cold-turkey strategy), and a case in which they happen gradually over time.[9] Table 2 lists all policy reforms we study. As said above, in each reform studied, we depart from the same status quo long-run solution. Also, as said above, we do not allow public spending to react to debt imbalances over time because, in our model, this leads to indeterminacy problems.

Table 2 around here

As described in Table 2, we study five policy reforms. In Reform 1, the public debt to output ratio is gradually brought down to 60% (from 80% in the pre-reform status quo) along the transition to the new long run equilibrium. In Reforms 2 and 3, we study the same experiment as in Reform 1 but, in addition, we have spending cuts. The difference between Reform 2 and Reform 3 is that in the former spending cuts take place immediately, while in the latter they happen gradually over time. To get a clearer picture of what drives our results, we will also report results for the case in which only spending cuts take place, i.e. without debt consolidation. This is in Reforms 4 and 5. Again, the difference between Reform 4 and Reform 5 is that in the latter spending cuts take place gradually.

It is well recognized that the implications of exogenous fiscal changes like the above depend heavily on the public financing policy instrument used, namely, the policy instrument that adjusts endogenously to accommodate these exogenous changes in fiscal policy (see e.g. Leeper et al., 2010, and Leeper, 2010). Here we assume that, along the transition path, fiscal reforms are accommodated by adjustments in tax rates, namely, the tax rates on capital income, labour income and

[9] As said above, in the case of immediate and permanent spending cuts, $\rho^x = 0$ in (11). In the case of gradual spending cuts, we set $\rho^x = 0.6$. The long run values x is the same in both types of

private consumption. To understand the logic of our results, and following usual practice in related studies, we will experiment with one tax rate at a time. This means that, along the transition path, we allow one of the tax rates to react to public debt imbalances, so as to stabilize debt around its target rate of 0.60 in 10-15 time periods (or within a 10 to 15 years period), and that, in the new reformed long run, the same tax rate follows residually to close the government budget; all other tax rates, except the one used for debt stabilization, are set as in the data averages. This implies that, when used for debt stabilization, the feedback policy coefficients, γ^x, corresponding to labour, capital and consumption taxes are set at 1.1, 1.3 and 1.2 respectively.

4.2 How we work

We work as follows. We first solve and compare long-run equilibria with and without reforms. We then check that, when log-linearized around its steady state solution, each model economy studied is saddle-path stable. This is for each type of reform and each method of public financing. In turn, setting, as initial conditions for the state variables, their steady state solution of the status quo economy, we compute the equilibrium transition path of each reformed economy and in turn calculate the associated discounted lifetime utilities of the two types of households as well as the resulting per capita lifetime utility. These utilities are finally compared to their associated values if we had remained in the status quo economy for ever. In other words, we work as in e.g. Lucas (1990), Cooley and Hansen (1992) and Mendoza and Tesar (1998). Recall that the model is deterministic so that the only source of transitional dynamics is that we depart from a pre reform steady state that differs from the new reformed one.

4.3 Long-run results

Table 3 presents the long-run solutions for the pre-reform status quo economy and all reformed economies. Notice that since reforms 2 and 3 on the one hand, and 4 and 5 on the other hand, differ only in the transition, their long-run solutions are identical. In each reform, we report results for each public financing case; thus, when the labor

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experiments and it is less by one percentage point relative to the data average. Recall that for spending rules, $\gamma^x = 0$, in all experiments.

tax rate, τ^l, or the capital tax rate, τ^k, or the consumption tax rate, τ^c, endogenously adjusts to satisfy the government budget constraint.[10]

Reform 1 (i.e. debt reduction) is trivial in the long run. This is because, if we focus on the long run only, a reduction in public debt is like a free lunch. Other things equal, such a reduction implies a lower debt burden which releases resources for other types of spending and/or allows tax cuts. Therefore, in the long run, we are interested in Reforms 2-5 that include cuts in public spending.

Table 3 around here

Inspection of the long-run results for Reforms 2-5 in Table 3 reveals the following. Households working in the private sector always benefit from a smaller public sector accompanied by lower taxes. This happens in all cases, irrespectively of how a smaller public sector is achieved (lower public spending, lower public debt, or a combination of both) and the tax instrument used to accommodate this fiscal consolidation. The same applies to the aggregate economy (see per capita values). That is, the "general public" always gains from a smaller public sector. Public employees, on the other hand, can benefit or lose depending on the form of fiscal consolidation and the public financing policy instrument used. Nevertheless, our solutions imply that there is a mix of policy changes that benefits public employees too and hence is Pareto superior to the status quo. In particular, a comparison of the long-run solution under the status quo to the long-run solutions under various fiscal reforms implies that an exogenous reduction in public debt at 60%, combined with an exogenous horizontal cut by 1% in all three categories of public spending, is Pareto superior to the status quo, if these reductions are compensated with an endogenous reduction in the capital tax rate.[11]

In other words, in the long run, a smaller public sector can be beneficial not only to the aggregate economy but also to each social group separately, to the extent that lower public spending (on the debt burden and the other categories of public spending) is used to finance lower capital taxes. The latter are particularly distorting

[10] Algebraically, we add one more equation, $B_t = \gamma_t Y_t$, or equivalently $v_t^p b_t^p + v_t^b b_t^b = \gamma_t v_t^p y_t^f$. Then, if γ_t is set exogenously in the long run, the extra endogenous variable is one of the three tax rates.

in the long run so that their reduction enhances aggregate efficiency and this proves to be good for both income groups (this is consistent with the normative results of Chamley, 1986, and especially Judd, 1985, for long-run capital taxation).

We report that we have experimented with changes in the parameter values and all the above are rather robust results.

4.4 Transition results

We next study what happens when we depart from the pre-reform economy, where fiscal policy variables are as in the data, and travel towards a new long-run according to the type of reform we perform. Now, in contrast to the long-run analysis above, debt consolidation is expected to be costly, since the reduction in the end-of-period debt over time requires higher taxes during the debt consolidation phase. As discussed above, during the transition, total public debt is modelled as an endogenous variable, while one of the tax rates reacts to deviations of debt from its target value of 0.6, with the associated feedback policy coefficient calibrated in such a way so as to bring down the end-of-period public debt from its 0.8 pre-reform value to its targeted 0.6 value within a period of 10 to 15 years.

Results for discounted lifetime utility of the two agents, denoted as U^p and U^b, as well as per capita discounted lifetime utility, denoted as U, are reported in Tables 4a, 4b and 4c. These three tables correspond to the case in which the policy instrument used for debt stabilization is the labor tax rate, the capital tax rate and the consumption tax rate respectively. To better understand the logic of our results, we also provide impulse response functions for the key macroeconomic variables in each reform studied. These are Figures 1a-e, 2a-e and 3a-e which correspond to the three tax rates used for debt stabilization.

Tables 4a, 4b and 4c around here

Figures 1a-e, 2a-e and 3a-e around here

Inspection of Tables 4a-c and Figures 1a-c reveals that, as it was the case in the long run, households working in the private sector, as well as the aggregate

[11] Actually, notice that this mix of reforms is not only Pareto superior but is also the most preferred one from the point of view of both groups of agents - see however below for lifetime utility.

economy, always benefit from a smaller public sector accompanied by lower taxes, while effects on the lifetime utility of households working in the public sector depends on the policy reform mix chosen. Nevertheless, there is a policy mix that is Pareto superior to the status quo and this policy mix is similar to the most preferred one in the long-run analysis above. In particular, both the aggregate economy and each social group can benefit relative to the status quo, if we permanently reduce all three categories of public spending by 1%, gradually reduce public debt at 60% within a period of 10 to 15 years, and use the capital tax rate as the public financing instrument that reacts to public debt imbalances over the transition to the new long run.

However, there are two problems associated with this policy mix. First, although the above policy mix is Pareto superior relative to the status quo, there is a conflict of interests between private and public employees when we compare alternative reform mixes. In particular, concerning the aggregate economy and private employees, the above mix - that includes a permanent reduction in public spending - is better than a mix that is based on debt consolidation only (this holds irrespectively of which tax rate is used to stabilize debt imbalances over time). This happens because taxes need to rise by less when we both cut public spending and reduce debt relative to the case where we reduce debt only. Hence, the recessionary effects of debt consolidation become milder when we also cut spending at the same time. On the other hand, public employees would prefer debt consolidation only, since a cut in public spending hurts their wages directly (again this holds irrespectively of which tax rate is used to stabilize debt over time).

Second, although the above mix is Pareto superior during life time, it comes at a cost in the short-run. In particular, even if public spending is also cut permanently, reaction to debt imbalances necessitates higher taxes in the first 10 years of debt consolidation, which hits the real economy. As a result, the consumption of both private and public employees (especially, of the latter) fall during the debt consolidation phase. Results for discounted utility in the first ten periods after the reform is enacted when the capital tax rate is the residual policy instrument are reported in Table 5, where we also report the related utility if we had remained in the status quo for ten periods.

Table 5 around here

Thus, there will be no support for a smaller public sector if agents are short-sighted, and this applies even to private agents. Notice that all this happens in all cases irrespectively of the tax instrument used to react to public debt imbalances over time.

Two further features of the solution are also interesting. First, our impulse response functions imply that the reform effects on output differ depending on the tax instrument used. Output falls in the short- and medium-run during the debt consolidation phase if we use consumption and especially labor taxes to react to debt. By contrast, output does not seem to suffer if we use capital taxes. This is for a number of reasons, for instance: the capital levy mechanism (see right below for details); labor supply rises because the fall in consumption and leisure push employees to work.

Second, other things equal, it is better to use capital taxes rather than labour and consumption taxes to react to public debt imbalances over time.[12] This happens because when we use the capital tax rate to react to public debt imbalances in the short run, this works like an implicit tax or a capital levy on existing wealth. At the same time, public debt stabilization in the short run is translated into a reduced fiscal burden and expectations of lower capital taxes in the future, which can stimulate investment. In other words, the standard capital levy mechanism is important to both the efficiency and the long-run welfare gains from a smaller public sector (see also Altig et al., 2001, for the US).

5. Conclusions and possible extensions

This paper has studied the aggregate and distributional implications of a smaller public sector in the euro area. In general, the model predicts medium- and long-run output and welfare benefits from a smaller public sector associated with lower taxes. But, looking at lifetime utilities, such reforms can come at the expense of some groups, in particular, public employees. Besides, such reforms are costly for all groups, including private employees, in the short-run. Thus, as usually, the answer to

[12] This applies to both groups including public employees; the latter are worse off when the government uses labour taxes or consumption taxes, instead of capital taxes, to react to public debt imbalances over time.

the question “are such reforms worth it?” requires a value judgement (see also Altig et al., 2001).

Our work can be extended in several ways. First, it would be interesting to allow for substitutability between public employment and goods purchased from the private sector in the production function of public goods. Second, here public and private sector employees differed in their role of production only. But it is widely recognized that they can differ in many other ways. For instance, we could introduce politico-economy issues, such as extra benefits on the part of public employees coming from rent seeking. Third, we could allow for unemployment and hence add a third socio-economic group of households, the unemployed, whose size is endogenously determined. Finally, here we focused on the implications of some policy reforms that seem to be consistent with observed fiscal consolidation policies and/or proposals currently under discussion in policy circles. But we have not attempted to study optimal (time-consistent) policy and compare this to our exogenous policy changes. We leave these extensions for future work.

Appendix

The DCE is summarized by the following equilibrium conditions:

$$\mu(e_t^p)^{\xi}(1+\tau_t^c)(c_t^p+\psi\bar{Y}_t^g)=(1-\tau_t^l)w_t^p \tag{A.1}$$

$$\frac{1}{(1+\tau_t^c)(c_t^p+\psi\bar{Y}_t^g)}=\beta\left[\frac{1-\delta+(1-\tau_{t+1}^k)r_{t+1}-\varphi^{p,k}\dfrac{k_{t+1}^p}{(v_{t+1}^p y_{t+1}^f)^2}}{(1+\tau_{t+1}^c)(c_{t+1}^p+\psi\bar{Y}_{t+1}^g)}\right] \tag{A.2}$$

$$\frac{1}{(1+\tau_t^c)(c_t^p+\psi\bar{Y}_t^g)}=\beta\left[\frac{1+\rho_{t+1}-\varphi^{p,b}\dfrac{b_{t+1}^p}{(v_{t+1}^p y_{t+1}^f)^2}}{(1+\tau_{t+1}^c)(c_{t+1}^p+\psi\bar{Y}_{t+1}^g)}\right] \tag{A.3}$$

$$(1+\tau_t^c)c_t^p+k_{t+1}^p-(1-\delta)k_t^p+\frac{\varphi^{p,k}}{2}\left(\frac{k_t^p}{v_t^p y_t^f}\right)^2+b_{t+1}^p-b_t^p+\frac{\varphi^{p,b}}{2}\left(\frac{b_t^p}{v_t^p y_t^f}\right)^2=$$

$$=(1-\tau_t^k)r_t k_t^p+(1-\tau_t^l)w_t^p e_t^p+\rho_t b_t^p+s_t^{tr,p}y_t^f \tag{A.4}$$

$$\mu(e_t^b)^{\xi}(1+\tau_t^c)(c_t^b+\psi\bar{Y}_t^g)=(1-\tau_t^l)w_t^g \tag{A.5}$$

$$\frac{1}{(1+\tau_t^c)(c_t^b+\psi\bar{Y}_t^g)}=\beta\left[\frac{1-\delta+(1-\tau_{t+1}^k)r_{t+1}-\varphi^{b,k}\dfrac{k_{t+1}^b}{(v_{t+1}^p y_{t+1}^f)^2}}{(1+\tau_{t+1}^c)(c_{t+1}^b+\psi\bar{Y}_{t+1}^g)}\right] \tag{A.6}$$

$$\frac{1}{(1+\tau_t^c)(c_t^b+\psi\bar{Y}_t^g)}=\beta\left[\frac{1+\rho_{t+1}-\varphi^{b,b}\dfrac{b_{t+1}^b}{(v_{t+1}^p y_{t+1}^f)^2}}{(1+\tau_{t+1}^c)(c_{t+1}^b+\psi\bar{Y}_{t+1}^g)}\right] \tag{A.7}$$

$$y_t^f=A(k_t^p+\frac{v_t^b}{v_t^p}k_t^b)^{\alpha}(e_t^p)^{1-\alpha} \tag{A.8}$$

$$\bar{Y}_t^g=A(s_t^g v_t^p y_t^f)^{\theta}(v_t^b e_t^b)^{1-\theta} \tag{A.9}$$

$$(s_t^w+s_t^g+s_t^{tr,p}+s_t^{tr,b})v_t^p y_t^f+(1+\rho_t)(v_t^p b_t^p+v_t^b b_t^b)=v_{t+1}^p b_{t+1}^p+v_{t+1}^b b_{t+1}^b+$$

$$+\tau_t^c(v_t^p c_t^p+v_t^b c_t^b)+\tau_t^k r_t(v_t^p k_t^p+v_t^b k_t^b)+\tau_t^l(w_t^p v_t^p e_t^p+w_t^g v_t^b e_t^b) \tag{A.10}$$

$$v_t^p\left[c_t^p+k_{t+1}^p-(1-\delta)k_t^p+\frac{\varphi^{p,k}}{2}\left(\frac{k_t^p}{v_t^p y_t^f}\right)^2+\frac{\varphi^{p,b}}{2}\left(\frac{b_t^p}{v_t^p y_t^f}\right)^2\right]+$$

$$+\nu_t^b\left[c_t^b+k_{t+1}^b-(1-\delta)k_t^b+\frac{\varphi^{b,k}}{2}\left(\frac{k_t^b}{\nu_t^p y_t^f}\right)^2+\frac{\varphi^{b,b}}{2}\left(\frac{b_t^b}{\nu_t^p y_t^f}\right)^2\right]+s_t^g\nu_t^p y_t^f=\nu_t^p y_t^f \qquad \text{(A.11)}$$

where the factor returns are given by:

$$r_t=\frac{\alpha y_t^f \nu_t^p}{\nu_t^p k_t^p+\nu_t^b k_t^b} \qquad \text{(A.12)}$$

$$w_t^p=\frac{(1-\alpha)y_t^f}{e_t^p} \qquad \text{(A.13)}$$

$$w_t^g=\frac{s_t^w \nu_t^p y_t^f}{\nu_t^b e_t^b} \qquad \text{(A.14)}$$

where (A.14) follows from the fiscal policy rule $s_t^w \equiv \frac{G_t^w}{Y_t}=\frac{w_t^g L_t^g}{Y_t}=\frac{w_t^g N_t^b e_t^b}{N_t^p y_t^f}=\frac{w_t^g \nu_t^b e_t^b}{\nu_t^p y_t^f}$.

Equations (A.1-A.3) and (A.5-A.7) are the optimality conditions of private and public employees respectively, with respect to labor, savings in capital and savings in bonds. Equations (A.4), (A.10) and (A.11) are the three linearly independent budget constraints (private employees', the government's and the economy's resource constraint). Equations (A.8) and (A.9) are the production functions for the private and the public good.

There are 14 equations. When $\{s_t^g, s_t^w, s_t^{tr,p}, s_t^{tr,b}, \tau_t^c, \tau_t^k, \tau_t^l, v_t^b\}_{t=0}^{\infty}$ are set by the government, $\{c_t^p, c_t^b, k_{t+1}^p, k_{t+1}^b, b_{t+1}^p, b_{t+1}^b, e_t^p, e_t^b, \rho_t, y_t^f, \bar{Y}_t^g, r_t, w_t, w_t^g\}_{t=0}^{\infty}$ are the 14 endogenous variables.

Table 1: Baseline parameterization

Parameters and policy instruments	Description	Value
α	Share of capital in private production	0.399
$1-\theta$	Share of public employment in public production	0.465
δ	Capital depreciation rate	0.05
β	Rate of time preference	0.96
ψ	Public consumption weight in utility	0.1
μ	Preference parameter on work hours in utility	5
ξ	Elasticity of work hours in utility	1
s^w	Public wage payments as share of GDP (data)	0.1067
s^g	Public purchases as share of GDP (data)	0.1224
s^{tr}	Public transfers as share of GDP (data)	0.2648
τ^c	Tax rate on consumption (data)	0.1936
τ^k	Tax rate on capital income (data)	0.2882
τ^l	Tax rate on labour (data)	0.3882
B/Y	Public debt as a share of GDP (data)	0.8 and 0.6
v^b	Public employees as share of population (data)	0.1602
A	Long-run TFP	1
$\varphi^{p,k}$	Transaction cost incurred by private agents in capital market	0.002
$\varphi^{p,b}$	Transaction cost incurred by private agents in bond market	0.002
$\varphi^{b,k}$	Transaction cost incurred by public employees in capital market	0.002
$\varphi^{b,b}$	Transaction cost incurred by public employees in bond market	0.002

Notes: Concerning the parameters in the feedback policy rules (11), see subsection 3.1 in the main text.

Table 2: Description of reforms

1	Transition from the status quo to a new long-run where the public debt to output ratio is 60%
2	Transition from the status quo to a new long-run where the public debt to output ratio is 60% and there is a permanent cut in each item of public spending by 1%
3	Transition from the status quo to a new long-run where the public debt to output ratio is 60% and there is a gradual cut in each item of public spending by 1%
4	Transition from the status quo to a new long-run where there is a permanent cut in each item of public spending by 1%
5	Transition from the status quo to a new long-run where there is a gradual cut in each item of public spending by 1%

Table 3: Long-run solutions

Residual policy instrument	u^p	u^b	u	c^p	c^b	e^p	e^b	w^g / w^p	y	c / y	k / y	τ^l	τ^k	τ^c	$s^{t,p}$	$s^{t,b}$
	Status quo															
	-1.2422	-0.9052	-1.1882	0.3699	0.4825	0.3239	0.2740	1.10	0.5367	0.7228	2.7833	0.3882	0.2882	0.1936	0.1846	0.0802
	Reform 1															
τ^l	-1.2358	-0.8982	-1.1817	0.3743	0.4879	0.3273	0.2770	1.0996	0.5427	0.7233	2.7862	**0.3747**	0.2882	0.1936	0.1846	0.0802
τ^k	-1.2274	-0.8883	-1.1731	0.3760	0.4912	0.3249	0.2747	1.1008	0.5489	0.7187	2.8661	0.3882	**0.2665**	0.1936	0.1846	0.0802
τ^c	-1.2391	-0.8983	-1.1845	0.3721	0.4867	0.3257	0.2752	1.1014	0.5398	0.7233	2.7848	0.3882	0.2882	**0.1804**	0.1846	0.0802
	Reforms 2-3															
τ^l	-1.2021	-0.9087	-1.1551	0.3918	0.4826	0.3338	0.2765	1.0180	0.5541	0.7333	2.7914	**0.3343**	0.2882	0.1936	0.1776	0.0772
τ^k	-1.1717	-0.8702	-1.1234	0.3977	0.4954	0.3244	0.2673	1.0237	0.5782	0.7150	3.1063	0.3882	**0.2027**	0.1936	0.1776	0.0772
τ^c	-1.2147	-0.9071	-1.1654	0.3829	0.4788	0.3275	0.2694	1.0256	0.5431	0.7333	2.7864	0.3882	0.2882	**0.1423**	0.1776	0.0772
	Reforms 4-5															
τ^l	-1.2081	-0.9145	-1.1611	0.3873	0.4779	0.3305	0.2736	1.0189	0.5483	0.7328	2.7888	**0.3479**	0.2882	0.1936	0.1776	0.0772
τ^k	-1.1848	-0.8852	-1.1368	0.3919	0.4876	0.3234	0.2666	1.0231	0.5663	0.7191	3.0247	0.3882	**0.2241**	0.1936	0.1776	0.0772
τ^c	-1.2179	-0.9137	-1.1691	0.3806	0.4748	0.3257	0.2682	1.0245	0.5399	0.7328	2.7849	0.3882	0.2882	**0.1552**	0.1776	0.0772

Notes: (i) We use the baseline parameterization in Table 1. (ii) $u = v^p u^p + v^b u^b$ (the same formula is used for all per capita quantities).

Table 4a: Discounted lifetime utility when the labor tax rate is the residual policy instrument

	Status quo	Reform 1	Reform 2	Reform 3	Reform 4	Reform 5
U^p	-31.0560	-31.0507	-30.2984	-30.3727	-30.3061	-30.3801
U^b	-22.6316	-22.6146	-22.9283	-22.8906	-22.9462	-22.9122
U	-29.7064	-29.6992	-29.1177	-29.1741	-29.1271	-29.1838

Notes: See notes in Tables 1 and 3.

Table 4b: Discounted lifetime utility when the capital tax rate is the residual policy instrument

	Status quo	Reform 1	Reform 2	Reform 3	Reform 4	Reform 5
U^p	-31.0560	-30.9429	-30.2065	-30.2664	-30.2859	-30.3463
U^b	-22.6316	-22.4418	-22.5326	-22.5076	-22.6689	-22.6489
U	-29.7064	-29.5810	-28.9771	-29.0234	-29.0657	-29.1132

Notes: See notes in Tables 1 and 3.

Table 4c: Discounted lifetime utility when the consumption tax rate is the residual policy instrument

	Status quo	Reform 1	Reform 2	Reform 3	Reform 4	Reform 5
U^p	-31.0560	-30.9952	-30.4196	-30.4713	-30.4772	-30.5311
U^b	-22.6316	-22.5154	-22.7511	-22.7107	-22.8675	-22.8262
U	-29.7064	-29.6367	-29.1911	-29.2281	-29.2581	-29.2968

Notes: See notes in Tables 1 and 3.

Table 5: Discounted utility in the first ten periods when the capital tax rate is the residual policy instrument

	Status quo	Reform 1	Reform 2	Reform 3	Reform 4	Reform 5
U^p	-10.4090	-10.4664	-10.4900	-10.5083	-10.4309	-10.4488
U^b	-7.5854	-7.5899	-7.8164	-7.8097	-7.8024	-7.7966
U	-9.9566	-10.0056	-10.0617	-10.0760	-10.0098	-10.0239

Notes: See notes in Tables 1 and 3.

Figures 1a-1e: Impulse responses when the labor tax rate is the residual policy instrument

Figure 1a: Reform 1

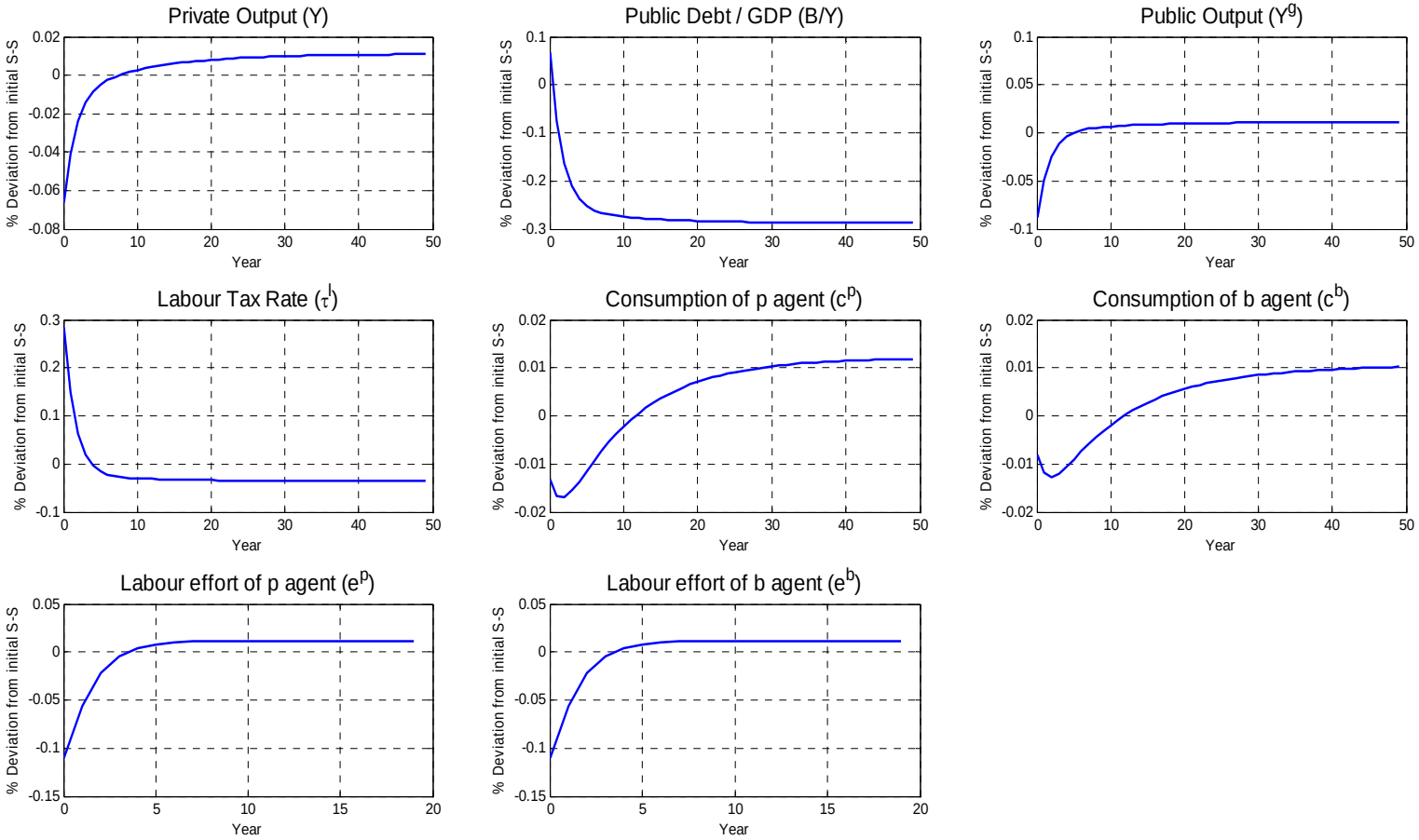


Figure 1b: Reform 2

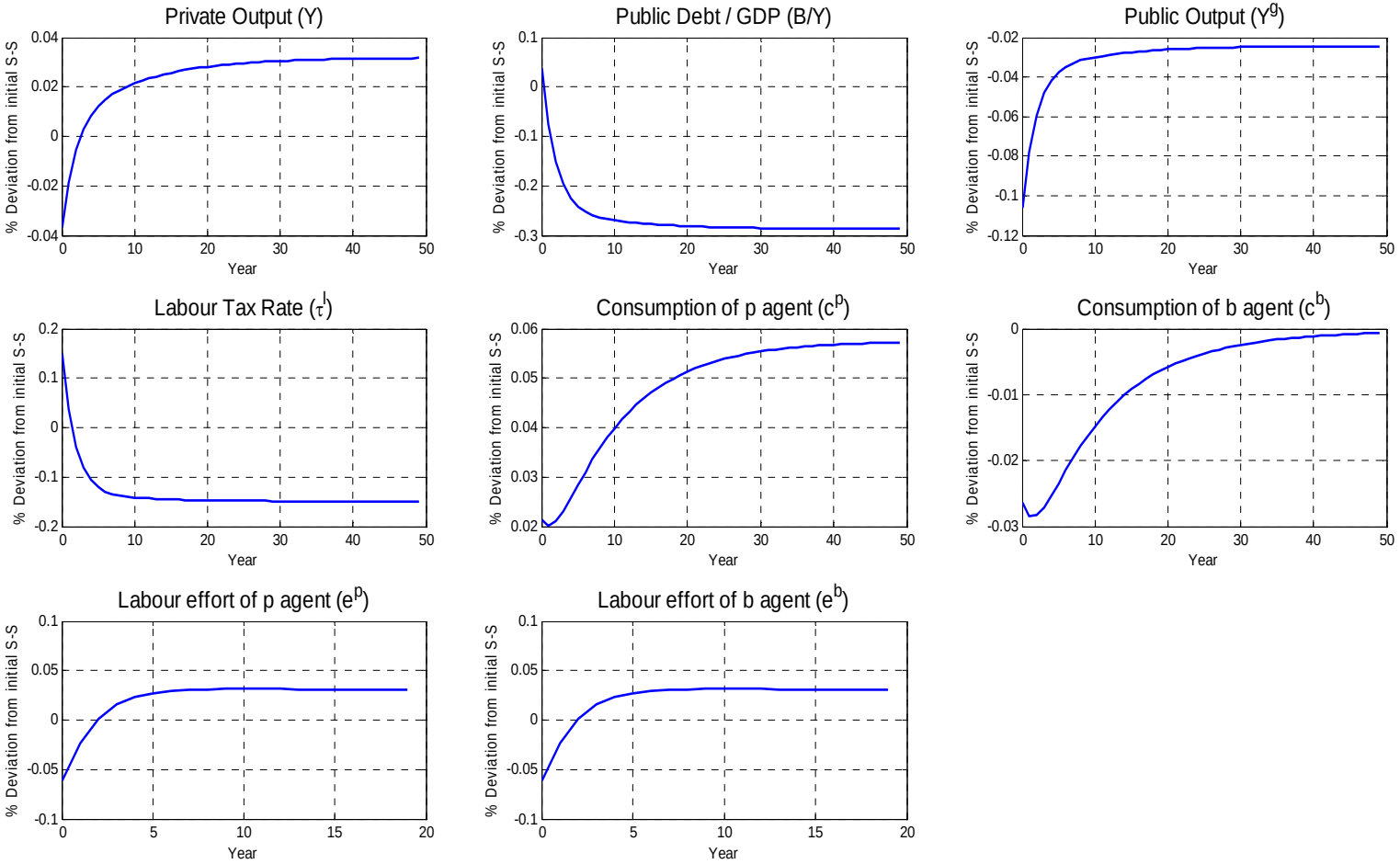


Figure 1c: Reform 3

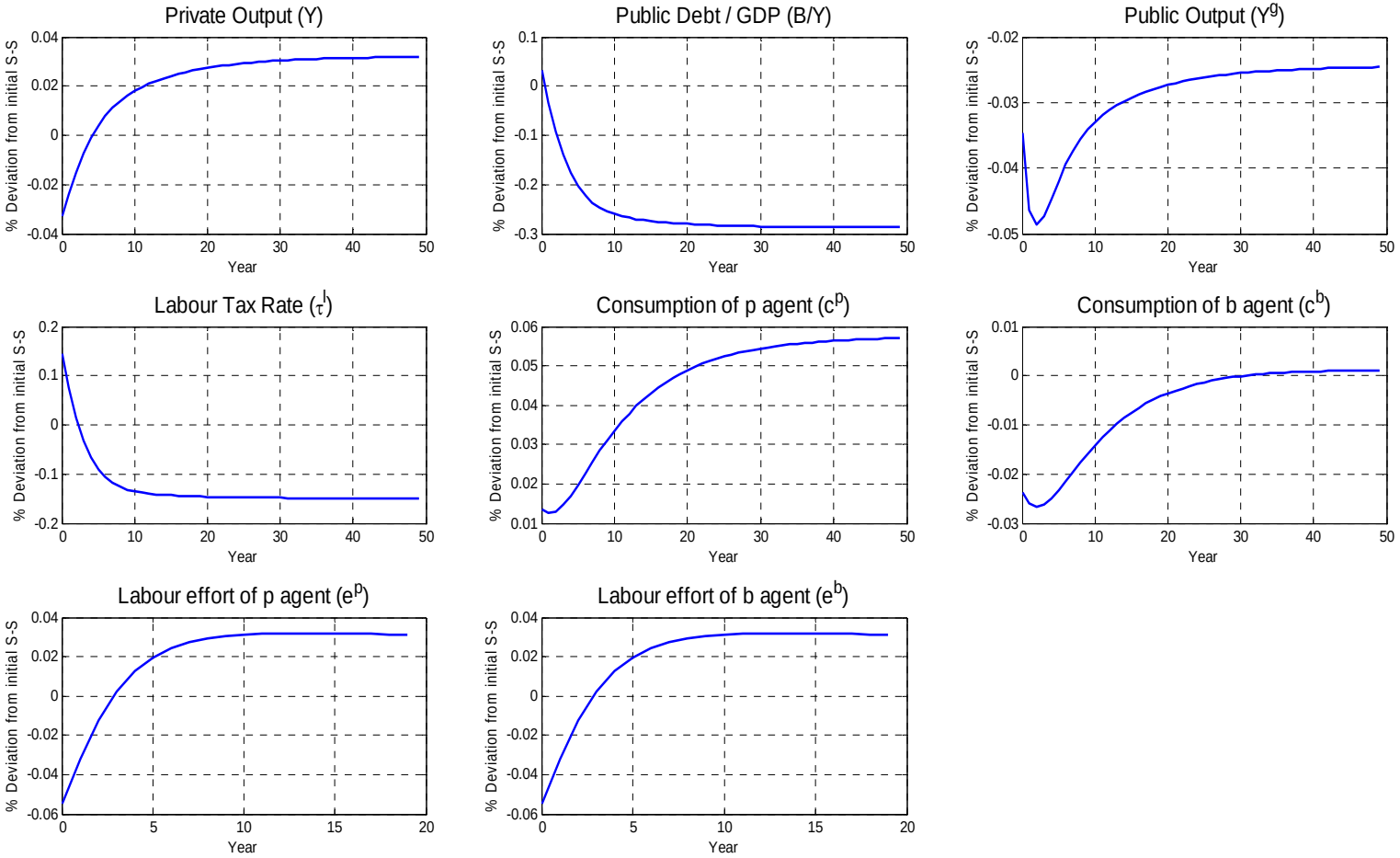


Figure 1d: Reform 4

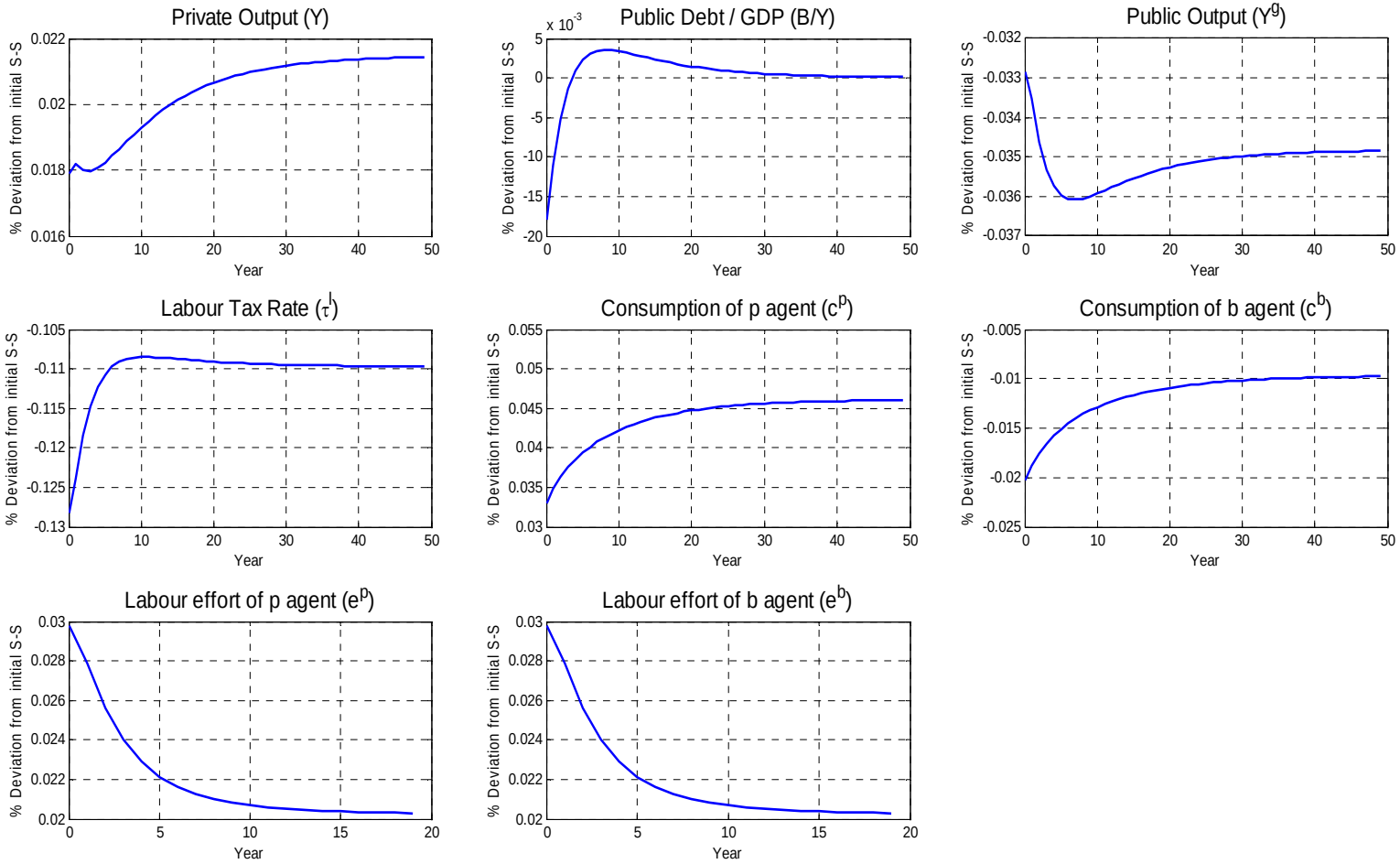
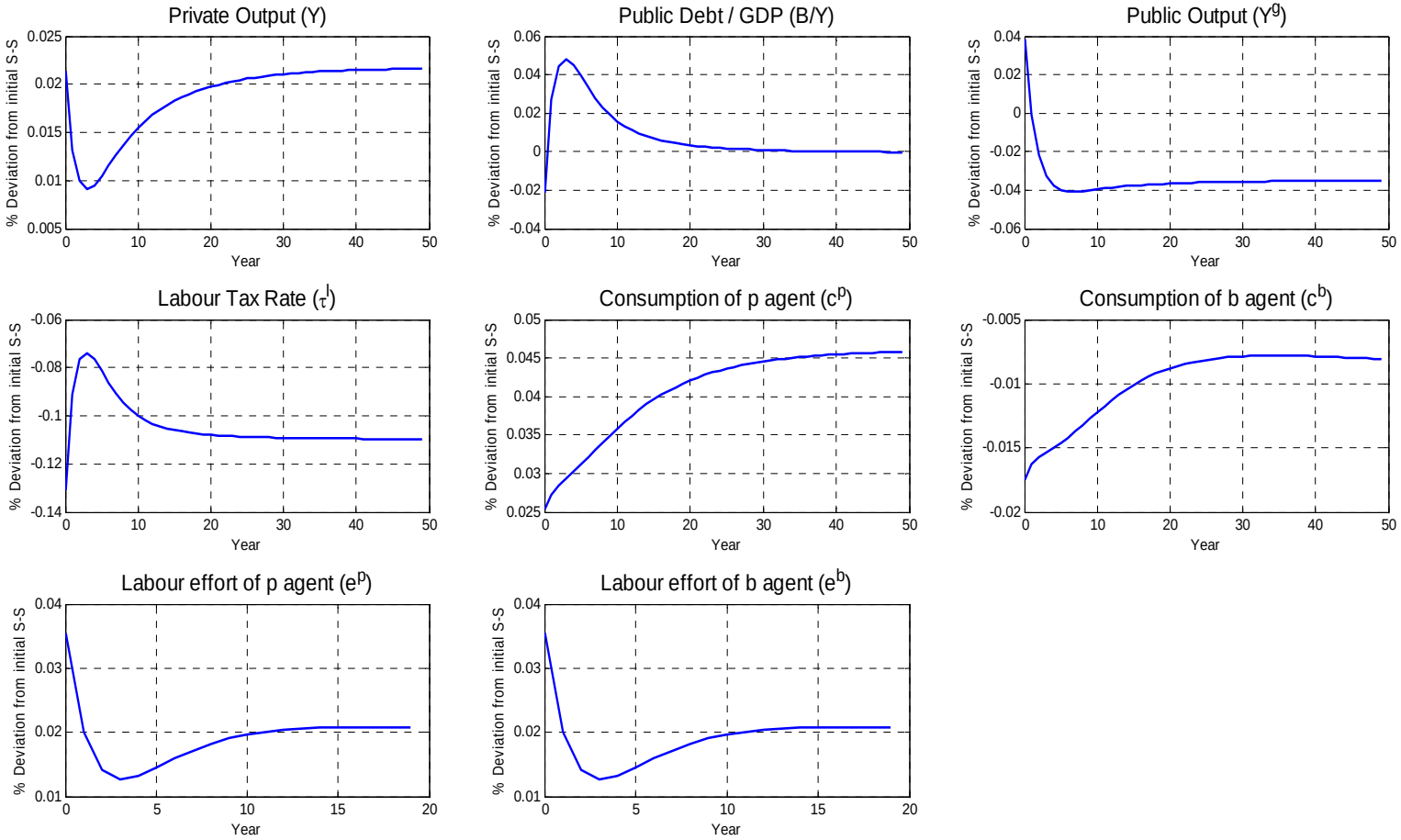


Figure 1e: Reform 5



Figures 2a-2e: Impulse responses when the capital tax rate is the residual policy instrument

Figure 2a: Reform 1

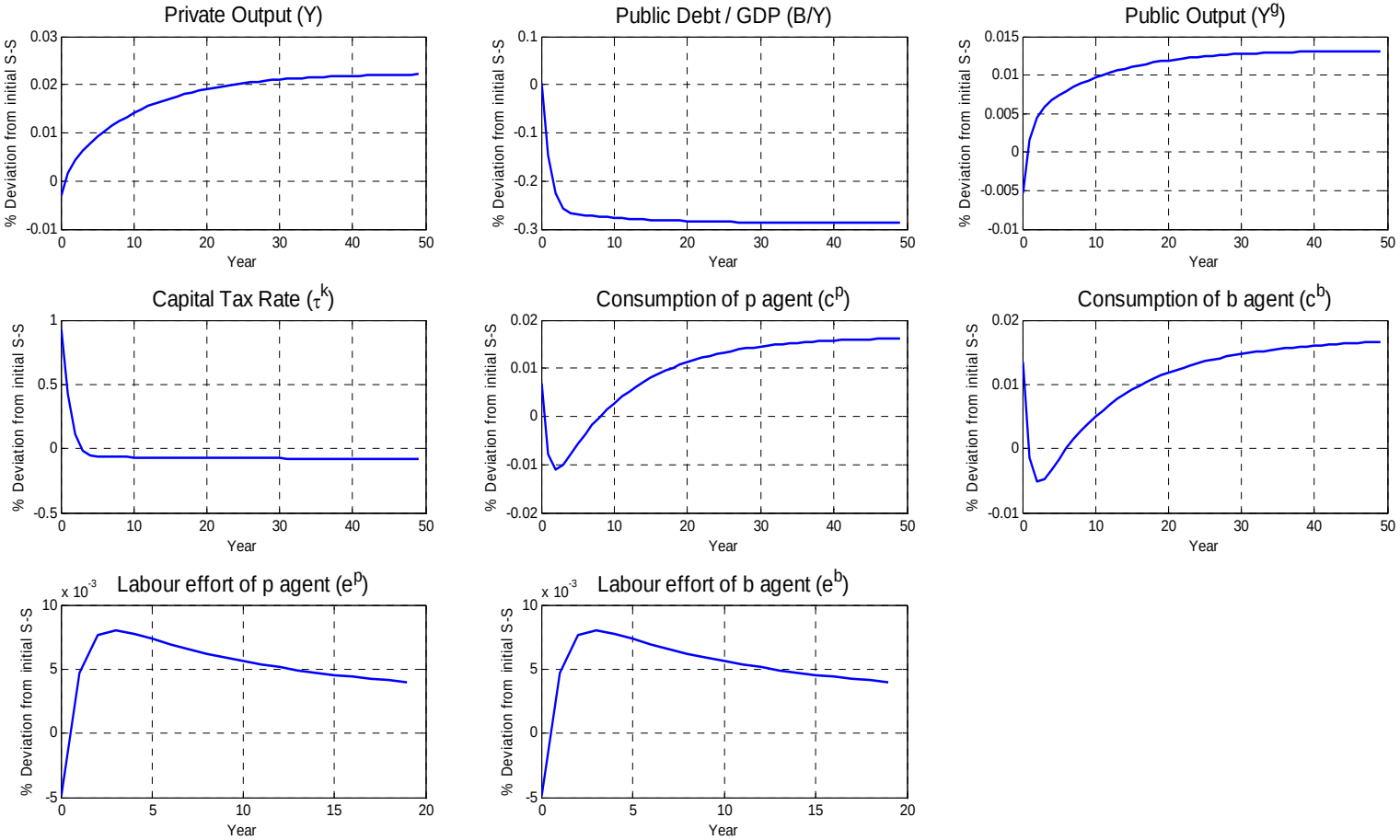


Figure 2b: Reform 2

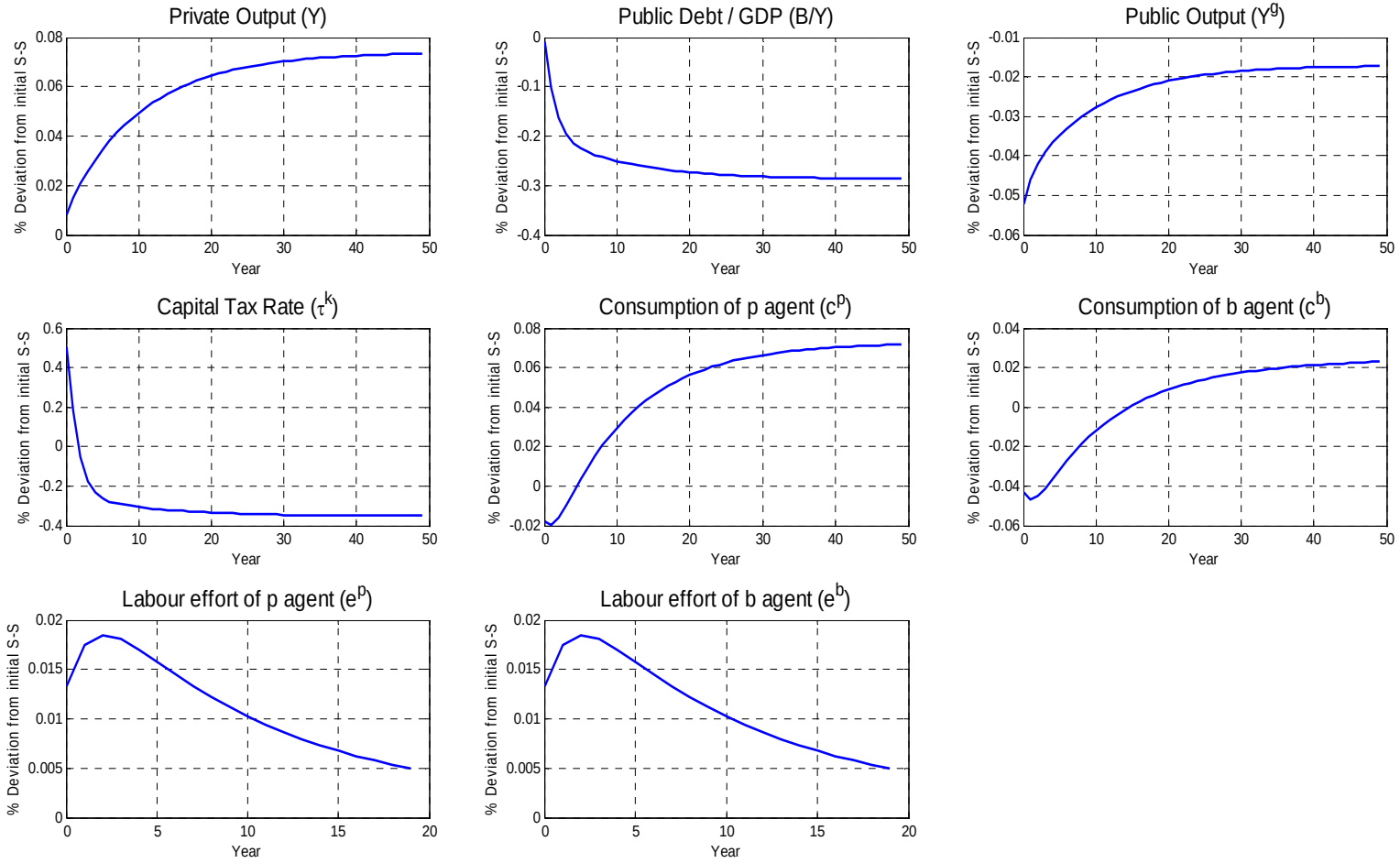


Figure 2c: Reform 3

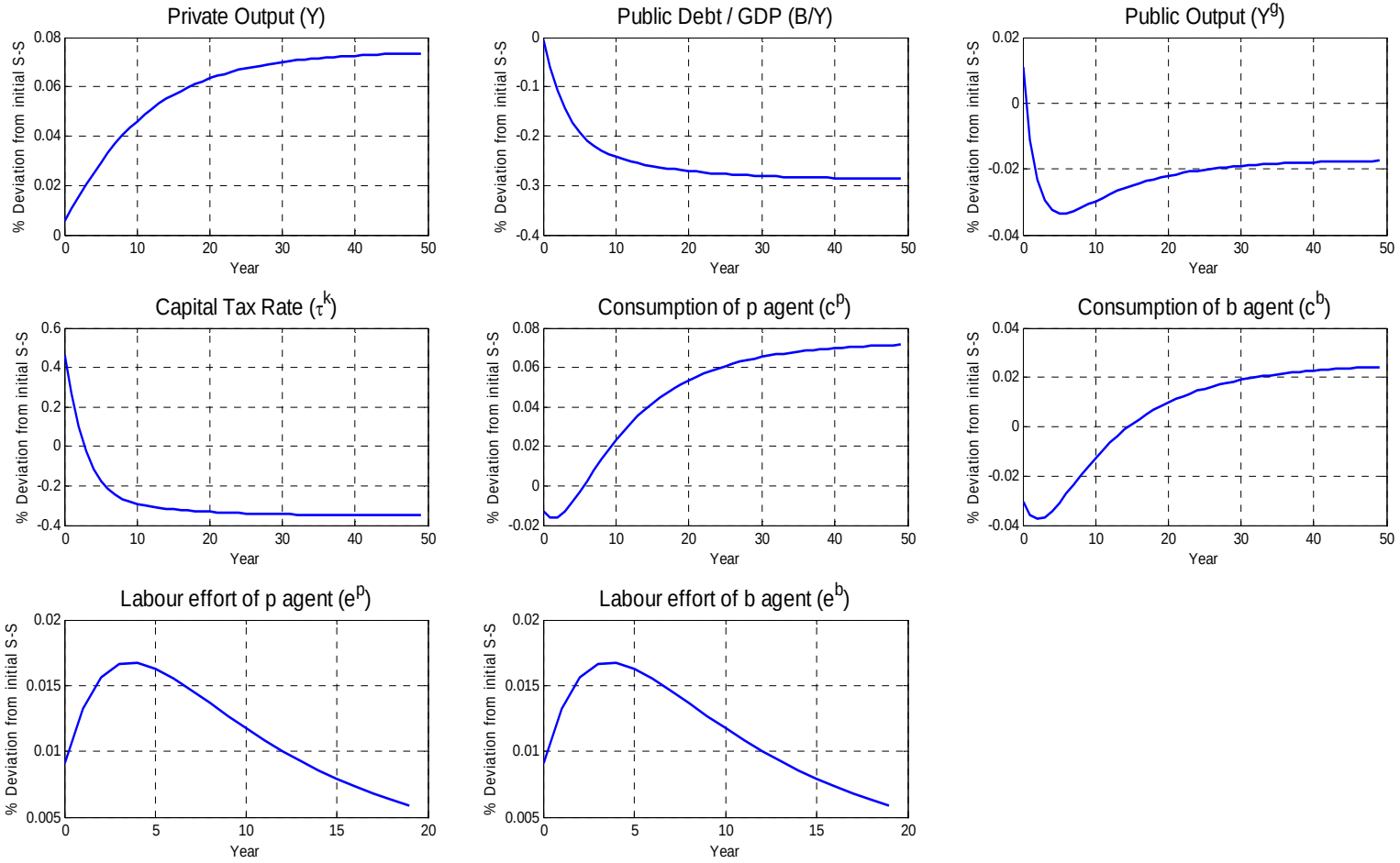


Figure 2d: Reform 4

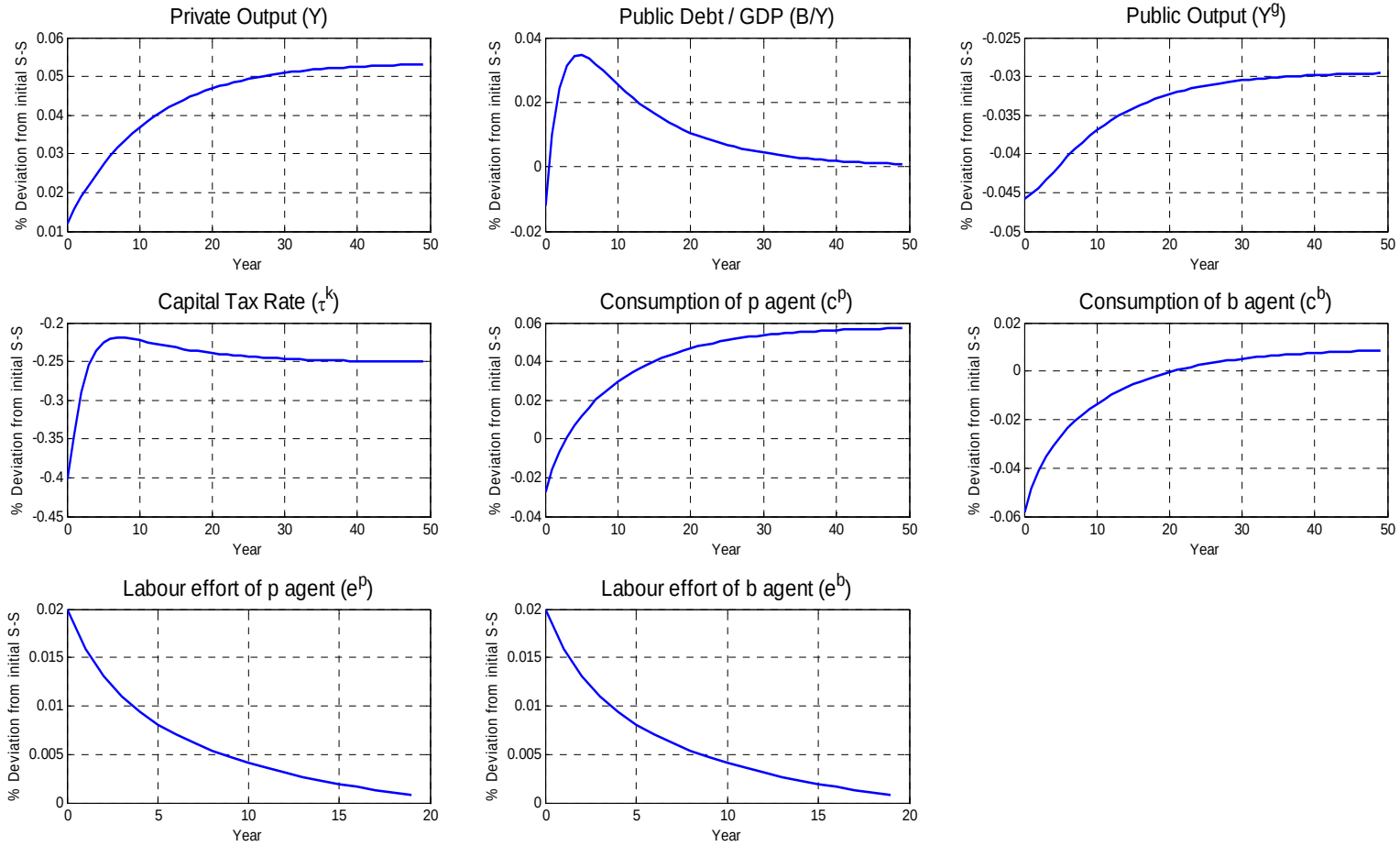
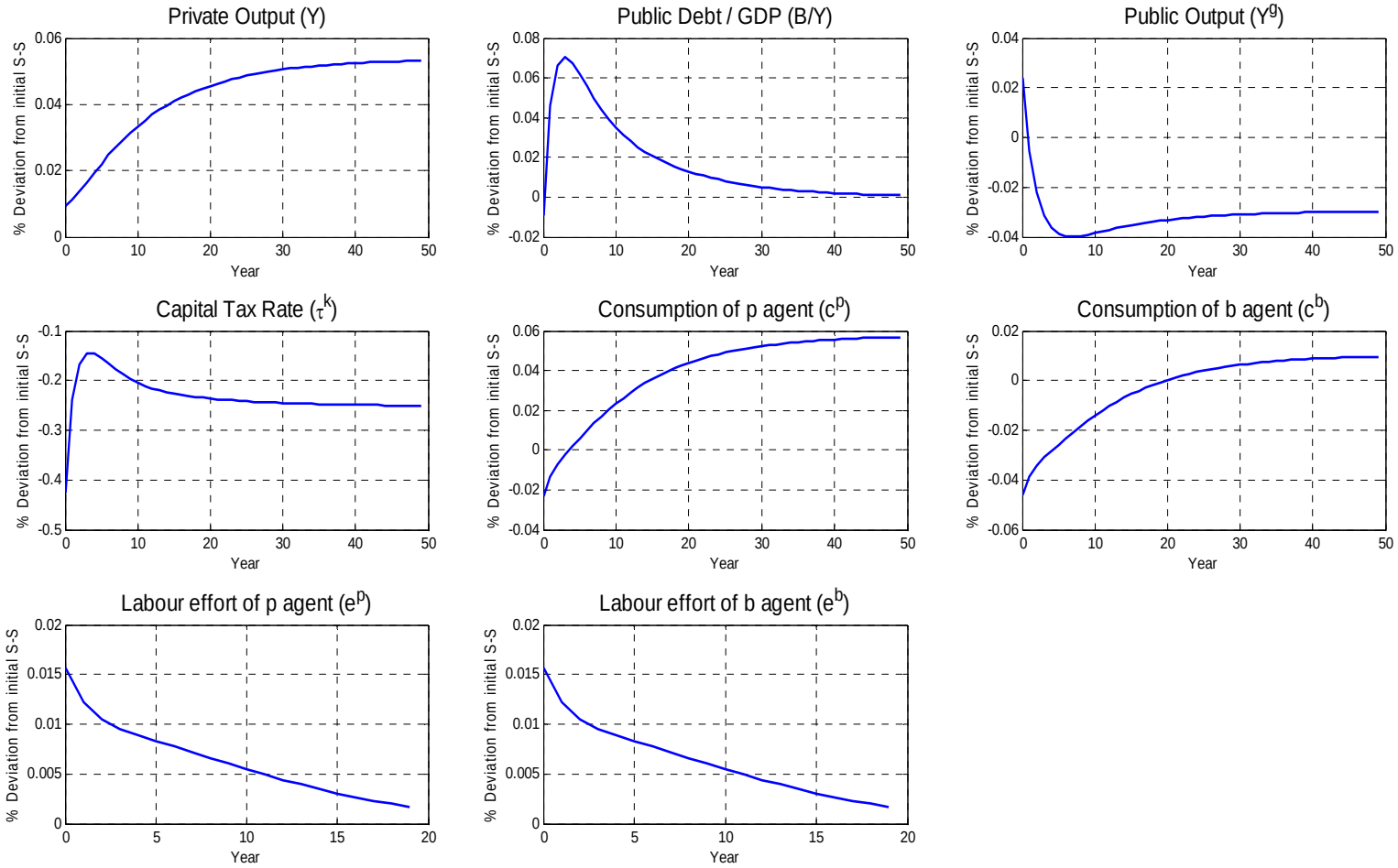


Figure 2e: Reform 5



Figures 3a-3e: Impulse responses when the consumption tax rate is the residual policy instrument

Figure 3a: Reform 1

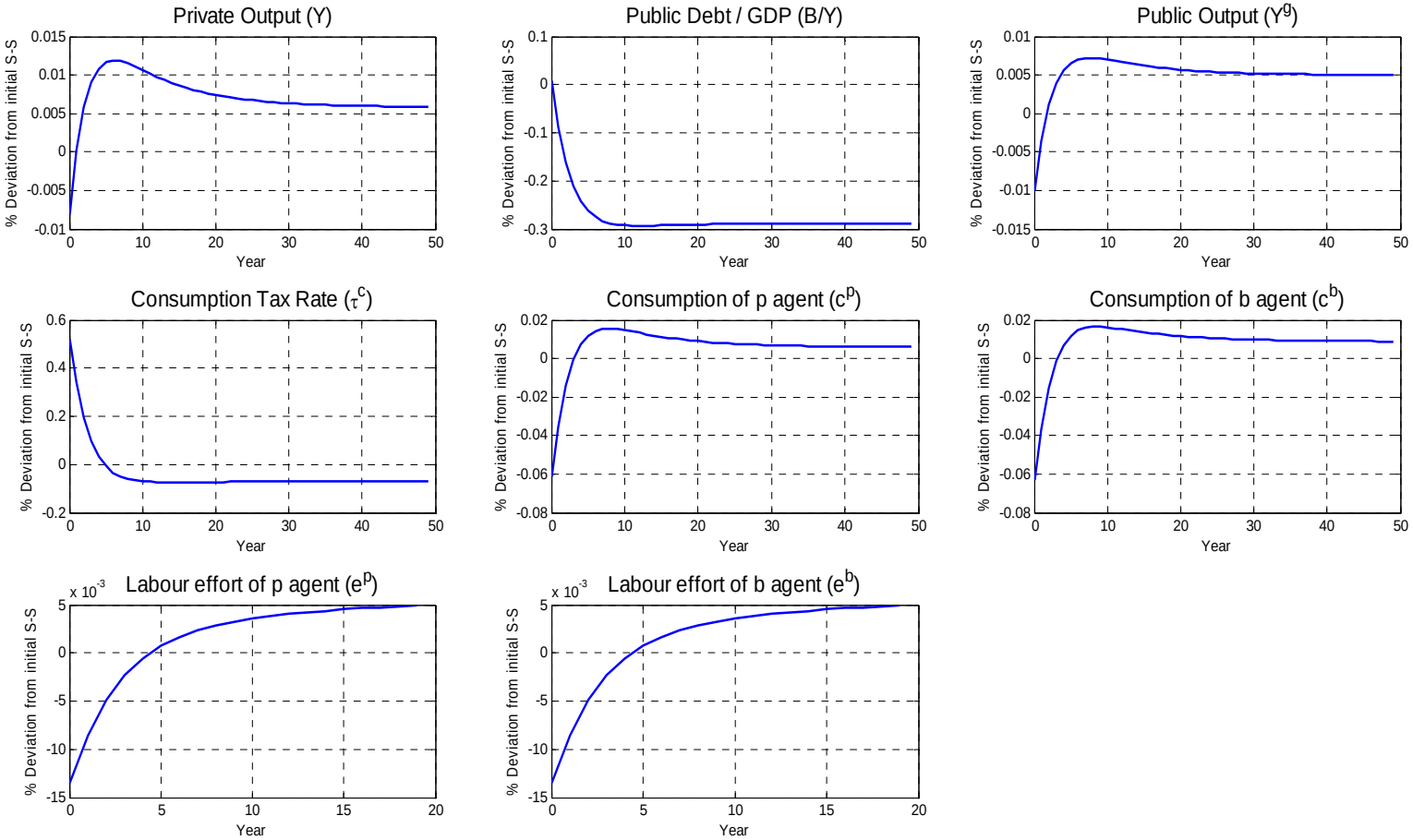


Figure 3b: Reform 2

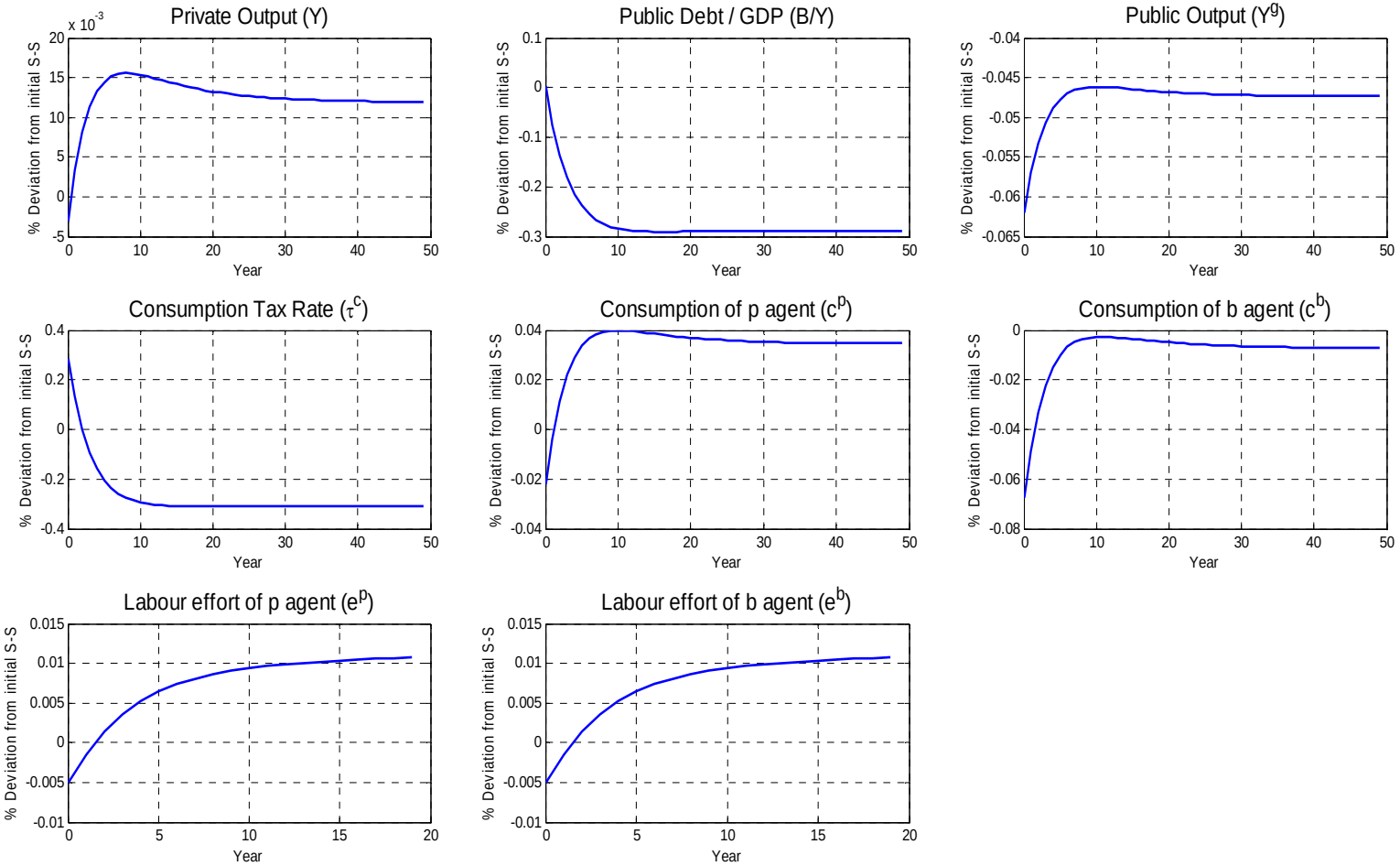


Figure 3c: Reform 3

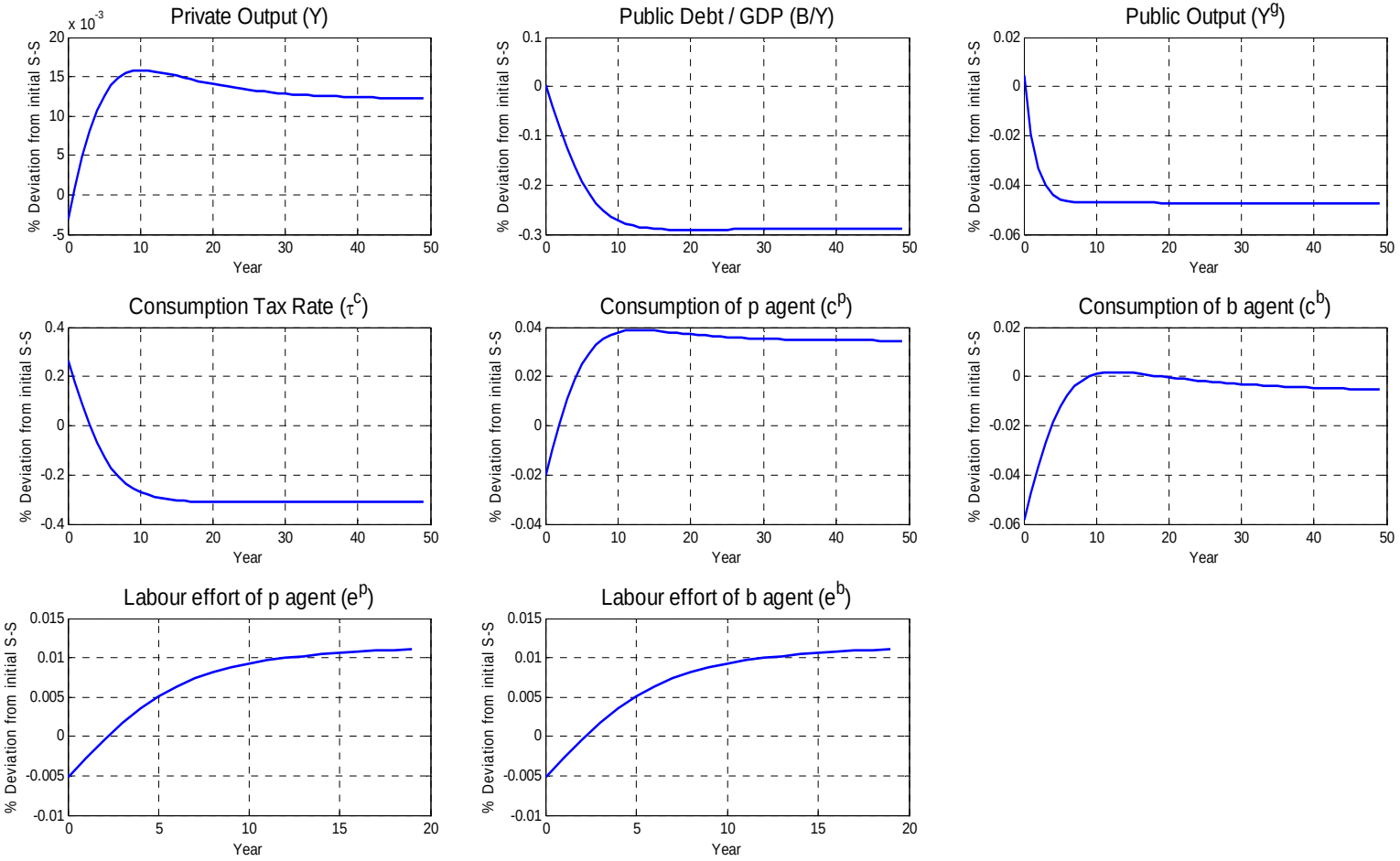


Figure 3d: Reform 4

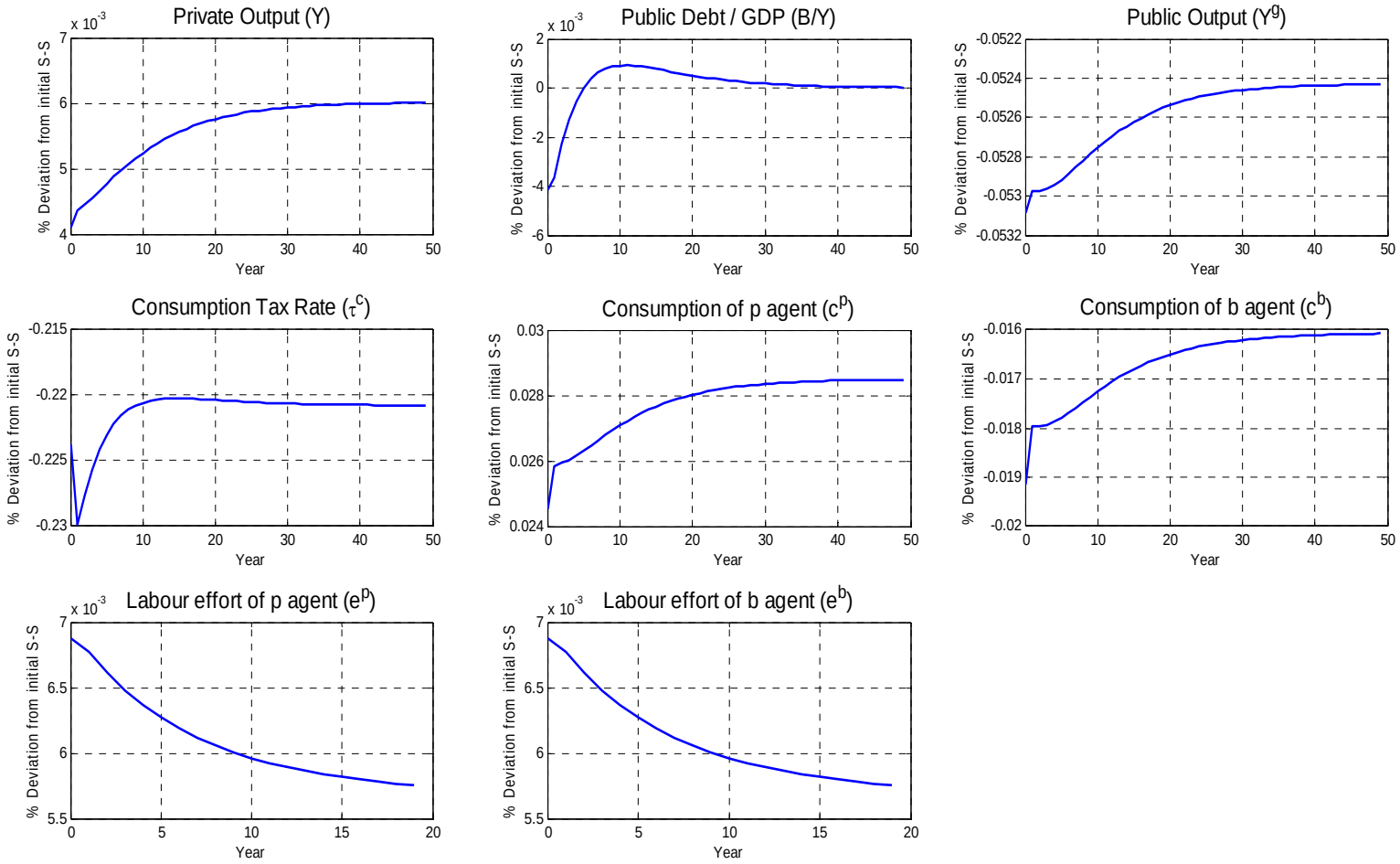
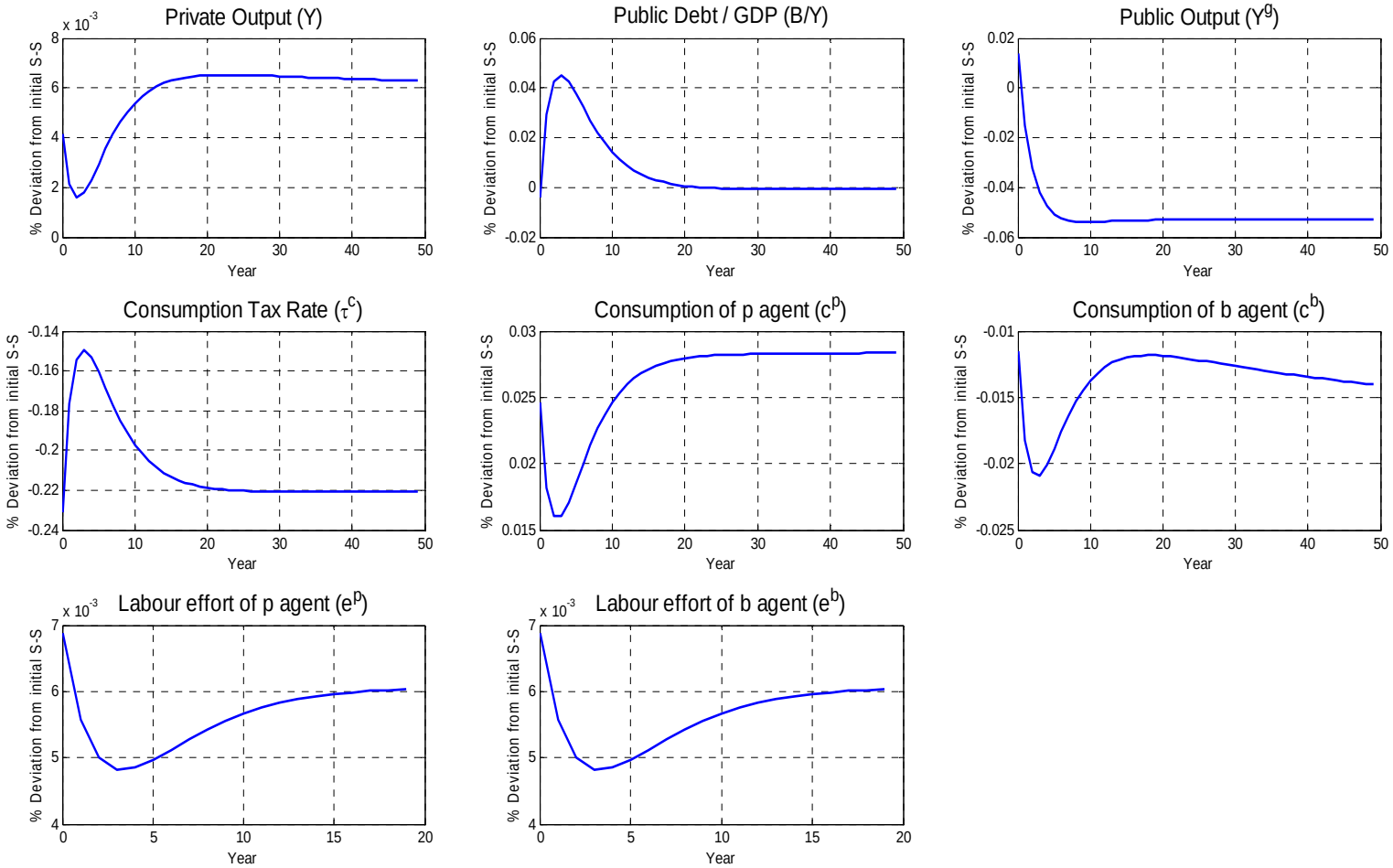


Figure 3e: Reform 5



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