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IGEM-PA: a Variant of the Italian General Equilibrium Model for Policy Analysis

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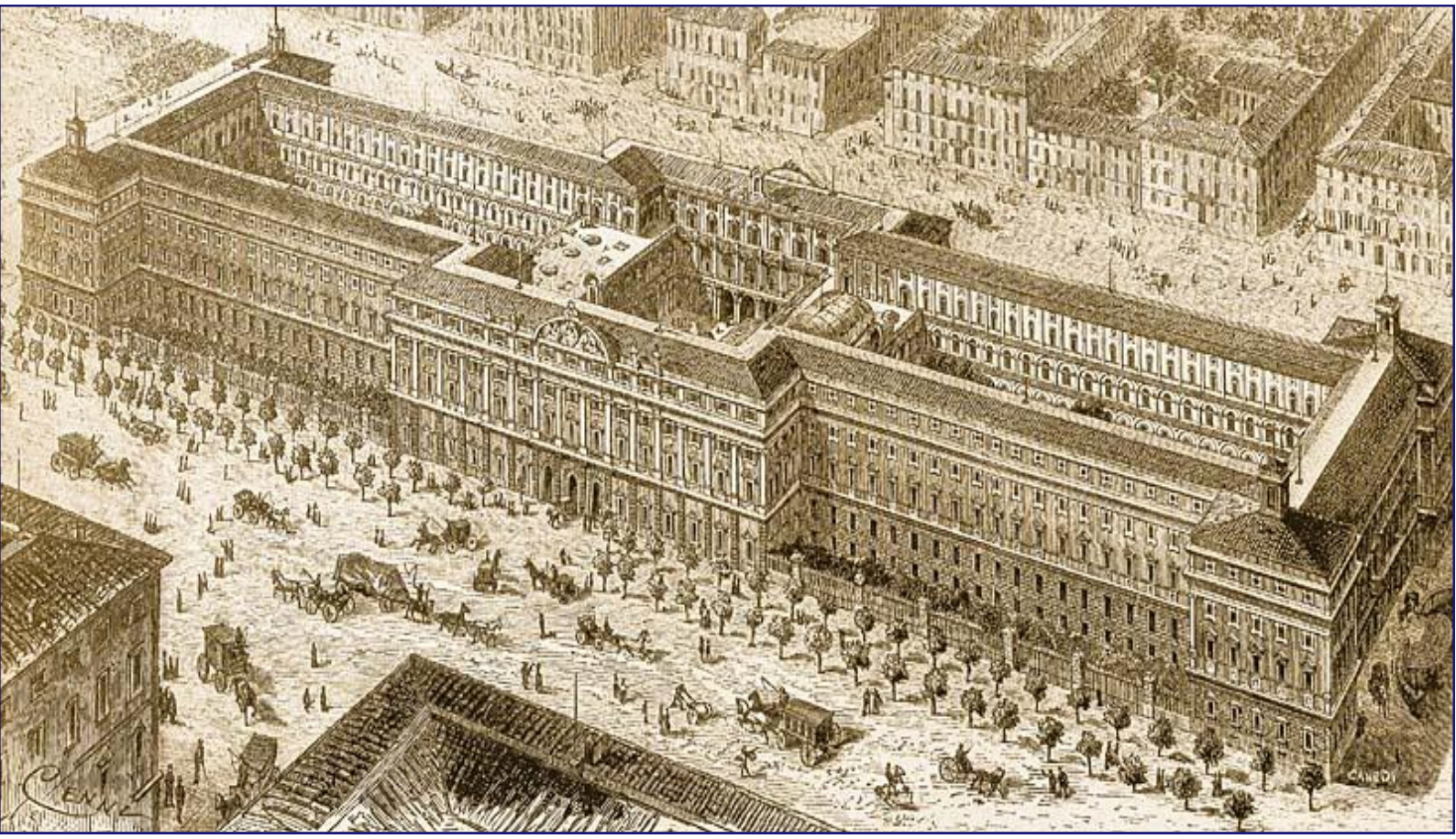

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IGEM-PA: a Variant of the Italian General Equilibrium Model for Policy Analysis

Barbara Annicchiarico[*], Claudio Battiati[‡], Claudio Cesaroni[§], Fabio Di Dio[**], Francesco Felici[††]

Abstract

This paper extends IGEM, the dynamic general equilibrium model for the Italian economy currently in use at the Italian Department of the Treasury for economic policy analysis. In this new variant of the model the public sector is explicitly modelled as suppliers of goods and services. With this tool in hand we are able to present an in-depth analysis of expenditure-based fiscal multipliers and ameliorate our understanding of the potential macroeconomic effects of several policy interventions, such as those aimed at the rationalization of public spending, at the improvement of the business environment and at fostering productivity of the public administration (PA).

JEL Classification: E27, E30, E60.

Keywords: Structural Reforms, Dynamic General Equilibrium Model, Italy, Public Administration Fiscal Multipliers, Simulation Analysis.

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1 Introduction

This paper presents a new variant of IGEM (Italian General Equilibrium Model), a large scale dynamic general equilibrium (DGE) model for the Italian economy, entirely developed at the Department of the Treasury of the Italian Ministry of Economics and Finance and currently used as a simulation tool for economic policy analysis.[1] In this new version of the model public capital is productivity-enhancing, while consumer preferences depend on goods and services provided by the government.[2] In particular, public spending on private final and investment goods are used in conjunction with public employment to produce good and services. In other words, in this extension of IGEM the public sector is explicitly modelled as a supplier of goods and services.

This extension of IGEM is motivated by the fact that an intensive reform agenda urges economic institutions to quantify the macroeconomic impact of complex reform scenarios and a vast area of policy interventions regards the public sector.[3] Notably, in a period of fiscal austerity, ensuring efficiency in public procurement is of paramount importance to ensure sound public service delivery. In the same way, reducing red tape and enhancing productivity are essential priorities in times of tight budget constraints. With this new variant of IGEM we are able to answer the following economic policy questions. Which are the macroeconomic effects of the rationalization of public spending? Which are the implications of major advances in the implementation of the digital agenda? How do the simplification reforms impact on the economy when the PA sector is explicitly modeled? What happens if the overall productivity of the public sector increases? These issues are all relevant for Italy. As a matter of fact, the policy area related to public administration and institutional efficiency represents a major challenge for the Italian economy. Despite the recent reform effort, in fact, available international comparisons show that the efficiency and effectiveness of the Italian public sector is still below the EU average, as recently pointed out by the European Commission.[4] In addition, with this new extension we are able to undertake a fully-fledged analysis of fiscal multipliers, distinguishing between different categories of public expenditures (purchases of goods from the private sector, public employment, changes in public capital by increasing the endowment of infrastructures of the economy).

In order to show the possible use of this variant of IGEM we conduct our analysis along two dimensions. We first study the impact of structural reforms acting in the area of public administration and institutional efficiency along with the implications of a rationalization of public spending, and then we undertake an analysis of fiscal multipliers.

[1] IGEM belongs to the class of the so-called New Neoclassical Synthesis models, embedding typical elements at the heart of New Keynesian models, such as nominal rigidities in wages and prices, with features central to the Real Business Cycle (RBC) models, such as the systematic application of intertemporal optimization and of the rational expectations hypothesis in shaping consumption, investment and factor supply decisions. For a full technical account of the baseline version of IGEM, see Annicchiarico et al. (2013a).

[2] Notably, public capital represents the 'wheels' of economic activity.

[3] In this respect, see the assessment of structural reforms undertaken in the National Reform Programme of Italy for the years 2013-2016.

[4] See the Country Report Italy 2016, available at http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_italy_en.pdf

The first part of the paper is devoted to the assessment of structural reforms involving the area of public administration and institutional efficiency. Specifically, in the spirit of the recent reforms and policy interventions put in place by the Italian government we consider the following scenarios: (i) rationalization of public spending, where for a given public provision of goods and services production costs are reduced; (ii) reduction of production costs of publicly provided goods and services by improving public procurement; (iii) reduction of production costs of publicly provided goods and services by means of improvement in the overall productivity level of the public sector; (iv) simplification of administrative framework. The first scenario evaluates the potential effects of a more efficient allocation of public spending related to the public provision of goods and services. The second scenario foresees a reduction of costs achieved by policies aimed at rendering public procurement more transparent, fair and competitive. The third scenario considers the effects of policy interventions addressed to increase the overall productivity of the PA in the provision of goods and services, such, for instance, as advances in the digital agenda. The fourth scenario refers to the set of policy aimed at simplifying the administrative framework and reducing red-tape. This last set of policies have effects on both private and public sector by reducing the time spent dealing with bureaucracy (i.e. overhead labor cost).

Overall our results show, as expected, that policies aimed at rendering the public administration framework more effective and efficient tend to improve the fiscal balance. The level of economic activity is going to increase when the improvement in public procurement entails a boost of competition in the private sector, and in response to policies oriented toward the simplification of the administrative framework. However, rationalization of public spending and improvement in the overall productivity level of public sector, while having always a positive impact on private consumption, are shown to be expansionary when the public resources saved with the implementation of these policies are used for tax reduction.

The second part of our analysis is devoted to an in-depth study of fiscal multipliers. In particular, as already emphasized, in this new variant of IGEM we are able to explore the potential macroeconomic effects of public spending, considering different categories of government expenditure along with changes in the spending mix. Notably, the issue on the economic effects of government spending has been the object of a huge debate in the literature, both from an empirical and from a theoretical perspective. A vast empirical literature has explored the size of government spending multipliers (e.g. Hall 2009, Christiano et al. 2011, Corsetti et al. 2012, Auerbach and Gorodnichenko 2011, Eggertson and Krugman 2012, Iwata 2013, Blanchard and Leigh 2013) and has shown the existence of a positive private consumption multiplier of government spending (e.g. Fatás and Mihov 2001, Blanchard and Perotti 2002, Marattin and Salotti 2011, Garcia and Ramajo 2005, Galí et al. 2007, Ramey 2011, Karras 2012). However, this prediction is at odds with the standard RBC literature, where an increase in public spending causes a rise in output, but yields a decline in consumption because of a negative wealth effect (see Baxter and King 1993). New Keynesian models have similar predictions, unless the basic model is modified to include a large share of households with limited asset market participation

(see Coenen and Straub 2005 and Galí et al. 2007), or an overlapping generations structure is introduced, as in Ganelli (2011), or in the presence of an unemployment insurance system coupled with distortionary taxation as in Linnemann (2004). Now these theoretical results are induced by a common underlying assumption, namely that public spending does not affect either utility nor production.[5] However, this hypothesis appears to be unsatisfactory along two important dimensions. First, treating public spending as a simple demand component is inherently wrong and in doing so one neglects the effects that publicly provided goods, services and public capital may have in shaping the behavior of consumption and production.[6] Second, the recovery after the recent great recession is under way, but many economies are involved in harsh fiscal consolidation processes, mainly consisting in large spending cuts. At present it is difficult to go further in this direction and more emphasis should be given to the quality of spending mechanisms and on its composition, aspects fully neglected by the standard modeling approach, but considered of utmost importance in the economic policy debate.[7]

By extending IGEM and allowing for the existence of productive government spending affecting productivity and of a publicly provided goods and services positively affecting households utility, we are able to fully assess the potential effects of public spending changes involving different components of public spending, namely public investment, public consumption and public employment. The extensions we consider in this paper are fully supported by the empirical literature. For evidence on the positive effects of public capital on output, see Aschauer (1989), Lynde and Richmond (1993), Ai and Cassou (1995), Calderon and Serven (2003) among others.[8] The existence of a non-separability between private and public consumption is also supported by the empirical evidence, with Aschauer (1985), pointing to the existence of a substitutability relationship between the two, and Evans and Karras (1996) and Obuko (2003) who find evidence of complementarity.

The key findings from our simulation analysis related to fiscal multipliers can be summarized as follows. First, output multipliers tend to be very high as a result of increases in public investments. Intuitively, a higher flow of public investments, not only increases aggregate demand, but also generates higher supply thanks to the positive effects that public capital has on the production function. Second, for positive shifts of public consumption short-run output multipliers are lower for permanent shocks than those observed for temporary shocks, while the opposite result is observed when public investment increases. Finally, a change in the composition of public spending from public consumption to public investment is shown to produce

[5] Laudable exceptions, allowing for utility enhancing public spending and/or productive public spending, include Linneman and Schabert (2004), Ganelli and Tervala (2009), Marattin and Palestrini (2014) and D'Auria (2015).

[6] In the macroeconomic jargon, public spending is said to enter the model as a "pure waste" of resources. Further, treating all public spending as a "pure waste" implies that indiscriminate horizontal cuts in all types of public spending are both admissible and desirable.

[7] For a recent analysis on the importance of the composition of public spending in a fiscal consolidation process, see Economides et al. (2015).

[8] However, using a structural vector autoregression approach, Perotti finds no evidence in support of the fact that public investments are more effective than public consumption in boosting output. For a complete overview of the literature, see IMF (2004).

beneficial effects for all the main macrovariables.

The remainder of this paper is as follows. Section 2 presents the basic features of IGEM, the simulation tool used, focusing on the new aspects of the model. Section 3 provides a description of model parametrization. Section 4 is devoted to the study of the potential macroeconomic impact of structural reforms involving the PA. Section 5 presents an analysis of fiscal multipliers considering different categories of government expenditures. Section 6 concludes.

2 Structure of IGEM - PA

The economy is populated by households, unions, final and intermediate good producing firms, a foreign sector and the public sector. The structure of the model consists in a standard neoclassical model, augmented to include a large assortment of real and nominal frictions in the spirit of the so called "New Neoclassical Synthesis". The major novelty of this new variant of IGEM regards the full modeling of the public sector, which is assumed to provide goods and services to the private sector. Public capital is productivity-enhancing, while the public sector produces public goods and services by hiring public employees and by purchasing consumption and investment goods from the private sector. However, given the very stylized structure that a DGE model imposes, the framework presents a unique aggregate of publicly provided goods and services. Therefore the aggregate bundle of publicly provided goods and services embodies 'pure' public goods (i.e. non-rival and non-exclusive goods such as national defense, public broadcasting, artwork in public places and the like), goods and services which can be either rival or exclusive ('impure' public goods) or even both. For instance, health services provided by the national health system can be rival since public hospitals have a limited capacity. Similarly, education at public university can be rival for limited capacity, but can also be exclusive, since students not paying the required tuition fees can be excluded. Further, to capture the positive effects that publicly provided goods and services have on individuals, we assume that this bundle of goods and services positively affects households utility, so altering agents intratemporal and intertemporal decisions. In what follows we outline in detail the behavior of the different types of agents. The complete set of equilibrium conditions can be found in the Appendix.[9]

2.1 Households

There is a continuum of households in the space $[0, 1]$. There are two types of households differing with respect to their ability to access financial markets: the non Ricardian households in the interval $[0, s_{NR}]$, who simply consume their disposable income (i.e. the hand to mouth consumers) and supply differentiated labor services as atypical workers and unskilled employees, and the Ricardian households in the interval $[1 - s_{NR}, 1]$, who are able to smooth consumption over time and supply differentiated labor services as skilled and unskilled employees and as self-employed. The typical household is endowed with one unit of time in each period and

[9] This Section is mainly based on Annicchiarico et al (2013a) and amends the original text in those parts presenting the variants of this version of IGEM.

divides it between leisure and working efforts. For the sake of simplicity it is assumed that each type of household provides all differentiated labor inputs within each category it supplies. It follows that by denoting s_{N_A}, s_{N_S}, s_{L_L} and s_{L_H}, respectively, the population shares of atypical workers, self-employed workers, unskilled and skilled employees, we have that the following identities must hold:

$$s_{NR} = s_{N_A} + \lambda_{L_L} s_{L_L}, \tag{1}$$

$$1 - s_{NR} = s_{N_S} + s_{L_H} + (1 - \lambda_{L_L})\, s_{L_L}, \tag{2}$$

where λ_{L_L} is the share of unskilled labor inputs supplied by non Ricardian households.

2.1.1 Ricardian Households

The representative Ricardian household derives utility from a consumption bundle $\tilde{C}_t^R$ of a composite good, combining private and public consumption (where the superscript R stands for "Ricardian") and experiences disutility from supplying labor inputs as unskilled employees L_L, skilled employees L_H and self-employed N_S:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[U(\tilde{C}_t^R - h_{C^R} \widetilde{\overline{C}}_{t-1}^R) + \sum_{\ell^R} V_{\ell^R}(\ell_t^R) \right] \right\}, \tag{3}$$

where E_0 is the expectations operator conditional on information available at time 0, $\beta \in (0,1)$ represents the subjective discount factor and $\ell^R \in \{L_L,\, L_H,\, N_S\}$ the index denoting the three different categories of workers and the consumption bundle $\tilde{C}_t^R$ composed by market and non-market (supplied by the public sector) goods and services. This bundle is given by

$$\tilde{C}_t^R = \left[\left(\omega_G^R\right)^{1/\theta_G} \left(C_t^R\right)^{(\theta_G - 1)/\theta_G} + (1 - \omega_G^R)^{1/\theta_G} \left(Y_{G,t}^R\right)^{(\theta_G - 1)/\theta_G} \right]^{\theta_G/(\theta_G - 1)}, \tag{4}$$

where $\theta_G > 0$ measures the degree of substitutability between private C_t^R and publicly provided goods and services $Y_{G,t}^R$ while $0 < \omega_G^R < 1$ is the weight attached to the private goods and services in the consumption bundle. In addition, preferences described by the period utility function U displays external habit formation (i.e. "catching up with the Joneses" preferences. See Abel 1990), with $h_{C^R} \in [0,1)$ being the habit coefficient and $\widetilde{\overline{C}}_{t-1}^R$ the lagged aggregate consumption bundle of Ricardian households (taken as given by each household). If the parameter $\theta_G > 1$, then publicly provided and privately purchased goods and services are imperfect substitutes. Given the hybrid nature of $Y_{G,t}$, which includes goods and services that may simultaneously be non-rival and non-exclusive, rival or exclusive or even both this is our benchmark case. On the contrary, if $0 < \theta_G < 1$, then public and private goods and services are imperfect complements.[10]

The typical household also derives utility from leisure according to the period utility func-

[10] An alternative specification of the utility function, accounting for useful government spending consists in a linear specification of the type, $\tilde{C}_t^R = C_t^R + \varrho_G Y_t$, with the parameter ϱ_G capturing the degree of substitutability if positive and of complementarity if negative. See Bailey (1971).

tions V_{ℓ^R}. In what follows we adopt the following standard functional forms:

$$u(\tilde{C}_t^R - h_{C^R}\widetilde{\overline{C}}_{t-1}^R) = \log\left(\tilde{C}_t^R - h_{C^R}\widetilde{\overline{C}}_{t-1}^R\right), \tag{5}$$

$$V_{\ell^R}(1-\ell_t^R) = \frac{\omega_{\ell^R}}{1-v_{\ell^R}}\tilde{s}_{\ell^R}\left(1-\ell_t^R\right)^{1-v_{\ell^R}}, \tag{6}$$

where ω_{ℓ^R} and v_{ℓ^R} denote category-specific preference parameters and $\tilde{s}_{\ell^R}$ denotes the share of time devoted by the typical Ricardian household to the working activity of kind ℓ^R.[11] Being each household endowed with one unit of time we have $\sum_{\ell^R}\tilde{s}_{\ell^R} = 1$.[12]

Ricardian households are assumed to own three assets: government bonds, B^R, paying a gross nominal interest rate equal to R, foreign financial assets, B_F^R, paying a gross rate equal to R^* adjusted for a risk premium ρ^F (increasing in the aggregate level of foreign debt), and physical capital K^R which accumulates according to:

$$K_{t+1}^R = (1-\delta_K)K_t^R + I_t^R, \tag{7}$$

where δ_K denotes the depreciation rate of physical capital and I^R investments. Investment decisions are subject to a convex adjustment cost of $\Gamma_I\left(I_t^R\right)K_t^R$ units of the final good, where

$$\Gamma_I\left(I_t^R\right) = \frac{\gamma_I}{2}\left(\frac{I_t^R}{K_t^R} - \delta_K\right)^2, \quad \gamma_I > 0. \tag{8}$$

Owners of physical capital are also assumed to control the rate of utilization at which this factor is utilized, u_t^K. As in Christiano et al. (2005), using the stock of capital at a rate u_t^K entails a cost in terms of the final good equal to $\Gamma_{u^K}\left(u_t^K\right)K_t^R$, where

$$\Gamma_{u^K}\left(u_t^K\right) = \gamma_{u_1^K}\left(u_t^K - 1\right) + \frac{\gamma_{u_2^K}}{2}\left(u_t^K - 1\right)^2, \quad \gamma_{u_1^K}, \gamma_{u_2^K} > 0. \tag{9}$$

Households rent out their capital stock to the intermediate goods producing firms and receive a competitive rental price, r_t^K, per unit of capital. Given the degree of capital utilization u_t^K, total gross income stemming from the rental amounts to $r_t^K u_t^K K_t^R$.

Households earn a gross labor income equal to $\sum_{\ell^R}\tilde{s}_{\ell^R}W_t^{\ell^R}\ell_t^R$ and wage decisions are made by unions which supply labor in monopolistic competitive markets and face Rotemberg-type quadratic adjustment costs in terms of domestic production, Y_t, on nominal wage changes specific for each category of represented workers, $\Gamma_{W^{\ell^R}}(W_t^{\ell^R})Y_t$.

Finally, households receive dividends, PRO^R, from the intermediate goods firms, transfers

[11] The functional form specification in (6) implies that the Frisch elasticity of labor supply is decreasing in the level of hours worked.

[12] It should be noted that from the economy's population structure we have: $\tilde{s}_{L_L} = \frac{\left(1-\lambda^{L_L}\right)s_{L_L}}{1-s_{N_R}}$, $\tilde{s}_{L_H} = \frac{s_{L_H}}{1-s_{N_R}}$ and $\tilde{s}_{N_S} = \frac{s_{N_S}}{1-s_{N_R}}$, so that on aggregate the labor force supplied by Ricardian households is exactly $1 - s_{NR} = s_{N_S} + s_{L_H} + (1-\lambda_{L_L})\,s_{L_L}$.

from the government, Tr^R, and pay lump-sum taxes, TAX^R, consumption taxes (at a rate τ^C), wage income taxes (at rates $\tau_t^{\ell^R}$) and capital income taxes (τ^K), less depreciation allowances and tax credit (tcr^K). Finally, we also assume that households pay contributions to social security (at rates $\tau_{h,t}^{W^{\ell^R}}$).

The period-by-period budget constraint for the typical Ricardian agent reads as:

$$(1+\tau_t^C)P_{C,t}C_t^R + B_t^R + S_t B_{F,t}^R + P_{I,t}I_t^R = \left(1-\tau_t^{\ell^R}-\tau_{h,t}^{W^{\ell^R}}\right)\sum_{\ell^R}\tilde{s}_{\ell^R}W_t^{\ell^R}\ell_t^R + \tag{10}$$

$$+R_{t-1}B_{t-1}^R + (R_{t-1}^* + \rho_{t-1}^F)S_t B_{F,t-1}^R +$$

$$+\left(PRO_t^R + Tr_t^R - TAX_t^R\right)P_t$$

$$+\tau_t^K \delta_K P_{I,t} u_t^K K_t^R + tcr_t^K P_{I,t} I_t^R +$$

$$+(1-\tau_t^K)r_t^K P_{I,t} u_t^K K_t^R - P_{I,t}\Gamma_I\left(I_t^R\right)K_t^R +$$

$$-P_{I,t}\Gamma_{u^K}\left(u_t^K\right)K_t^R - P_t\sum_{\ell^R}\tilde{s}_{\ell^R}\Gamma_{W^{\ell^R}}(W_t^{\ell^R})Y_t,$$

where P_C denotes the price of a unit of the consumption good, P_I the price of a unit of the investment good, S_t is the nominal exchange rate defined as units of domestic currency per unit of foreign currency, P_t is the price level. The solution to the Ricardian household problem is summarized in Appendix A.

2.1.2 Non Ricardian Households

The representative non Ricardian household faces a periodic utility function of the form:

$$U(\tilde{C}_t^{NR} - h_{C^R}\widetilde{\overline{C}}_{t-1}^{NR}) + \sum_{\ell^{NR}} V_{\ell^{NR}}(\ell_t^{NR}), \tag{11}$$

where all variables are as in the previous section, the superscript NR stands for "non Ricardian" and

$$\tilde{C}_t^{NR} = \left[\left(\omega_G^{NR}\right)^{1/\theta_G}\left(C_t^{NR}\right)^{(\theta_G-1)/\theta_G} + (1-\omega_G^{NR})^{1/\theta_G}\left(Y_{G,t}^{NR}\right)^{(\theta_G-1)/\theta_G}\right]^{\theta_G/(\theta_G-1)}, \tag{12}$$

with

$$u(\tilde{C}_t^{NR} - h_{C^{NR}}\widetilde{\overline{C}}_{t-1}^{NR}) = \log\left(\tilde{C}_t^{NR} - h_{C^{NR}}\widetilde{\overline{C}}_{t-1}^{NR}\right). \tag{13}$$

As already mentioned, non Ricardian households only supply labor services as atypical workers and as unskilled employees (represented by trade unions), hence $\ell^{NR} \in \{L_L,\, N_A\}$. We assume that functional forms of $U(\cdot)$ and $V(\cdot)$ are as in (5) and (6). By assumption, non Ricardian households have no access to financial markets and do not own physical capital (i.e. non Ricardian households can neither save nor borrow), hence they derive income only from labor

activities, adjusted for taxation. The flow budget constraint in nominal terms reads as:

$$(1+\tau_t^C)P_{C,t}C_t^{NR} = \left(1-\tau_t^{\ell^{NR}}-\tau_{h,t}^{W^{\ell^{NR}}}\right)\sum_{\ell^{NR}}\tilde{s}_{\ell^{NR}}W_t^{\ell^{NR}}\ell_t^{NR}+ \\ -\sum_{\ell^{NR}}\tilde{s}_{\ell^{NR}}\Gamma_{W^{\ell^{NR}}}(W_t^{\ell^{NR}})Y_t+P_t\left(Tr^{NR}-TAX_t^{NR}\right), \tag{14}$$

where Tr^{NR} and TAX^{NR} denote government transfers and lump-sum taxes and $\Gamma_{W^{\ell^{NR}}}(W_t^{\ell^{NR}})$ denotes the nominal wage adjustment costs faced by non-Ricardian individuals in changing nominal wages. See Appendix A for details.

2.2 Wage Setting and Labor Supply

For self-employed workers and skilled and unskilled employees labor decisions are made by a central authority within the household: a professional order will act in the interest of each variety of labor services supplied as self-employed and a union will represent each variety of labor services supplied as employee. Atypical workers, instead, have no market power and supply labor services taking wage as given. See Appendix A for details.

2.2.1 Self-Employed Workers

For the self-employed labor decisions are taken under the tutelage of professional orders which supply labor services monopolistically to a continuum of labor markets of measure 1 indexed by $h_{N_S}\in[0,1]$. It is assumed that in each market h_{N_S} the professional order faces a demand for labor given by $N_{S,t}(h_{N_{S,t}}) = \left(\frac{W_t^{N_S}(h_{N_S})}{W_t^{N_S}}\right)^{-\sigma_{N_S}}N_{S,t}$, where $\sigma_{N_S}>1$ is the elasticity of substitution between labor inputs, $W_t^{N_S}(h_{N_S})$ is the market-specific nominal retribution, $W_t^{N_S}$ is the wage index and $N_{S,t}=\int_0^1 N_{S,t}(h_{N_S})dh_{N_S}$ so to satisfy the time resource constraint.

The monopolistic professional order sets $W_t^{N_S}(h_{N_{S,t}})$ in order to maximize households' expected utility (3), given the demand for its differentiated labor services and subject to a convex adjustment costs function:

$$\Gamma_{W^{N_S}}(W_t^{N_S}(h_{N_S})) = \frac{\gamma_{W^{N_S}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{N_S}(h_{N_s})}{W_{t-1}^{N_S}(h_{N_s})}-1\right)^2 Y_t, \tag{15}$$

where $\gamma_{W^{N_S}}>0$ and $\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}$ is a geometric average of past (gross) and long-run inflation, where the weight of past inflation is determined by the indexation parameter $\kappa_W\in[0,1]$.

The first-order condition for labor supply, $N_{S,t}$, in the symmetric steady-state equilibrium reads as:

$$\frac{W^{N_S}}{P} = \frac{\sigma_{N_S}}{\sigma_{N_S}-1}\frac{1}{1-\tau^{N_S}-\tau_h^{W^{N_S}}}\frac{\omega_{N_S}}{\lambda^R(1-N_s)^{\upsilon_{N_S}}}, \tag{16}$$

where λ^R is the Lagrange multiplier associated to the budget constraint (10) expressed in

real terms. Notice that market power in the labor market introduces a wedge between the real remuneration of self-employed workers, W^{N_S}/P, and the marginal rate of substitution between leisure and consumption adjusted for direct and indirect taxation. This markup $\frac{\sigma_{N_S}}{\sigma_{N_S}-1}$ is decreasing in the elasticity of substitution between differentiated labor services, σ_{N_S}, and reflects the degree of imperfect competition characterizing the labor market. The impact of structural reforms aimed at increasing the degree of competition among self-employed, such as the liberalization of professional orders, can be simulated by permanently modifying the elasticity parameter σ_{N_S}.

2.2.2 Skilled Employees

Within each Ricardian household, a union is assumed to supply labor inputs as skilled employee monopolistically to a continuum of labor markets of measure 1 indexed by $h_{L_H} \in [0,1]$. In each market, the union faces a demand for labor given by $L_{H,t}(h_{L_H}) = \left(\frac{W_t^{L_H}(h_{L_H})}{W_t^{L_H}}\right)^{-\sigma_{L_H}} L_{H,t}$ where $\sigma_{L_H} > 1$ is the elasticity of substitution between differentiated labor services, $W_t^{L_H}(h_{L_H})$ is the market-specific nominal wage, $W_t^{L_H}$ is the wage index and $L_{H,t} = \int_0^1 L_{H,t}(h_{L_H})dh_{L_H}$. We also assume for employees costly nominal wages adjustment of the form $\Gamma_{W^{L_H}}(W_t^{L_H}(h_{L_H})) = \frac{\gamma_{W^{L_H}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{L_H}(h_{L_H})}{W_{t-1}^{L_H}(h_{L_H})} - 1\right)^2 Y_t$, where $\gamma_{W^{L_H}} > 0$.

In steady-state and imposing symmetry across differentiated skilled labor services, the wage equation boils down to

$$\frac{W^{L_H}}{P} = \frac{\sigma_{L_H}}{\sigma_{L_H}-1}\frac{1}{1-\tau^{L_H}-\tau_h^{W^{L_H}}}\frac{\omega_{L_H}}{\lambda^R(1-L_H)^{v_{L_H}}}. \tag{17}$$

It follows that reforms, aimed at reducing the bargaining power of insiders and align wages to productivity trends, are simply mapped onto the model by increasing the elasticity of substitution between pairs of differentiated skilled labor inputs so to reduce the wage markup $\frac{\sigma_{L_H}}{\sigma_{L_H}-1}$.

2.2.3 Unskilled Employees

Unskilled labor services are assumed to be supplied by both Ricardian and non Ricardian households. As for skilled employees, we assume a continuum of differentiated labor inputs indexed by $h_{L_L} \in [0,1]$ supplied monopolistically by unions. For simplicity we assume that households are distributed uniformly across unions, hence aggregate demand of labor type h_{L_L}, that is $L_{L,t}(h_{L_L}) = \left(\frac{W_t^{L_L}(h_{L_L})}{W_t^{L_L}}\right)^{-\sigma_{L_L}} L_{L,t}$, is evenly distributed between all households, with $\sigma_{L_L} > 1$ denoting the elasticity of substitution between differentiated labor services, $W_t^{L_L}(h_{L_L})$ is the nominal wage of type h_{L_L}, $W_t^{L_L}$ is the wage index of the category and $L_{L,t} = \int_0^1 L_{L,t}(h_{L_L})dh_{L_L}$. It follows that a share λ^{L_L} of the associates are non Ricardian consumers, while the remaining share is composed by Ricardian agents. The union will set the nominal wage $W_t^{L_L}(h_{L_L})$, so as

to maximize a weighted average of agents' lifetime utilities. Adjustment costs on nominal wages are given by a quadratic cost function, $\Gamma_{W^{L_L}}(W_t^{L_L}(h_{L_L})) = \frac{\gamma_{W^{L_L}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\bar{\Pi}^{1-\kappa_W}}\frac{W_t^{L_L}(h_{L_L})}{W_{t-1}^{L_L}(h_{L_L})}-1\right)^2 Y_t$, where $\gamma_{W^{L_L}} > 0$.

In steady state the first-order condition for wage setting, after having imposed symmetry across differentiated unskilled labor services, reads as follows:

$$\frac{W^{L_L}}{P} = \frac{\sigma_{L_L}}{\sigma_{L_L}-1}\frac{1}{1-\tau^{L_L}-\tau_h^{W^{L_L}}}\frac{\omega_{L_L}}{\left[(1-\lambda^{L_L})\lambda^R+\lambda^{L_L}\lambda^{NR}\right](1-L_L)^{v_{LL}}}, \tag{18}$$

where we have used the fact that given the population structure the weights attached by the union to Ricardian and non Ricardian households are given by $(1-s_{NR})$ and s_{NR}, respectively, and that given the allocation of time within each household, the effective weights boil down to $(1-\lambda_{L_L})$ and λ_{L_L}, respectively.[13] By permanently modifying the elasticity parameter σ_{L_L} we are able to alter the market power of the trade unions representing unskilled labor workers.

2.2.4 Atypical Workers

By assumption, only non Ricardian households supply labor services as atypical workers. For this category of workers, with no union coverage, the labor supply equation solves the optimization problem of the typical non Ricardian household and equates the real wage to marginal rate of substitution between leisure and consumption:

$$\frac{W_t^{N_A}}{P_t} = \frac{1}{1-\tau_t^{N_A}-\tau_{h,t}^{W^{N_A}}}\frac{\omega_{N_A}}{\lambda_t^{NR}(1-N_{A,t})^{v_{N_A}}}. \tag{19}$$

According to the above condition, it is possible to increase labor supply of atypical workers simply by reducing the tax wedge.

2.3 Firms

The economy features four types of firms: (i) a continuum of firms producing differentiated tradable intermediate goods; (ii) a continuum of monopolistically competitive exporting firms transforming domestic tradable into exportable goods using a linear technology; (iii) a continuum of monopolistically competitive importing firms transforming foreign tradable goods into importable goods using a linear technology; (iv) perfectly competitive firms producing a final non-tradable good by combining domestically produced intermediate goods with imported intermediate goods. In Appendix A we report the first-order conditions characterizing the optimal solution to the firms problem.

[13] Given the population structure and the allocation of time within each household, the weights attached by the union to Ricardian and non Ricardian households are, in fact, given by $(1-s_{NR})\frac{1-\lambda_{L_L}}{1-s_{NR}}s_{L_L}$ and $s_{NR}\frac{\lambda_{L_L}}{s_{NR}}s_{L_L}$.

2.3.1 Intermediate-Good Firms

The intermediate goods sector is made by a continuum of monopolistically competitive producers indexed by $j \in [0,1]$. The typical firm j uses labor inputs and capital to produce intermediate goods $Y_t(j)$ according to the following technology:

$$Y_t(j) = A_t \left[\left(L_{CES,t}(j) - OH_t^L \right)^{\alpha_L} \left(N_{CES,t}(j) - OH_t^N \right)^{\alpha_N} \left(u_t^K K_t(j) \right)^{1-\alpha_L-\alpha_N} \right]^{1-\alpha_G} \left(K_{G,t}^P \right)^{\alpha_G} \tag{20}$$

where $0 < \alpha_L, \alpha_N, \alpha_G < 1$, $\alpha_L + \alpha_N < 1$, A_t denotes total factor productivity, $L_{CES,t}$ and $N_{CES,t}$ denote CES aggregates of labor inputs hired as employees and as self-employed and atypical workers. The first bundle represents a combination of skilled and unskilled labor inputs hired in less competitive markets with more stable labor contracts, while the second bundle includes labor inputs hired in the form of more flexible labor patterns. OH_t^L and OH_t^N stand for overhead labor which captures the notion that a firm must employ a minimum amount of labor to produce any output (this includes tasks like management, supervision, breaks, meetings, maintenance, time spent with government bureaucracy), while $K_{G,t}^P$ is the stock of government capital whose level depends on the public infrastructure investment decisions $I_{G,t}^P$ and evolves as $K_{G,t}^P = (1-\delta_G)K_{G,t-1}^P + I_{G,t}^P$, with δ_G being the depreciation rate. In the spirit of Barro (1990) this productive role of government capital creates a positive linkage between government spending and output. Note that production exhibits decreasing returns to private inputs if the (complementary) government capital inputs do not expand in a parallel manner.[14]

The labor aggregates $L_{CES,t}$ and $N_{CES,t}$ are defined as follows:

$$L_{CES,t} = \left[sy_{L_L}^{\frac{1}{\sigma_L}} \left(ef_{L_L} LY_{L,t} \right)^{\frac{\sigma_L - 1}{\sigma_L}} + sy_{L_H}^{\frac{1}{\sigma_L}} \left(ef_{L_H} LY_{H,t} \right)^{\frac{\sigma_L - 1}{\sigma_L}} \right]^{\frac{\sigma_L}{\sigma_L - 1}}, \tag{21}$$

$$N_{CES,t} = \left[sy_{N_S}^{\frac{1}{\sigma_N}} \left(ef_{N_S} NY_{S,t} \right)^{\frac{\sigma_N - 1}{\sigma_N}} + sy_{N_A}^{\frac{1}{\sigma_N}} \left(ef_{N_A} NY_{A,t} \right)^{\frac{\sigma_N - 1}{\sigma_N}} \right]^{\frac{\sigma_N}{\sigma_N - 1}}, \tag{22}$$

where we have dropped index j to save on notation, $\sigma_L, \sigma_N > 1$ measure the elasticity of substitution between the categories of workers of each CES aggregate, the coefficients ef_{L_L}, ef_{L_H}, ef_{N_S}, ef_{N_A} measure efficiency, the terms sy_{L_L}, sy_{L_H}, sy_{N_S}, sy_{N_A} represent the shares of each category of workers in their respective aggregate and $LY_{L,t}$, $LY_{H,t}$, $NY_{S,t}$, $NY_{A,t}$ denote the labor inputs. Labor inputs $LY_{L,t}$, $LY_{H,t}$, $NY_{S,t}$, are, in turn, CES bundles of differentiated labor inputs with elasticity of substitution equal to σ_{L_L}, σ_{L_H} and σ_{N_S}, respectively, so that at the optimum and after aggregation across the continuum of intermediated-good firms j, the demand schedule for each variety within each category will be as outlined in the previous section

[14] The output elasticity of public capital α_G plays an important role in shaping the macroeconomic impact of the policy changes. A lower α_G, for instance, by implying higher returns to private inputs, tends to increase the positive impact of reforms aimed at boosting the level of economic activity by inducing a larger private investments and/or employment. On the other hand, a lower α_G diminishes the effects of an increase in public investment on the overall level of economic activity. See Appendix D, where we show our results for a lower value of α_G.

on wage setting.

The production function (20) with (21) and (22) has a particular nesting structure which deserves some more explanation. The idea here is to capture the fact that a production unit needs to employ labor services both in stable and in more flexible patterns.[15] As a matter of fact, on the one hand, firms need more stabilized workers (on whom they can always count) involved in the core business activities and in those which are strictly functional to these activities themselves, on the other, firms externalize activities that do not involve core competencies, relying on workers who supply their services as self-employed or atypical workers. Furthermore, the possibility of having substitutability between self-employed and atypical is meant to capture some particular features of the Italian labor markets. In the first place, atypical workers in Italy are not necessarily low skilled and in most cases they have tertiary education.[16] Secondly, as already explained, the category of workers labeled as atypical, also includes a small fraction of self-employed workers (the young), so as to capture the phenomenon of the false independent work. In addition, firms tend to employ a core of permanent workers on whom an investment in training is made to increase productivity and obtain better functional flexibility. Yet, firms are also likely to employ a group of peripheral workers or rely on external services to be able to better meet temporary changes in the economic conditions.

Firms are assumed to pay social contributions at rates $\tau_f^{W^{L_H}}$, $\tau_f^{W^{L_L}}$, $\tau_f^{N_A}$ and $\tau_f^{W^{N_S}}$, respectively for skilled and unskilled employees, atypical workers and self-employed workers, and may receive incentives in the form of subsidies for hiring workers with the (exception of self-employed) at the differentiated rates sub^{L_H}, sub^{L_L}, sub^{N_A}.

The objective of each firm j is to maximize the sum of expected discounted real profits by setting the optimal price $P_t(j)$ and making choices about labor inputs and physical capital, given the available technology (20), the demand schedule for variety j, $Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\theta_Y} Y_t$,[17] quadratic adjustment costs on price setting à la Rotember (1982):

$$\Gamma_P(P_t(j)) = \frac{\gamma_P}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_P}\overline{\Pi}^{1-\kappa_P}}\frac{P_t(j)}{P_{t-1}(j)} - 1\right)^2 Y_t, \tag{23}$$

with $\gamma_p > 0$ and $\kappa_P \in [0,1]$ denoting weight of past inflation in the indexation, and quadratic adjustment costs on labor inputs changes:

$$\Gamma_{L_H}(LY_H(j)) = \frac{\gamma_{L_H}}{2}\left(\frac{LY_{H,t}(j)}{LY_{H,t-1}(j)} - 1\right)^2 Y_t, \tag{24}$$

[15] Other nesting hypotheses will be considered in future extensions, since the quantitative effects of policy interventions on hours worked and labor remuneration of the single categories of workers can considerably change.

[16] See ISFOL (2012). As an example, in 2010 about 30% of workers with tertiary education, since four years from the first job, were still employed in "temporary" positions.

[17] The intermediate good j is demanded by final good firms to produce consumption and investment goods and by exporters to produce tradable goods.

$$\Gamma_{L_L}(LY_L(j)) = \frac{\gamma_{L_L}}{2}\left(\frac{LY_{L,t}(j)}{LY_{L,t-1}(j)} - 1\right)^2 Y_t, \tag{25}$$

$$\Gamma_{N_S}(NY_S(j)) = \frac{\gamma_{N_S}}{2}\left(\frac{NY_{S,t}(j)}{NY_{S,t-1}(j)} - 1\right)^2 Y_t, \tag{26}$$

$$\Gamma_{N_A}(NY_A(j)) = \frac{\gamma_{N_A}}{2}\left(\frac{NY_{A,t}(j)}{NY_{A,t-1}(j)} - 1\right)^2 Y_t, \tag{27}$$

where we assume that $0 < \gamma_{N_A} < \gamma_{N_S} < \gamma_{L_H} = \gamma_{L_L}$ in order to capture the higher costs associated with changes in the labor inputs related to workers with stable contracts.

Optimal Price Setting The elasticity of substitution between products of differentiated intermediate goods, θ_Y, determines the market power of each firm. In steady state, the first order condition for price setting reads as:

$$P = \frac{\theta_Y}{\theta_Y - 1} MC^N, \tag{28}$$

where MC^N denotes the nominal marginal cost. The above result implies that in the steady state the real marginal cost, $MC = MC^N/P$, is equal to the inverse of the markup (measuring the degree of market power of intermediate-good producers) which, in turn, is decreasing in the elasticity of substitution θ_Y. Pro-competitive reforms in the production market are simulated by increasing the elasticity of substitution between pairs of intermediate goods varieties θ_Y.

Capital and Labor Inputs Decisions Under symmetry, the first-order condition to the optimization problem with respect to physical capital inputs is given by:

$$\frac{P_t^I}{P_t} u_t^K r_t^k = (1 - \alpha_G)(1 - \alpha_L - \alpha_N) MC_t \frac{Y_t}{K_t}. \tag{29}$$

where u_t^K is the capital utilization rate decided by households and r_t^k is the rental cost.

Turning to the decisions on labor inputs, in steady state, the following first-order conditions must hold for unskilled and skilled employees, atypical and self-employed workers:

$$\frac{W^{L_L}}{P}\left(1 - sub^{L_L} + \tau_f^{W^{L_L}}\right) = \alpha_L (1 - \alpha_G) MC \frac{Y}{L_{CES} - OH^L}\left(\frac{L_{CES}}{LY_L}\right)^{\frac{1}{\sigma_L}} s_{L_L}^{\frac{1}{\sigma_L}} ef_{L_L}^{\frac{\sigma_L - 1}{\sigma_L}}, \tag{30}$$

$$\frac{W^{L_H}}{P}\left(1 - sub^{L_H} + \tau_f^{W^{L_H}}\right) = \alpha_L (1 - \alpha_G) MC_t \frac{Y_t}{L_{CES,t} - OH_t^L}\left(\frac{L_{CES,t}}{LY_H}\right)^{\frac{1}{\sigma_L}} s_{L_H}^{\frac{1}{\sigma_L}} ef_{L_H}^{\frac{\sigma_L - 1}{\sigma_L}}, \tag{31}$$

$$\frac{W^{N_A}}{P}\left(1 - sub^{N_A} + \tau_f^{W^{N_A}}\right) = \alpha_N (1 - \alpha_G) MC \frac{Y_t}{N_{CES} - OH^N}\left(\frac{N_{CES}}{NY_A}\right)^{\frac{1}{\sigma_N}} s_{N_S}^{\frac{1}{\sigma_N}} ef_{N_S}^{\frac{\sigma_N - 1}{\sigma_N}}, \tag{32}$$

$$\frac{W^{N_S}}{P}\left(1 + \tau_f^{W^{N_S}}\right) = \alpha_N (1 - \alpha_G) MC \frac{Y}{N_{CES} - OH^N}\left(\frac{N_{CES}}{NY_S}\right)^{\frac{1}{\sigma_N}} s_{N_S}^{\frac{1}{\sigma_N}} ef_{N_S}^{\frac{\sigma_N - 1}{\sigma_N}}. \tag{33}$$

Clearly, payroll taxes and subsidies introduce a wedge between the wage rate and the marginal revenue of labor inputs.

2.3.2 Exporting and Importing Firms

We assume the existence of a continuum of monopolistically competitive exporting firms transforming domestic intermediate goods into exportable goods using a linear technology. This implies that exporters are able to set the price for their product at a markup over their marginal cost. Furthermore, we assume that there are costs to adjusting prices:

$$\Gamma_{P_X}(P_{X,t}(j)) = \frac{\gamma_{EXP}}{2}\left[\frac{1}{\left(\Pi^*_{t-1}\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}\frac{P_{X,t}(j)}{P_{X,t-1}(j)} - 1\right]^2 EXP_t, \tag{34}$$

where $P_{X,t}(j)$ is the price set by the exporter in foreign currency for the good j, $\gamma_{EXP} > 0$, $\left(\Pi^*_{t-1}\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}$ is a geometric average of past (gross) and long-run inflation prevailing in the foreign market, where the weight of past inflation is determined by the indexation parameter $\kappa_{EXP} \in [0,1]$.

The typical exporting firm will thus set the exporting price $P_{X,t}(j)$, so as to maximize the expected discounted value of future profits, taking as given the adjustment cost (34), the exchange rate S_t and the world demand for good j $EXP_t(j) = \left(\frac{P_{X,t}(j)}{P_{X,t}}\right)^{-\theta_{EXP}} EXP_t$, where $\theta_{EXP} > 1$ is the elasticity of substitution between tradeable goods, EXP_t denotes the total demand of exportations and $P_{X,t}$ is the ideal export price index, given by $P_{X,t} = \left[\int_0^1 P_{X,t}(j)^{1-\theta_{EXP}}\, dj\right]^{\frac{1}{1-\theta_{EXP}}}$. Export demand, in turn, is a function depends on world demand WD_t, on the export price index $P_{X,t}$, ond the consumption price index prevailing abroad $P^*_{C,t}$ and on the elasticity σ_{EXP}: $EXP_t = \alpha_{EXP}\left(\frac{P_{X,t}}{P^*_{C,t}}\right)^{-\sigma_{EXP}} WD_t$, where $0 < \alpha_{EXP} < 1$.

In steady state the markup charged by exporting firms will be constant:

$$SP_X = \frac{\theta_{EXP}}{\theta_{EXP} - 1}P. \tag{35}$$

By analogy, the same logic applies to importers, which are domestic firms setting prices in local currency as a markup over the import price of intermediate goods produced abroad and facing a demand $IMP_t(j) = \left(\frac{P_{M,t}(j)}{P^M_t}\right)^{-\theta_{IMP}} IMP_t$ where $\theta_{IMP} > 1$ is the elasticity of substitution between imported goods, IMP_t denotes the total demand of imported goods, $P_{M,t}(j)$ is the price of the imported good expressed in domestic currency and $P_{M,t}$ is the ideal import price index, given by $P_{M,t} = \left[\int_0^1 P_{M,t}(j)^{1-\theta_{IMP}}\, dj\right]^{\frac{1}{1-\theta_{IMP}}}$. Since we assume an identical setup for importing firms, the quadratic cost function to adjusting prices is:

$$\Gamma_{P_M}(P_{M,t}(j)) = \frac{\gamma_{IMP}}{2}\left[\frac{1}{\Pi^{\kappa_{IMP}}_{t-1}\overline{\Pi}^{1-\kappa_{IMP}}}\frac{P_{M,t}(j)}{P_{M,t-1}(j)} - 1\right]^2 IMP_t, \tag{36}$$

where $\gamma_{IMP} > 0$ and $\kappa_{IMP} \in [0,1]$. Notice that in steady state the optimal pricing condition of the typical importing firm is:

$$P_M = \frac{\theta_{IMP}}{\theta_{IMP} - 1} SP^*. \tag{37}$$

2.3.3 Final-Good Firms

We assume that firms producing final non-tradable goods are symmetric and act under perfect competition. Final goods can be used for private and public consumption and for private and public investment.

The representative firm producing the final non-tradable good E_t combines a bundle of domestically produced intermediate goods $Y_{H,t}$ with a bundle of imported intermediate goods IMP_t according to a constant elasticity of substitution (CES) technology:

$$E_t = \left[(1 - \alpha_{IMP})^{\frac{1}{\sigma_{IMP}}} Y_{H,t}^{\frac{\sigma_{IMP}-1}{\sigma_{IMP}}} + \alpha_{IMP}^{\frac{1}{\sigma_{IMP}}} IMP_t^{\frac{\sigma_{IMP}-1}{\sigma_{IMP}}} \right]^{\frac{\sigma_{IMP}}{\sigma_{IMP}-1}}, \tag{38}$$

where σ_{IMP} is the elasticity of substitution between domestically produced goods and internationally produced goods, α_{IMP} represents the share of foreign intermediate goods used in the production of the final goods and

$$Y_{H,t} = \left[\int_0^1 Y_{H,t}(j)^{\frac{\theta_Y - 1}{\theta_Y}} dj \right]^{\frac{\theta_Y}{\theta_Y - 1}}, \tag{39}$$

$$IMP_t = \left[\int_0^1 IMP_t(j)^{\frac{\theta_{IMP}-1}{\theta_{IMP}}} dj \right]^{\frac{\theta_{IMP}}{\theta_{IMP}-1}}, \tag{40}$$

where θ_Y, $\theta_{IMP} > 1$ denote the elasticities of substitution between the differentiated intermediate goods produced at home and abroad. At the optimum:

$$Y_{H,t} = (1 - \alpha_{IMP}) \left(\frac{P_t}{P_{E,t}} \right)^{-\sigma_{IMP}} E_t, \tag{41}$$

$$IMP_t = \alpha_{IMP} \left(\frac{P_{M,t}}{P_{E,t}} \right)^{-\sigma_{IMP}} E_t, \tag{42}$$

where the price (ideal) index $P_{E,t}$ is defined as

$$P_{E,t} \equiv \left[(1 - \alpha_{IMP}) (P_t)^{1-\sigma_{IMP}} + \alpha_{IMP} (P_{M,t})^{1-\sigma_{IMP}} \right]^{\frac{1}{1-\sigma_{IMP}}}. \tag{43}$$

Perfect competition and free entry drive the final good-producing firms' profits to zero, so that from the zero-profit condition we obtain:

$$P_t = \left[\int_0^1 P_t(j)^{1-\theta_Y} dj \right]^{\frac{1}{1-\theta_Y}}. \tag{44}$$

which defines the aggregate price index of our economy.

2.4 Public Sector

The public sector produces public goods and services by hiring public employees and by purchasing consumption and investment goods from the private sector. In particular, following most of the related literature, the government is assumed to produce goods and services Y^G by combining labor L_G (public employment), purchases of final goods G_t and $I^G_{G,t}$ according to the following CES technology:

$$Y_{G,t} = A^G_t \left[\begin{array}{c} (1-\gamma_G-\gamma_{LG})^{1/\alpha_{PA}} \left(K^G_{G,t}\right)^{\frac{\alpha_{PA}-1}{\alpha_{PA}}} + (\gamma_G)^{1/\alpha_{PA}} \left(\kappa_g G_t\right)^{\frac{\alpha_{PA}-1}{\alpha_{PA}}} + \\ +(\gamma_{LG})^{1/\alpha_{PA}} \left(L_{G,t} - OH^{L_G}_t\right)^{\frac{\alpha_{PA}-1}{\alpha_{PA}}} \end{array} \right]^{\frac{\alpha_{PA}}{\alpha_{PA}-1}}, \quad (45)$$

where A^G_t measures the level of productivity of the public sector, $K^G_{G,t}$ denotes public capital, $OH^{L_G}_t$ captures the overhead labor of public employment, $\alpha_{PA} > 0$ is the degree of substitutability between the three inputs, while $1 < \gamma_G, \gamma_{LG} < 0$ are the weights associated to G_t and to $L_{G,t}$, respectively.[18]

Public capital $K^G_{G,t}$ depends on the public infrastructure investment decisions $I^G_{G,t}$ and evolves as $K^G_{G,t} = (1-\delta_G)K^G_{G,t-1} + I^G_{G,t}$, with δ_G being the depreciation rate. All the three inputs are exogenously set by the government. The coefficient $0 < \kappa_g \leq 1$ attached to G_t is meant to capture the possible inefficiency and/or waste of resources in the utilization of the final good when producing goods and services. We further assume that the wage paid to public employees is that set by the union for permanent workers employed in the intermediate good sector, that is $W^{L_L}_t$.

In addition, the government decides over the components of public investment that accumulates in the share of public capital positively affecting productivity IG^P_t, makes transfers to households Tr_t, gives subsidies to intermediate goods producers SUB_t, receives lump-sum taxes TAX_t and tax payments on labor income, consumption and capital, namely $LTAX_t$, $TVAT_t$, $KTAX_t$, and issues nominal bonds B_t. Finally, we assume that the government undertakes an additional government spending, G^U_t, which enters the economy as a component of aggregate demand. Technically speaking, this is the so called "pure waste" component of public spending, since it concurs neither to the production of the public services, nor to the public capital formation. Wasteful public spending may be related to crimes, illicit deeds and frauds in relation to public contracts and public administration in general, but also to revenue losses caused by public officials, to litigation costs due to delays in executing public works and the like.

[18] The production function of publicly provided goods and services follows closely that adopted by Forni et al. (2010), where a fixed production factor (land and the stock of public buildings) is considered instead of public capital. Linnemann (2009) and Economides et al. (2014), instead, consider a public sector production function which employs only final goods and public employment, while Pappa (2010) uses a production function in public capital and public employment.

The flow budget constraint of the government in nominal terms is then given by

$$\begin{aligned} B_t &= R_{t-1}B_{t-1} + P_{C,t}G_t + P_{C,t}G_t^U + P_{I,t}\left(I_{G,t}^G + I_{G,t}^P\right) + P_t Tr_t + \\ &\quad -P_t TAX_t - P_t\left(LTAX_t + TVAT_t + KTAX_t\right) + \\ &\quad +P_t SUB_t + W_t^{L_L} L_t^G, \end{aligned} \tag{46}$$

where is the term $W_t^{L_L} L_t^G$ represents the compensation for public employees, with $W_t^{L_L}$ being the wage index for low-skilled employees operating in the private sector (see Appendix B for details).

$$TAX_t = s_{NR} TAX_t^{NR} + (1 - s_{NR}) TAX_t^R \tag{47}$$

$$Tr_t = s_{NR} Tr_t^{NR} + (1 - s_{NR}) Tr_t^R, \tag{48}$$

$$\begin{aligned} LTAX_t &= s_{L_L} L_{L_L} WR^{L_L}\left(\tau_t^{L_L} + \tau_{h,t}^{W_{L_L}} + \tau_{f,t}^{W_{L_L}}\right) + \\ &\quad +s_{L_H} L_{L_H} WR^{L_H}\left(\tau_t^{L_H} + \tau_{h,t}^{W_{L_H}} + \tau_{f,t}^{W_{L_H}}\right) + \\ &\quad +s_{N_S} L_{N_S} WR^{N_S}\left(\tau_t^{N_S} + \tau_{h,t}^{W_{N_S}} + \tau_{f,t}^{W_{N_S}}\right) + \\ &\quad +s_{N_A} L_{N_A} WR^{N_A}\left(\tau_t^{N_A} + \tau_{h,t}^{W_{N_A}} + \tau_{f,t}^{W_{N_A}}\right), \end{aligned} \tag{49}$$

$$TVAT_t = \tau_t^C\left[s_{NR} C_t^{NR} + (1 - s_{NR}) C_t^R\right], \tag{50}$$

$$KTAX_t = \tau_t^K\left(r_t^K - \delta^K\right) u_t^K K_t - tcrk_t \frac{P_{I,t}}{P_t} I_t, \tag{51}$$

$$\begin{aligned} BTAX_t &= \tau_{Y,t} Y_t + \\ &-\tau_{Y,t}\left[\left(1 + \tau_{f,t}^{N_S}\right) s_{N_S} L_{t,N_S} WR_t^{N_S} + \left(1 - sub_t^{N_A} + \tau_{f,t}^{W_A^N}\right) s_{N_A} L_{t,N_A} WR_t^{N_A}\right] + \\ &-\tau_{Y,t}\frac{P_{I,t}}{P_t} u_t^k r_t^k K_t + \\ &-I_{\tau_Y}\tau_{Y,t}\left[s_{L_L} L_{t,L_L} WR_t^{L_L}\left(1 - sub_t^{L_L} + \tau_t^{W^{L_L}}\right) + s_{L_H} L_{t,L_H} WR_t^{L_H}\left(1 - sub_t^{L_H} + \tau_t^{W^{L_H}}\right)\right], \end{aligned} \tag{52}$$

$$SUB_t = sub_t^{L_L} s_{L_L} L_L WR^{L_L} + sub_t^{L_H} s_{L_H} L_H WR^{L_H} + sub_t^{N_A} s_{N_A} N_A WR^{N_A}, \tag{53}$$

with $WR^{L_L} = W^{L_L}/P$, $WR^{L_H} = W^{L_H}/P$, $WR^{N_A} = W^{N_A}/P$ and $WR^{N_S} = W^{N_S}/P$.

The lump-sum component of taxation is set endogenously according to the following "passive rule" as meant by Leeper (1991):

$$P_t TAX_t = P_t\overline{TAX} + T_B\left(B_{t-1} - \overline{B}\right) + T_D D_t + T_Y P_t\left(Y_t - Y_{t-1}\right). \tag{54}$$

where T_B, T_D and T_Y are policy parameters, $\overline{TAX}$ and $\overline{B}$ are the long-run level of lump-sum

taxation and of public debt, and D_t denotes the budget deficit:

$$\begin{aligned} D_t &= (R_{t-1}-1)B_{t-1} + P_{C,t}G_t + P_{C,t}G_t^U + P_{I,t}\left(I_{G,t}^G + I_{G,t}^P\right) + P_t Tr_t + \\ &\quad -P_t TAX_t - P_t\left(LTAX_t + CVAT_t + KTAX_t\right) + P_t SUB_t + P_t WR_t^{L_L} L_t^G. \end{aligned} \tag{55}$$

The monetary authority adopts a Taylor-type interest rate rule specified as follows:

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}}\right)^{\iota_R}\left[\left(\frac{\Pi_t}{\Pi^T}\right)^{\iota_\Pi}\left(\frac{Y_t}{Y_{t-1}}\right)^{\iota_Y}\left(\frac{S_t}{S_{t-1}}\right)^{\iota_S}\right]^{1-\iota_R}\varepsilon_t^R. \tag{56}$$

where $\overline{R}$ is the equilibrium nominal interest rate, Π^T is the monetary authority inflation target, ε_t^R is an exogenous process describing possible monetary policy shocks and ι_R, ι_Π, ι_Y, ι_S are policy parameters.

2.5 Aggregation and Foreign Asset Position

Since only Ricardian households hold financial assets, accumulate physical capital and own domestic firms, equilibrium requires that the following conditions must be satisfied: $(1-s_{NR})B_t^R = B_t$, $(1-s_{NR})B_{F,t}^R = B_{F,t}$, $I_t = (1-s_{NR})I_t^R$, $(1-s_{NR})K_t^R = K_t$, $(1-s_{NR})PRO_t^R = PRO_t$ while aggregate consumption is:

$$C_t = (1-s_{NR})C_t^R + s_{NR}C_t^{NR}. \tag{57}$$

Similarly, for public services we have that:

$$Y_{G,t} = (1-s_{NR})Y_{G,t}^R + s_{NR}Y_{G,t}^{NR}. \tag{58}$$

Equilibrium in the labor markets requires that the quantity of each category of labor employed in the intermediate good sector must be equal to the supply, hence:

$$LY_{L,t} = s_{L_L}L_{L,t}, \tag{59}$$

$$LY_{H,t} = s_{L_H}L_{H,t}, \tag{60}$$

$$NY_{S,t} = s_{N_S}N_{S,t}, \tag{61}$$

$$NY_{A,t} = s_{N_A}N_{A,t}. \tag{62}$$

Aggregate capital accumulates as follows:,

$$K_{t+1} = I_t + (1-\delta)K_t. \tag{63}$$

Since the final good can be used for private and public consumption and for private and

public investments, we have:

$$P_{C,t} = P_{I,t} = P_{E,t} = \left[(1-\alpha_{IMP})P_t^{1-\sigma_{IMP}} + \alpha_{IMP}P_{M,t}^{1-\sigma_{IMP}}\right]^{\frac{1}{1-\sigma_{IMP}}}. \tag{64}$$

The economy's net foreign asset position denominated in domestic currency evolves as:

$$S_t B_{F,t} = \left(R_{t-1}^* + \rho_{t-1}^F\right) S_t B_{F,t-1} + S_t P_{X,t} EXP_t - P_{M,t} IMP_t, \tag{65}$$

where the risk premium ρ_t^F is assumed to be increasing in the aggregate level of foreign debt. As in Schmitt-Grohé and Uribe (2003) we use the following functional form for the risk premium: $\rho_t^F = -\varphi^F(e^{BR_t^F - BR^F} - 1)$, where φ^F is a positive parameter, $BR_t^F = S_t B_{F,t}/P_t$ and BR^F is the steady state level of net foreign assets in real terms. Clearly, in the steady-state $\rho_t^F = 0$.

The resource constraint of the economy immediately follows:

$$\begin{aligned} Y_t \;=\; & \frac{P_t^C}{P_t}\left(C_t + G_t + G_t^U + I_t + I_{G,t}^G + I_{G,t}^P\right) + \frac{S_t P_{X,t}}{P_t} EXP_t - \frac{P_{M,t}}{P_t} IMP_t + \\ & + \Gamma_P(P_t) + \frac{P_{M,t}}{P_t}\Gamma_{P_M}(P_{M,t}) + \frac{S_t P_{X,t}}{P_t}\Gamma_{P_X}(P_{X,t}) + \frac{P_t^C}{P_t}\Gamma_{P_E}(P_{E,t}) \\ & + \Gamma_{L_H}(LY_H) + \Gamma_{L_L}(LY_L) + \Gamma_{N_A}(NY_A) + \Gamma_{N_S}(NY_S) + \\ & + \Gamma_{W^{L_H}}(W_t^{L_H}) + \Gamma_{W^{L_L}}(W_t^{L_L}) + \Gamma_{W^{N_S}}(W_t^{N_S}) + \Gamma_{W^{N_A}}(W_t^{N_A}) \\ & + \frac{P_t^I}{P_t}\Gamma_{u^K}\left(u_t^K\right) + \frac{P_t^I}{P_t}\Gamma_I\left(I_t^R\right) + WR_t^{L_L} L_t^G, \end{aligned} \tag{66}$$

where as common practice in national accounts statistics the expenditure for public employment enters in the definition of GDP in equilibrium.

The equilibrium equations of the model are listed in Appendix B.

3 Parametrization

In this Section we summarize the parametrization of the model which is mainly based on calibration, with the exception of the main parameters governing the supply of labor inputs for which we have used the estimates obtained with the microsimulation model EconLav. Specifically, IGEM is calibrated on a quarterly basis in order to match steady-state ratios and some specific features of the Italian economy over the period 2002-2008.

The parametrization is summarized in Tables 1 and 2. We set the benchmark parameters in line with the existing literature. The discount factor β is equal to 0.99, so as to imply an annual real interest rate of 4%. The rates of depreciation of private and public physical capital δ_K, δ_G are set to 0.025 (so as to imply a 10% annual depreciation rate of capital). The capital share in the intermediate goods production is equal to 0.3, hence $1 - \alpha_L - \alpha_N = 0.3$, while the labor shares are such that $\alpha_L = \alpha_N = 0.35$. The CES parameters σ_L and σ_N are set at 1.4 according to Katz and Murphy (1992) estimates also used in QUEST III for Italy.

The elasticity of substitution between domestic goods in the intermediate sector, θ_Y, is set

equal to 5 so to have a steady-state level of net markup equal to 25% which is consistent with the value set in the Italian version of QUEST III with R&D (see D'Auria et al. 2009). Since in IGEM tradeable goods are produced in the intermediate sector, we also set the elasticities of substitution between imported and exported varieties, θ_{IMP} and θ_{EXP}, at 5.

The contribution of imported intermediate goods to the final good production, summarized by the parameter α_{IMP} is equal to 0.26, consistently with QUEST III, while the elasticity of substitution between domestic and foreign intermediate varieties σ_{IMP} is set at 1.1. Similarly and consistently with QUEST III, the share of foreign goods in total consumption for the rest of the world, α_{EXP}, equals 0.26, and the elasticity of substitution between domestic and foreign intermediate varieties in the rest of the world, σ_{EXP}, equals that in the domestic economy and amounts to 1.1. The habit persistence parameter of Ricardian households, h_{C^R}, is set to 0.7 as in QUEST III (see Ratto et al. 2009), while that of non Ricardian households, $h_{C^{NR}}$, is set at 0.3. This different setting in habit persistence between Ricardian and non Ricardian households reflects their relative ability to change their consumption profile over time in response to shocks. The values we set for the habit formation parameters are consistent with the estimates of Sommer (2007).

For simplicity, in this version, the steady-state inflation is set equal to zero, $\Pi = 1$, and we assume full backward indexation of prices and wages, $\kappa_P = \kappa_W = 1$.

Using the RCFL - ISTAT 2008 data, labor categories are defined as follows. Employees are identified with those workers with a stable labor contract and eligible for employment protection, so belonging to the primary labor market. According to the available data, this category amounts to 53% of the whole workforce. In turn, within this category the share of the employees with tertiary education corresponds to the skilled workers and represents 11% of the workers (i.e. $s_{L_H} = 0.11$), while the remaining share is identified with the unskilled employees (i.e. $s_{L_L} = 0.42$). According to the same data, the share of self-employed workers older than 35, is 21% and we set the model share s_{N_S} accordingly. As a matter of fact, we exclude from this category of workers the young, since at early stages of their careers they tend to be precarious and face the same difficulties of the workers with atypical contracts. Hence, the last category of workers labeled as "atypical" includes young self-employed, apprentices, temporary workers and other workers with atypical contracts characterized by weak security protection and low firing costs, so belonging to the secondary market. According to the data this residual fraction of workers amounts to 26% (i.e. $s_{N_A} = 0.26$). In this version of the model we assume that non Ricardian households supply only atypical labor (i.e. $\lambda_{L_L} = 0$), hence $s_{N_R} = 0.26$.

The tax system calibration points to heavy taxation on capital and labor income, where different rates are considered for each labor category. The tax rate on consumption τ^C is equal to 0.17, while the tax rate on physical capital τ^K is 0.33, consistently with the calibration used in the Italian version of QUEST III (see D'Auria et al. 2009). For the tax rates on wage income the calibration is based on the data taken from RFCL - ISTAT 2008. In particular, the average tax rate on labor income paid by skilled employees τ^{L_H} is equal to 0.27, that for the unskilled, τ^{L_L} is set at 0.24, for the self-employed τ^{N_S} is 0.26 and for the atypical workers τ^{N_A} is 0.24. The

social contribution rates paid by firms and workers are set, respectively, at 0.33 and 0.09 as legal rates of contribution. Turning to the parameters characterizing the labor markets, according to the estimates based on EconLav microsimulation model, the Frisch elasticity of labor supply for the employees is 0.30, while for the atypical component of the labor force the Frisch elasticity is equal to 0.35. For the self-employed workers we set the Frisch elasticity at 0.30, since we conjecture that the reactivity of their labor supply to changes in their remuneration is closer to that experienced by workers with stable contracts. The elasticities of substitution between different varieties of labor σ_{L_L}, σ_{L_H}, σ_{N_S} are all set at 2.65 in line with the literature (see Forni et al. 2010), reflecting the limited competition protecting the insiders.

On the grounds that workers with stable contracts tend to be more prone to accumulate skills and human capital than temporary workers, as emphasized by the empirical literature (see Boeri and Garibaldi 2007 among others), the CES parameters measuring efficiencies are calibrated to capture this aspect. In particular, efficiencies are set so as to generate a skill premium for skilled workers (those with tertiary education only) of 50% with respect to the unskilled (consistently with AMECO 2005 data on labor compensations). Also for self-employed we assume a 50% higher remuneration than that granted to the atypical workers.

The value assigned to the output elasticity of public capital, α_G, is prudentially set at 0.14, reflecting the wide range of estimates found in the empirical studies (e.g. Ai and Cassou 1995). Turning to the parameters specific to this extension of IGEM, we mainly follow the parametrization proposed by Forni et al. (2010). We set the degree of substitutability between the three kinds of inputs, α_{PA}, is set at 0.95[19], while the weights associated to the utilization of public employment and purchases of goods and services from the private sector, γ_{LG} and γ_G, are set at 0.15. We set the consumption bias towards private consumption to 0.8 for both types of households (i.e. $\omega_G^R = \omega_G^{NR} = 0.8$). We assume that the elasticity of substitution θ_G between private and publicly provided goods is equal to 1.5. The baseline size of the wasteful component of public spending, G^U, has been set to 2% of GDP with reference to the results achieved in 2015 by the Guardia di Finanza in its activities of public spending monitoring and countering offences against the public administration. In particular, we assume a detection probability of 0.2. See the Annual Report 2015 of the Guardia di Finanza. Finally, we set the coefficient κ_G to 0.8, reflecting the observed share of the effective use of public resources with respect to the total amount of committed resources in the year 2015.[20]

4 Reform Scenarios

In this Section we undertake a battery of simulation exercises with the aim of validating the model and understanding its properties. In particular, we examine how some key macrovariables respond to a range of policy interventions involving the area of public administration and

[19] This parametrization implies a mild degree of complementarity between the three production inputs.

[20] To be sure, this measure represents a proxy for the inefficient use and management of public resources. See MEF - Ministry of Economy and Finance, Banca Dati Amministrazioni Pubbliche (BDAP), 2016.

institutional efficiency. We consider four main scenarios in the spirit of the recent reforms and policy interventions adopted by the Italian government. However, these exercises are intended to be only illustrative of the model functioning. To the same extent, the simulation hypotheses concerning the credibility, the timing, the speed and the size of the shocks are entirely arbitrary. In addition, all agents have perfect foresight, therefore any possible source of uncertainty about the underlying path of policy changes is ruled out by construction. In what follows we assume that the policy interventions are immediately put in place, with no delay (i.e. Big Bang hypothesis).

Our analysis considers fours main policy interventions: (i) rationalization of public spending, where for a given public provision of goods and services production costs are reduced; (ii) reduction of production costs of publicly provided goods and services by improving public procurement; (iii) reduction of production costs of publicly provided goods and services by means of improvement in the overall productivity level of the public sector; (iv) simplification of the administrative framework.

Using the parametrization outlined in the previous Section, the non-linear version of this version of IGEM is solved in Troll which relies on a Newton-type algorithm to solve non-linear deterministic models. As usual, in order to consider the effects of the policy experiments in isolation, we switch off any possible feedback channels coming from the Taylor rule. For this reason, in each scenario, we consider a deterministic simulation of 1,000 quarters, where the interest rate rule is neutralized for the first 400 quarters. As common practice when dealing with large scale general equilibrium model, we solve the two-point boundary-problem that arises in the analysis of permanent shocks by reformulating the model so that the terminal conditions are invariant to policy shifts, as proposed by Roeger and in't Veld (1999).

4.1 Rationalization of Public Spending

In this first scenario we assess the potential effects of a more efficient allocation of public spending related to the public provision of goods and services. In particular, we consider a reallocation of factor inputs in the production function of the PA, so as to achieve a reduction of costs by 0.5% of GDP. The experiment is conducted in such a way that the public provision of goods and services, Y^G, stays unchanged. In detail, we leave the stock of public capital unchanged, while public employment L_G and the purchases of goods and services from the private sector, G, do adjust so as to reduce the production cost by 0.5% of GDP.[21]

The top panel of Table 3 reports the results of this experiment under the assumption that the savings deriving from the rationalization are not used by the government to reduce taxes,

[21] To map this reform we proceed in three steps. First, given the available technology (45), we compute the marginal rate of technical substitution between G and L_G, taking K_G^G as given. Second, from the relative price of these factor inputs we are able to construct a measure of inefficiency of the PA. Under cost minimization, in fact, the marginal rate of technical substitution would equalize the relative price of factor inputs. This condition is not satisfied in the baseline calibration. Third, by means of a numerical solver we compute the variations in G and L_G necessary to reduce the total production cost by 0.5% of GDP, leaving Y^G at its initial level. In this case G should decrease, while L_G should increase.

while the bottom panel reports the results under the assumption that the resources saved by the PA are recycled back for cutting tax on labor income. All variables are expressed as percentage deviation from the initial steady state, with the exception of the public deficit to GDP ratio which is expressed in percentage points deviation.

In the first case, the rationalization of public spending entails a negative effect on GDP already in the second year. The negative effect on output is driven by the reduction of public spending induced by the policy. However, consumption and investments increase sustaining aggregate demand. As a result of the reduction of the production cost, the public deficit to GDP ratio decreases. The overall level of labor inputs decreases, however we notice a certain reallocation towards self-employment.

Consider now the bottom panel of Table 3. Here we assume that the resources saved thanks to the rationalization of public spending in the public provision of goods and services are channelled for the reduction of taxes on labor income of workers with stable labor contracts. As we can see the effects are now highly expansionary for all the main macroeconomic variables, while the public deficit to GDP ratio decreases as a result of the higher level of economic activity and of the higher tax revenues. As expected the labor inputs of workers with stable contracts increase, while for the non-stable component of the labor force we observe a reduction of the atypical, who are less productive, in favor of self-employed.

4.2 Public Procurement Improvement

The second scenario foresees a reduction of costs achieved by policies aimed at rendering public procurement more transparent, fair and competitive. Consistently with the previous scenario we assume that the policy entails a reduction of production costs equal to 0.5% of GDP. A better public procurement is likely, on the one hand, to improve the quality of goods or services purchased from companies, on the other hand is able to boost competition in the private sector. To map this reform we then change two different variables, namely we increase the parameter κ_g of (45), capturing the improved quality of goods or services purchased from the private sector and we consider a markup reduction in the manufacturing sector equal to 1 percentage point. The increase in κ_g is compensated by a proportional decrease in G so that the overall provision of goods and services stays unaltered as in the previous scenario. The results are shown in Table 4. Clearly, this composite policy intervention has beneficial effects on the economy. As a matter of fact, the lower purchases of goods and services from the private sector has the usual crowd-in effect on private consumption and investments, while the lower markup entails a reduction of the inefficiency which, through prices, has positive effects on both the private and the public sector. Concerning labor we notice that the overall effects are quite small and negative, yet we observe a slight increase in the labor inputs of self-employed.

4.3 Increase in the Productivity of the Public Sector

The third scenario considers the effects of policy interventions aimed at increasing the overall productivity of the PA in the provision of goods and services, such for instance advances in the digital agenda. The reform is mapped onto the model by simply increasing the coefficient A^G of (45) and by cutting G and L_G in order to cut production costs by 0.5% of GDP. As in the first scenario we also explore the potential effects of recycling these extra resources to reduce tax on labor income. Table 5 shows the results. In the top panel of the Table we show the results without tax reduction. In this case consumption increases in response to the lower public expenditure, whereas investments increase only in the first year. At later stages, in fact, given the permanent decrease of aggregate demand and of the level of economic activity, investments diminish accordingly. When instead the public resources saved, thanks to the higher efficiency of the PA, are used to reduce taxes on labor income, all the main macrovariables increase, especially consumption. In this case we also notice a positive effects on the labor inputs of all categories of workers, with the exception of atypical workers who are less efficient.

4.4 Simplification of Administrative Framework

The fourth scenario refers to the set of policy aimed at simplifying the administrative framework and reducing red-tape. Given the intrinsic fixed-cost nature of administrative costs this last set of policies have effects on both private and public sectors by reducing the time spent dealing with bureaucracy (overhead labor cost). We assume that this policy intervention should imply a 18% reduction of the time spent in dealing with bureaucracy and compliance with administrative burden.[22] The reduction of $OH_t^{L_G}$ in (45) is compensated by a decrease in L_G so as to leave the public provision of goods and services unchanged. See Table 6 for the results of this exercise.

Simplification of public administration contributes to enhance GDP by 1.1 percent in the long run. The increase in labor productivity linked to the reduction in administrative burdens leads firms to change their production mix by increasing capital at the expense of labor. Firms tend to substitute labor with capital as a result of a more efficient use of labor. In particular, this reduction of employment, although of modest size, is induced by the diminished overhead labor cost (time spent with bureaucracy) which necessarily entails a reduction of worked hours of the private sector. As a result of the higher level of economic activity and of the higher tax revenues, the fiscal balance strongly improves.

4.5 The Role of Timing

As explained above, in all the the previous experiments the policy interventions are assumed to be immediately introduced, with no delay. However, the Big Bang implementation represents an upper bound of the possible effects deriving from a reform plan. In Appendix C we show the results under the assumption that all measures are implemented gradually over a 5-year

[22] The size of this policy is consistent with that assumed in the Italian National Reform Programme 2015.

time horizon which represents a realistic time span for a reasonably smooth implementation timetable. In general, we observe that in all reform scenarios under a gradual introduction of policy measures, during the adjustment process the reaction of output, consumption and investment tends to be smoother. When a credible reform plan is announced, agents start to adjust their decisions accordingly, anticipating the future policy changes and smoothing adjustment costs when relevant. In the long run, for all scenarios the main difference between the two timing assumptions lies in the cumulated reduction of public deficit to GDP ratio which, as expected, is much higher in the case of immediate implementation of the reforms.[23]

5 Fiscal Multipliers

In this Section we construct several simulation scenarios in order to uncover the differences in the response of the main macroeconomic variables following permanent and temporary changes in the different categories of government spending, namely government purchases of final goods from the private sector, G_t^U and G_t, public employment L_t^G and the two components of public investments $I_{G,t}^G$ and $I_{G,t}^P$. In order to isolate the effects of the policy shifts from possible feedback and automatic mechanisms for all the simulations both the fiscal and the monetary rules are inactivated.[24] To conduct our simulation exercise, we treat G_t, L_t^G, $I_{G,t}^G$ and $I_{G,t}^P$ as exogenous variables and examine the deterministic response of the economy to unexpected permanent and temporary changes in these variables occurring at the beginning of our simulation time horizon.

5.1 Permanent Shocks to Public Spending

We start by considering the effects of permanent increases in public spending. In what follows all variables are expressed as percentage deviations from their initial steady state.

Table 7 presents the effects of a permanent 1% of GDP increase in the component of public consumption which does not concur to the public production of goods and services, G_t^U. Clearly, a permanent increase in this wasteful component of public expenditure crowds out private consumption of Ricardian households both in the short and in the long run, whereas investment is displaced in the first year only. In fact, in order to support the permanent increase in aggregate demand investment is required to increase in the subsequent periods. As regards non-Ricardian households, they benefit from the policy as their consumption increases at any time horizon along with aggregate demand.

In Table 8 we consider the effects of a permanent 1% of GDP increase in the component of public consumption which is used for the public production of goods and services, G_t. The effects on Ricardian households' consumption and investment decisions triggered by a permanent increase in G_t are qualitatively similar to the previous reform scenario. However since the

[23] In Appendix D we report the results of the simulations for a smaller value of the output elasticity to public capital. Overall the results of the analysis do not change considerably. The major differences are observed in the scenario envisaging a reduction of overhead labor. Clearly, a lower α_G implies a higher contribution of private inputs to private function, that is why we observe a higher impact than that observed in the baseline case.

[24] We are able to inactivate both rules for 400 quarters.

reform targets a productive component of public consumption, the crowding-out effect on private consumption is amplified and the fiscal multiplier on output is lower. The relationship of substitutability between private goods and publicly provided goods implies a larger reduction in private consumption and a smaller increase in labor supply and, therefore, a lower effect on output.

Table 9 shows the potential macroeconomic impact of a permanent 1% of GDP increase in public employment expenditure. Similarly to an increase in productive public consumption, a permanent increase in public employment raises the government provision of goods, that is why also in this case we observe a stronger crowding out of private consumption.

We conclude the analysis of permanent shifts in public spending by exploring the effects of a 1% overall increase of GDP in public investment. In particular, we consider that half of this expansionary policy contributes to the accumulation of public capital that positively affects private production, while the other half concurs positively to the accumulation of public capital used for the provisions of goods and services on the part of the government. In this case, a boost in public investment has two effects: it increases productivity in the production sector and expands the supply of the public good. See Table 10 for the results. A permanent increase in public investment boosts output, consumption and investment in the long run. However, it crowds out Ricardian households' consumption and private investments in the short run. The effect on investment is strengthened by the fact that the agents postpone the investment activity to the future, when the productivity of private capital will be higher due to accumulation of public capital. At a later stage, in fact, as public capital builds up the productivity of private capital increases yielding a rise in private investment. Non-Ricardian households are always better-off as the increase in aggregate demand permanently raises their wages above their initial steady state level, which enables them to afford higher consumption. [25] It goes without saying that these high multipliers are also to be ascribed to the fact that we are not considering the financing problem. That this why in Table 11 we propose a balanced budget change in the composition of public spending from public consumption to public investments. The size of the policy is shift is always 1% of GDP. As expected, in this case, output multipliers tend to be lower than those shown in Table 10, yet the long-run output multiplier is well above one and this policy intervention is shown to generate strong positive effects on all the main macroeconomic variables.[26]

To conclude this analysis and highlight the importance of distinguishing between different categories of government spending, in Table 12 we compare the output fiscal multipliers obtained with IGEM-PA to those stemming out from the basic version of IGEM where public spending is modelled as a simple component of aggregate demand.[27]

[25] We acknowledge that the different size of the various fiscal multipliers obtained in this paper also depends on some other specific features, such as the share of liquidity-constrained consumers and the degree of price and wage rigidity. We leave these robustness checks to future research.

[26] In Appendix D we show how the results of these last two experiments are crucially affected by the size of the the output elasticity to public capital α_G.

[27] In the baseline version of IGEM, in fact, the productivity enhancing channel of public capital is switched off.

5.2 Temporary Shocks to Public Spending

In this section we consider the effects of temporary changes in public spending. In particular, we assume an increase in useful public spending by 1% of GDP for two years. Note that since all simulations are run under perfect foresight, agents anticipate future changes in public policies and are fully aware that government spending will return to its baseline value after two years.

In Table 13 we show the impact of a temporary increase in the component of public expenditure which contributes to public production of goods and services. The effects are qualitatively similar to those observed in the previous case, however given the positive effects of this expansion on the public provision of goods and services which positively affects utility, agents are induced to reduce their private consumption by more and so diminishing the expansion of aggregate demand and so of output. Overall, in both cases we observe that short-run output multipliers are always larger in absolute value than in case of a permanent expenditure shifts.

Table 14 reports the effects of a temporary increase in public investment. As done in the previous case we increase both components of public investments by the same size. A two-year increase in public investment produces a positive effect on output, whereas aggregate consumption and investment are crowded out as long as the policy is in place. Compared to a permanent policy of the same type, the short-run multipliers are clearly much lower. Non-Ricardian households are better off in terms of consumption in the first two years, due to the higher demand for labor prompted by the increase in public investment. As the public intervention ends, their consumption multiplier is almost zero Ricardian households, instead, initially reduce consumption and investment. They postpone investment decisions until the policy is over in order to exploit the higher productivity of capital. Their consumption and investment multipliers are both positive after ten years.

6 Conclusions

This paper presents a full technical account of a variant of IGEM, the Italian General Equilibrium Model, a large scale dynamic general equilibrium (DGE) model for the Italian economy, in use at the Department of the Treasury of the Italian Ministry of Economics and Finance. The model is extended to include productivity-enhancing public capital is, while consumer preferences depend on goods and services provided by the government. Specifically, in this new version of IGEM the public sector is explicitly modeled as suppliers of goods and services produced by combining consumption and investment goods from the private sector with public employment.

With these characterizations the model can be fruitfully used to assess the impact of several reforms aimed at improving the functioning of the public administration and to conduct an analysis of fiscal multipliers distinguishing between various categories of public spending. To illustrate the properties of the model in this paper we undertake two kinds of analysis, namely the assessment of structural reforms and of policy interventions oriented to improve the efficiency and the effectiveness of public administration and the study of fiscal multipliers.

As regards the first set of results, concerning structural reforms, we have shown that policy interventions and measures that improve the effectiveness and the efficiency of public administration are likely to produce a sizable reduction of the public debt. The level of output tends to increase in response to an improvement in public procurement and as a result of policies that reduce red-tape and simplify the administrative framework. On the other hand, the rationalization of public spending and the boost of productivity level of public sector, while producing a positive impact on private consumption, are shown to be expansionary on output only when the extra public resources let out by these policies are recycled by the government for tax reduction.

Turning to the second set of results, we observe that output fiscal multipliers are very high for public investments. Higher public investment, in fact, not only increases aggregate demand, but it also increases aggregate supply through the positive impact that accumulated public capital has on the marginal productivity of labor inputs and private capital. The size of the multipliers associated to public consumption, instead, depends significantly on the nature of the fiscal spending. In the case of temporary fiscal shocks, short-run output multipliers are higher than those observed for permanent shocks when we consider positive shifts of public consumption, while the opposite is true for positive shifts of public investment. Finally, an ex-ante budget neutral change in the composition of public spending from useful public consumption to public investment is shown to generate positive effects on all the main macrovariables. The results of this analysis suggest that the sizes of public spending multipliers are likely to depend on many factors and that treating public spending only as a component of aggregate demand can lead to misleading results. We argue that more emphasis should be given by economic policy models on quality of spending mechanisms and on its composition so to be able to fruitfully contribute to the economic policy debate.

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Tables

Table 1: Parametrization

Math Symbol	Label	Value
α_{IMP}	Share of foreign goods in total consumption	0.26
α_{EXP}	Share of foreign goods in total consumption for the rest of the world	0.26
σ_{IMP}	Elasticity of substitution between domestic and foreign goods	1.1
σ_{EXP}	Elasticity of substitution between domestic and foreign goods	1.1
α_L	Production function parameter, LL and LH workers	0.35
α_N	Production function parameter, NS and NA workers	0.35
α_G	Production function parameter, public capital	0.14
α_{PG}	Elasticity of sub. between factors of production of the public goods	0.95
β	Discount factor	0.99
δ_K	Depreciation rate of K	0.025
δ_G	Depreciation rate of K_G^G, K_G^P	0.025
ef_{L_L}	Efficiency of unskilled employed workers	0.42
ef_{L_H}	Efficiency of skilled employed workers	0.42
ef_{N_s}	Efficiency of self-employed workers	0.42
ef_{N_A}	Efficiency of atypical workers	0.42
κ_g	Share of non-wasteful public expenditure	0.8
γ_I	Adjustment costs parameter, investments	75
γ_{L_H}	Adjustment costs parameter, skilled employed workers	71
γ_{L_L}	Adjustment costs parameter, skilled employed workers	71
γ_{N_S}	Adjustment costs parameter, self-employed workers	10
γ_{N_A}	Adjustment costs parameter, atypical workers	10
γ_{PG}	Share parameter of public expenditure in Y_G	0.15
γ_{LG}	Share parameter of public employment in Y_G	0.15
γ_{px}	Adjustment costs parameter, price	15
$\gamma_{W^{N_s}}$	Adjustment cost parameter wage of self-employed	15
$\gamma_{W^{L_H}}$	Adjustment cost parameter wage of LH	15
$\gamma_{W^{L_L}}$	Adjustment cost parameter wage of LL	15
h_{C^R}	Habit parameter, Ricardian households	0.7
$h_{C^{NR}}$	Habit parameter, non-Ricardian households	0.3
v_{L_H}	Preference parameter, skilled workers	8.00
v_{L_L}	Preference parameter, unskilled workers	8.36
v_{N_A}	Preference parameter, atypical workers	12.76
v_{N_s}	Preference parameter, self-employed workers	8.00
κ_p	backward indexation, prices	1
κ_W	Backward indexation, wage	1
τ^C	VAT of consumption	0.17
τ^K	Capital tax rate	0.33
τ^{L_L}	Average tax rate on LL	0.24

Table 2: Parametrization (ctd.)

Math Symbol	Label	Value
τ^{LN}	Average labor tax rate, total	0.25
$\tau_h^{W^{L_L}}$	Social contributions on unskilled workers	0.09
$\tau_f^{W^{L_L}}$	Contributions levied on firms, unskilled	0.33
τ^{L_H}	Average tax rate on LH	0.27
$\tau_h^{W^{L_H}}$	Social contributions on skilled workers	0.09
$\tau_f^{W^{L_H}}$	Contributions levied on firms, skilled	0.33
τ^{N_S}	Average tax rate on NS	0.26
$\tau_h^{W_{N_s}}$	Social contributions on NS	0.09
$\tau_h^{W_{N_A}}$	Social contributions on NA	0.09
$\tau_f^{W_{N_A}}$	Contributions levied on firms	0.33
τ^{N_A}	Average tax rate on NA	0.24
σ_{L_H}	Elasticity of substitution, skilled workers	2.65
σ_{L_L}	Elasticity of substitution, unskilled workers	2.65
σ_{N_S}	Elasticity of substitution, self-employed workers	2.65
σ_N	CES parameter atypical and self-employed workers	1.4
σ_L	CES parameter employed workers	1.4
θ_Y	Elasticity of substitution goods	5
θ_{EXP}	Elasticity of export demand	5
θ_{IMP}	Elasticity of import demand	5
Π	Inflation factor	1
Π^C	Consumption Inflation factor	1
Π^I	Investment goods inflation	1
Π^{IMP}	Import goods inflation	1
Π^{EXP}	Export goods inflation	1
θ_G	Elasticity of substitution between private and public goods	1.5 (0.35)
ω_G^R	Consumption bias toward public goods	0.8
ω_{L_H}	Preference parameter, skilled workers	0.14 (0.13)
ω_{L_L}	Preference parameter, unskilled workers	0.1 (0.09)
ω_{N_A}	Preference parameter, atypical workers	0.15 (0.17)
ω_{N_s}	Preference parameter, self-employed workers	0.29 (0.27)
s_{L_H}	Population share of skilled employed workers	0.11
s_{N_S}	Population share of self-employed workers	0.21
s_{N_A}	Population share of atypical workers	0.26
s_{L_L}	Population share of unskilled employed workers	0.42
sx_{L_H}	Employment share of skilled workers	0.1
sx_{L_L}	Employment share of unskilled workers	0.9
sx_{N_s}	Employment share of self-employed workers	0.8
sx_{N_A}	Employment share of atypical workers	0.2

Table 3: Rationalization of Public Spending - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	without tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.053	-0.042	-0.072	-0.080	-0.077	-0.061
consumption	0.905	1.108	1.089	1.087	1.086	1.089
consumption R	1.037	1.264	1.239	1.237	1.237	1.241
consumption NR	0.215	0.292	0.305	0.300	0.298	0.296
investments	0.261	0.132	0.128	0.146	0.161	0.215
labor	-0.022	-0.077	-0.136	-0.158	-0.160	-0.160
labor - unskilled workers	-0.026	-0.076	-0.163	-0.197	-0.199	-0.198
labor - skilled workers	-0.021	-0.058	-0.132	-0.181	-0.194	-0.198
labor - atypical workers	-0.041	-0.156	-0.200	-0.200	-0.200	-0.199
labor - self-employed workers	0.013	0.010	0.012	0.011	0.011	0.014
terms of trade	0.794	1.161	1.199	1.187	1.178	1.147
real deficit/GDP ratio	-0.663	-0.699	-0.773	-0.942	-1.151	-4.702
	with labor income tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.091	0.043	0.128	0.191	0.212	0.252
consumption	1.009	1.322	1.418	1.454	1.466	1.493
consumption R	1.160	1.520	1.630	1.670	1.685	1.716
consumption NR	0.220	0.285	0.309	0.320	0.322	0.322
investments	0.233	0.151	0.200	0.254	0.293	0.423
labor	0.036	0.068	0.188	0.261	0.275	0.280
labor - unskilled workers	0.060	0.135	0.281	0.340	0.343	0.342
labor - skilled workers	0.156	0.385	0.883	1.223	1.318	1.352
labor - atypical workers	-0.060	-0.195	-0.249	-0.245	-0.244	-0.245
labor - self-employed workers	0.019	0.025	0.049	0.063	0.067	0.075
terms of trade	0.774	1.022	0.947	0.896	0.873	0.819
real deficit/GDP ratio	-0.182	-0.224	-0.296	-0.396	-0.495	-2.042

Table 4: Improving of Public Procurement - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.064	0.121	0.139	0.165	0.189	0.276
consumption	0.771	1.062	1.076	1.093	1.109	1.171
consumption R	0.878	1.195	1.195	1.213	1.232	1.306
consumption NR	0.212	0.366	0.457	0.467	0.466	0.468
investments	0.555	0.499	0.552	0.654	0.740	1.046
labor	0.021	0.037	0.031	0.026	0.025	0.027
labor - unskilled workers	0.012	0.022	0.009	-0.006	-0.008	-0.010
labor - skilled workers	0.004	0.007	0.001	-0.005	-0.007	-0.010
labor - atypical workers	0.020	0.022	-0.012	-0.012	-0.013	-0.015
labor - self-employed workers	0.056	0.115	0.165	0.175	0.180	0.196
terms of trade	0.430	0.664	0.693	0.657	0.625	0.514
real deficit/GDP ratio	-0.644	-0.735	-0.831	-1.017	-1.247	-5.115

Table 5: Improvement in the Overall Productivity Level of the Public Sector - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	without tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	-0.075	-0.069	-0.106	-0.122	-0.127	-0.140
consumption	0.471	0.637	0.611	0.601	0.596	0.579
consumption R	0.575	0.764	0.733	0.722	0.716	0.696
consumption NR	-0.073	-0.027	-0.026	-0.031	-0.033	-0.036
investments	0.043	-0.030	-0.057	-0.074	-0.087	-0.135
labor	-0.036	-0.072	-0.126	-0.146	-0.148	-0.148
labor - unskilled workers	-0.030	-0.070	-0.147	-0.177	-0.179	-0.177
labor - skilled workers	-0.022	-0.052	-0.119	-0.163	-0.174	-0.177
labor - atypical workers	-0.078	-0.138	-0.179	-0.179	-0.179	-0.177
labor - self-employed workers	-0.004	-0.004	-0.009	-0.013	-0.014	-0.016
terms of trade	-0.274	-0.094	-0.049	-0.045	-0.044	-0.037
real deficit/GDP ratio	-0.495	-0.544	-0.597	-0.724	-0.884	-3.601
	with labor income tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	-0.035	0.018	0.096	0.150	0.163	0.175
consumption	0.570	0.841	0.929	0.961	0.968	0.976
consumption R	0.691	1.007	1.110	1.146	1.155	1.164
consumption NR	-0.065	-0.031	-0.019	-0.009	-0.007	-0.007
investments	0.017	-0.012	0.015	0.035	0.046	0.075
labor	0.023	0.075	0.200	0.275	0.289	0.293
labor - unskilled workers	0.056	0.142	0.300	0.362	0.366	0.365
labor - skilled workers	0.155	0.391	0.898	1.244	1.340	1.375
labor - atypical workers	-0.095	-0.174	-0.225	-0.221	-0.221	-0.221
labor - self-employed workers	0.002	0.011	0.028	0.039	0.042	0.044
terms of trade	-0.284	-0.217	-0.286	-0.326	-0.338	-0.353
real deficit/GDP ratio	-0.007	-0.057	-0.107	-0.167	-0.215	-0.894

Table 6: Simplification of the Administrative Framework

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	1.123	1.153	1.068	1.061	1.075	1.140
consumption	0.916	1.281	1.206	1.209	1.219	1.261
consumption R	1.196	1.646	1.586	1.595	1.608	1.658
consumption NR	-0.551	-0.631	-0.781	-0.812	-0.814	-0.815
investments	0.539	0.427	0.440	0.515	0.579	0.809
labor	-0.168	-0.301	-0.453	-0.502	-0.508	-0.508
labor - unskilled workers	-0.073	-0.165	-0.348	-0.421	-0.428	-0.428
labor - skilled workers	-0.052	-0.123	-0.281	-0.387	-0.417	-0.428
labor - atypical workers	-0.441	-0.713	-0.843	-0.839	-0.840	-0.841
labor - self-employed workers	-0.129	-0.229	-0.331	-0.345	-0.343	-0.331
terms of trade	-1.271	-0.959	-0.873	-0.902	-0.927	-1.013
real deficit/GDP ratio	-0.266	-0.330	-0.313	-0.373	-0.455	-1.872

Table 7: Permanent 1% of GDP Increase in Public Consumption G_t^U

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.132	0.148	0.223	0.256	0.265	0.285
consumption	-1.185	-1.540	-1.481	-1.461	-1.450	-1.418
consumption R	-1.428	-1.827	-1.755	-1.734	-1.722	-1.684
consumption NR	0.090	-0.036	-0.042	-0.031	-0.028	-0.022
investments	-0.185	0.017	0.068	0.095	0.115	0.190
labor	0.074	0.160	0.281	0.325	0.331	0.330
labor - unskilled workers	0.064	0.157	0.330	0.397	0.401	0.398
labor - skilled workers	0.047	0.116	0.266	0.364	0.391	0.398
labor - atypical workers	0.161	0.310	0.403	0.402	0.401	0.398
labor - self-employed workers	0.004	0.004	0.013	0.020	0.022	0.026
terms of trade	0.340	-0.175	-0.268	-0.271	-0.271	-0.275
real deficit/GDP ratio	1.135	1.236	1.357	1.646	2.008	8.188

Table 8: Permanent 1% of GDP Increase in Public Consumption G_t

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.111	0.134	0.206	0.238	0.246	0.264
consumption	-1.290	-1.553	-1.495	-1.478	-1.469	-1.441
consumption R	-1.560	-1.847	-1.774	-1.754	-1.744	-1.712
consumption NR	0.123	-0.017	-0.039	-0.031	-0.028	-0.023
investments	-0.142	0.019	0.066	0.091	0.109	0.177
labor	0.066	0.145	0.257	0.299	0.304	0.303
labor - unskilled workers	0.060	0.147	0.309	0.372	0.376	0.373
labor - skilled workers	0.044	0.109	0.249	0.342	0.367	0.373
labor - atypical workers	0.148	0.290	0.378	0.378	0.377	0.374
labor - self-employed workers	-0.010	-0.021	-0.023	-0.018	-0.016	-0.012
terms of trade	0.251	-0.158	-0.244	-0.248	-0.249	-0.255
real deficit/GDP ratio	1.154	1.241	1.365	1.657	2.022	8.248

Table 9: Permanent 1% of GDP Increase in Public Employment L_t^G

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.194	0.141	0.210	0.245	0.259	0.297
consumption	-0.986	-1.134	-1.071	-1.052	-1.041	-1.003
consumption R	-1.244	-1.395	-1.316	-1.295	-1.282	-1.238
consumption NR	0.364	0.232	0.213	0.219	0.222	0.226
investments	0.035	0.144	0.201	0.248	0.286	0.423
labor	0.068	0.125	0.221	0.257	0.262	0.263
labor - unskilled workers	0.057	0.128	0.267	0.322	0.326	0.323
labor - skilled workers	0.040	0.095	0.215	0.296	0.317	0.323
labor - atypical workers	0.161	0.249	0.326	0.327	0.327	0.324
labor - self-employed workers	-0.005	-0.025	-0.027	-0.021	-0.018	-0.011
terms of trade	1.030	0.788	0.713	0.700	0.690	0.655
real deficit/GDP ratio	0.985	1.059	1.163	1.413	1.723	7.023

Table 10: Permanent 1% of GDP Increase in Public Investments

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.434	0.451	1.048	1.722	2.131	2.892
consumption	-0.523	-0.607	-0.313	0.020	0.281	1.095
consumption R	-0.703	-0.763	-0.409	-0.011	0.296	1.244
consumption NR	0.420	0.210	0.189	0.185	0.198	0.317
investments	-0.634	-0.284	-0.035	0.324	0.628	1.837
labor	0.042	0.016	-0.006	-0.075	-0.130	-0.249
labor - unskilled workers	0.020	0.018	0.013	-0.056	-0.120	-0.269
labor - skilled workers	0.009	0.007	-0.002	-0.058	-0.115	-0.268
labor - atypical workers	0.129	0.061	0.023	-0.066	-0.126	-0.266
labor - self-employed workers	0.007	-0.042	-0.096	-0.146	-0.169	-0.163
terms of trade	1.313	0.281	-0.576	-1.440	-1.904	-2.437
real deficit/GDP ratio	0.936	0.965	0.942	0.992	1.116	4.101

Table 11: Permanent 1% of GDP Shift from Public Consumption to Public Investments

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.297	0.298	0.846	1.490	1.890	2.633
consumption	0.909	0.967	1.186	1.506	1.760	2.545
consumption Ricardian	1.040	1.109	1.369	1.753	2.053	2.967
consumption non-Ricardian	0.221	0.228	0.227	0.216	0.227	0.339
investments	-0.375	-0.303	-0.087	0.248	0.533	1.670
labor	-0.025	-0.128	-0.257	-0.364	-0.423	-0.538
labor - unskilled workers	-0.039	-0.126	-0.289	-0.418	-0.485	-0.626
labor - skilled workers	-0.035	-0.100	-0.246	-0.390	-0.470	-0.626
labor - atypical workers	-0.024	-0.229	-0.347	-0.433	-0.491	-0.625
labor - self-employed workers	0.016	-0.019	-0.068	-0.122	-0.147	-0.144
terms of trade	0.787	0.469	-0.339	-1.200	-1.663	-2.195
real deficit/GDP ratio	-0.252	-0.271	-0.416	-0.655	-0.893	-4.109

Table 12: Output Fiscal Multipliers: IGEM1 v. IGEM-PA

	Shock 1% of GDP	Impact	Year 1	Year 2	Year 5	Year 10	Year 15
IGEM 1	G^U	0.681	0.261	0.320	0.325	0.343	0.352
IGEM-PA	G^U	0.629	0.132	0.148	0.223	0.256	0.265
IGEM-PA	G	0.492	0.111	0.134	0.206	0.238	0.246
IGEM-PA	L^G	0.847	0.194	0.141	0.210	0.245	0.259
IGEM-PA	I^G	2.431	0.446	0.456	1.048	1.722	2.131

Table 13: Temporary 1% of GDP Increase in Public Consumption G_t

	Impact	Year 1	Year 2	Year 5
GDP	0.799	0.161	0.117	0.002
consumption	-0.480	-0.682	-0.810	-0.119
investments	-0.314	-0.400	-0.402	-0.074
consumption NR	0.402	0.296	0.214	-0.039
consumption R	-0.648	-0.868	-1.005	-0.134

Table 14: Temporary 1% of GDP Increase in Public Investment

	Impact	Year 1	Year 2	Year 5
GDP	0.869	0.241	0.480	0.407
consumption	-0.155	-0.523	-0.728	0.196
investments	-0.420	-0.395	-0.160	0.194
consumption NR	0.317	0.289	0.196	-0.002
consumption R	-0.245	-0.678	-0.905	0.234

Appendix A

Solution to the Households' Problem

Defining as λ_t^R the Lagrange multiplier associated to the budget constraint (10) expressed in real terms, and ξ_t to the capital accumulation equation (7), the first-order conditions for maximization of the lifetime utility function (3) with respect to C_t^R, B_t^R, $B_{F,t}^R$, I_t^R, K_{t+1}^R and u_t^K are given by:

$$\frac{\Omega_t^R \left(\omega_G^R\right)^{1/\theta_G} \left(C_t^R\right)^{-\frac{1}{\theta_G}}}{\tilde{C}_t^R - h_{C^R} \widetilde{\overline{C}}_{t-1}^R} = (1+\tau_t^C)\frac{P_{C,t}}{P_t}\lambda_t^R, \tag{A-1}$$

where $\Omega_t^R \equiv \left[\left(\omega_G^R\right)^{1/\theta_G} \left(C_t^R\right)^{(\theta_G-1)/\theta_G} + (1-\omega_G^R)^{1/\theta_G} \left(Y_{G,t}^R\right)^{(\theta_G-1)/\theta_G}\right]^{\frac{1}{\theta_G-1}}$

$$\frac{\lambda_t^R}{P_t} = \beta E_t \frac{\lambda_{t+1}^R}{P_{t+1}} R_t, \tag{A-2}$$

$$S_t \frac{\lambda_t^R}{P_t} = \beta E_t \frac{\lambda_{t+1}^R}{P_{t+1}} (R_t^* + \rho_t^F) S_{t+1}, \tag{A-3}$$

$$q_t - 1 = \gamma_I \left(\frac{I_t^R}{K_t^R} - \delta_K\right) - tcr_t^K, \tag{A-4}$$

$$q_t = \beta E_t \frac{\lambda_{t+1}^R}{\lambda_t^R} \frac{\Pi_{t+1}^I}{\Pi_{t+1}} \left[\begin{array}{c} (1-\tau_{t+1}^K) r_{t+1}^K u_{t+1}^K + \tau_{t+1}^K u_{t+1}^K \delta_K \\ +q_{t+1}(1-\delta_K) + \\ -\frac{\gamma_I}{2}\left(\frac{I_{t+1}^R}{K_{t+1}^R} - \delta_K\right)^2 + \gamma_I \left(\frac{I_{t+1}^R}{K_{t+1}^R} - \delta_K\right) \frac{I_{t+1}^R}{K_{t+1}^R} + \\ -\gamma_{u_1^K}\left(u_{t+1}^K - 1\right) - \frac{\gamma_{u_2^K}}{2}\left(u_{t+1}^K - 1\right)^2 \end{array}\right] + \tag{A-5}$$

$$(1-\tau_t^K) r_t^K + \tau_t^K \delta_K - \gamma_{u_1^K} - \gamma_{u_2^K}\left(u_t^K - 1\right) = 0, \tag{A-6}$$

where $\Pi_t = P_t/P_{t-1}$, $\Pi_t^I = P_{I,t}/P_{I,t-1}$ and $q_t = \frac{\xi_t}{\lambda_t^R}\frac{P_t}{P_t^I}$ represents the shadow price of a unit of investment good (i.e. the Tobin's q).

The representative hand-to-mouth household chooses consumption so as to maximize (11) given (14). We denote by λ_t^{NR} the Lagrange multiplier of the budget constraint expressed in real terms. The optimal condition with respect to C^{NR} is given by:

$$\frac{\Omega_t^{NR} \left(\omega_G^{NR}\right)^{1/\theta_G} \left(C_t^{NR}\right)^{-\frac{1}{\theta_G}}}{\tilde{C}_t^{NR} - h_{C^{NR}} \widetilde{\overline{C}}_{t-1}^{NR}} = (1+\tau_t^C)\frac{P_{C,t}}{P_t}\lambda_t^{NR}, \tag{A-7}$$

where $\Omega_t^{NR} \equiv \left[\left(\omega_G^{NR}\right)^{1/\theta_G} \left(C_t^{NR}\right)^{(\theta_G-1)/\theta_G} + (1-\omega_G^R)^{1/\theta_G} \left(Y_{G,t}^{NR}\right)^{(\theta_G-1)/\theta_G}\right]^{\frac{1}{\theta_G-1}}$.

Wage Setting

The monopolistic professional order sets $W_t^{N_S}(h_{N_{S,t}})$ in order to maximize households' expected utility (3), given the demand for its differentiated labor services and subject to a convex adjustment costs function (15). At the optimum and imposing symmetry across differentiated labor services supplied as self-employed we have that the following condition must hold:

$$
\begin{aligned}
0 = {} & \omega_{N_S}\sigma_{N_S}\left(1-N_{s,t}(h_{N_S})\right)^{-\upsilon_{N_S}} N_{s,t}(h_{N_S}) + \\
& - \left(\sigma_{N_S}-1\right)\lambda_t^R\left(1-\tau_t^{N_S}-\tau_{h,t}^{W^{N_S}}\right)N_{s,t}(h_{N_S})\frac{W_t^{N_S}(h_{N_S})}{P_t} + \\
& - \lambda_t^R\gamma_{W^{N_S}}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{N_S}(h_{N_S})}{W_{t-1}^{N_S}(h_{N_S})}-1\right)\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{N_S}(h_{N_S})}{W_{t-1}^{N_S}(h_{N_S})}Y_t + \\
& + \beta E_t\lambda_{t+1}^R\gamma_{W^{N_S}}\left(\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{N_S}(h_{N_S})}{W_t^{N_S}(h_{N_S})}-1\right)\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{N_S}(h_{N_S})}{W_t^{N_S}(h_{N_S})}Y_{t+1}.
\end{aligned}
\tag{A-8}
$$

In steady state, given symmetry, (A-8) boils down to (16).

For skilled labor services at the optimum the wage setting equation reads as:

$$
\begin{aligned}
0 = {} & \omega_{L_H}\sigma_{L_H}\left(1-L_{H,t}\right)^{-\upsilon_{L_H}} L_{H,t} + \\
& - \left(\sigma_{L_H}-1\right)\lambda_t^R\left(1-\tau_t^{L_H}-\tau_{h,t}^{W^{L_H}}\right)L_{H,t}\frac{W_t^{L_H}}{P_t} + \\
& - \lambda_t^R\gamma_{W^{L_H}}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{L_H}}{W_{t-1}^{L_H}}-1\right)\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{L_H}}{W_{t-1}^{L_H}}Y_t + \\
& + \beta E_t\lambda_{t+1}^R\gamma_{W^{L_H}}\left(\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{L_H}}{W_t^{L_H}}-1\right)\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{L_H}}{W_t^{L_H}}Y_{t+1}.
\end{aligned}
\tag{A-9}
$$

which in steady state gives (17).

Finally, the first-order condition for wage setting for unskilled labor services, after having imposed symmetry is:

$$
\begin{aligned}
0 = {} & \omega_{L_L}\sigma_{L_L}\left(1-L_{L,t}\right)^{-\upsilon_{LL}} L_{L,t} + \\
& - \left(\sigma_{L_L}-1\right)\left(1-\tau_t^{L_L}-\tau_{h,t}^{W^{L_L}}\right)L_{L,t}\frac{W_t^{L_L}}{P_t} + \\
& - \left[(1-\lambda^{L_L})\lambda_t^R+\lambda^{L_L}\lambda_t^{NR}\right]\gamma_{W^{L_L}}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{L_L}}{W_{t-1}^{L_L}}-1\right)\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{L_L}}{W_{t-1}^{L_L}}Y_t + \\
& + \beta\left[(1-\lambda^{L_L})\lambda_{t+1}^R+\lambda^{L_L}\lambda_{t+1}^{NR}\right]\gamma_{W^{L_L}}\left(\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{L_L}}{W_t^{L_L}}-1\right)\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{L_L}}{W_t^{L_L}}Y_{t+1}.
\end{aligned}
\tag{A-10}
$$

In steady state the above condition becomes (18).

Solution to the Intermediate Goods Producers Problem

Given technology, the adjustment costs on price setting (23) and on labor inputs (24)-(27) and the demand schedule for its own variety j, $Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\theta_Y} Y_t$ firm j will make choices about the price and labor inputs, so as to maximize the present discounted value of future profits. At the optimum and under symmetry we have the optimal pricing decision equation which describes the time path of domestic inflation Π_t:

$$\begin{aligned}
&\left[(1-\tau_{Y,t})(1-\theta_Y) + MC_t\theta_Y\right] Y_t + \\
&-\gamma_P \left(\frac{\Pi_t}{\Pi_{t-1}^{\kappa_P}\overline{\Pi}^{1-\kappa_P}} - 1\right) \frac{\Pi_t}{\Pi_{t-1}^{\kappa_P}\overline{\Pi}^{1-\kappa_P}} Y_t + \\
&+\beta\gamma_P E_t \frac{\lambda_{t+1}^R}{\lambda_t^R} \left(\frac{\Pi_{t+1}}{\Pi_t^{\kappa_P}\overline{\Pi}^{1-\kappa_P}} - 1\right) \frac{\Pi_{t+1}}{\Pi_t^{\kappa_P}\overline{\Pi}^{1-\kappa_P}} Y_{t+1} = 0,
\end{aligned} \tag{A-11}$$

and the demand for unskilled and skilled employees, atypical workers and labor services provided by self-employed workers are:

$$\begin{aligned}
&\frac{W_t^{L_L}}{P_t}\left(1 - sub_t^{L_L} + \tau_{f,t}^{W^{L_L}}\right) = \\
&\alpha_L(1-\alpha_G) MC_t(j) \frac{Y_t(j)}{L_{CES,t}(j) - OH_t^L} \left(\frac{L_{CES,t}(j)}{LY_{L,t}(j)}\right)^{\frac{1}{\sigma_L}} s_{L_L}^{\frac{1}{\sigma_L}} ef_{L_L}^{\frac{\sigma_L - 1}{\sigma_L}} + \\
&-\gamma_{L_L}\left(\frac{LY_{L,t}(j)}{LY_{L,t-1}(j)} - 1\right) Y_t \frac{1}{LY_{L,t-1}(j)} + \beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{L_L}\left(\frac{LY_{L,t+1}(j)}{LY_{L,t}(j)} - 1\right) Y_{t+1}\frac{LY_{L,t+1}(j)}{LY_{L,t}(j)^2},
\end{aligned} \tag{A-12}$$

$$\begin{aligned}
&\frac{W_t^{L_H}}{P_t}\left(1 - sub_t^{L_H} + \tau_{f,t}^{W^{L_H}}\right) = \\
&\alpha_L(1-\alpha_G) MC_t(j) \frac{Y_t(j)}{L_{CES,t}(j) - OH_t^L} \left(\frac{L_{CES,t}(j)}{LY_{H,t}(j)}\right)^{\frac{1}{\sigma_L}} s_{L_H}^{\frac{1}{\sigma_L}} ef_{L_H}^{\frac{\sigma_L - 1}{\sigma_L}} + \\
&-\gamma_{L_H}\left(\frac{LY_{H,t}(j)}{LY_{H,t-1}(j)} - 1\right) Y_t \frac{1}{LY_{H,t-1}(j)} + \beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{L_H}\left(\frac{LY_{H,t+1}(j)}{LY_{H,t}(j)} - 1\right) Y_{t+1}\frac{LY_{H,t+1}(j)}{LY_{H,t}(j)^2},
\end{aligned} \tag{A-13}$$

$$\begin{aligned}
&\frac{W_t^{N_A}}{P_t}\left(1 - sub_t^{N_A} + \tau_{f,t}^{W^{N_A}}\right) = \\
&\alpha_N(1-\alpha_G) MC_t(j) \frac{Y_t(j)}{N_{CES,t}(j) - OH_t^N} \left(\frac{N_{CES,t}(j)}{NY_{A,t}(j)}\right)^{\frac{1}{\sigma_N}} s_{N_S}^{\frac{1}{\sigma_N}} ef_{N_S}^{\frac{\sigma_N - 1}{\sigma_N}} + \\
&-\gamma_{N_A}\left(\frac{NY_{A,t}(j)}{NY_{A,t-1}(j)} - 1\right) Y_t \frac{1}{NY_{A,t-1}(j)} + \beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{N_A}\left(\frac{NY_{A,t+1}(j)}{NY_{A,t}(j)} - 1\right) Y_{t+1}\frac{NY_{A,t+1}(j)}{NY_{A,t}(j)^2}.
\end{aligned} \tag{A-14}$$

$$\frac{W_t^{N_S}}{P_t}\left(1+\tau_{f,t}^{W^{N_S}}\right)=\alpha_N\left(1-\alpha_G\right)MC_t\left(j\right)\frac{Y_t\left(j\right)}{N_{CES,t}(j)-OH_t^N}\left(\frac{N_{CES,t}(j)}{NY_{S,t}(j)}\right)^{\frac{1}{\sigma_N}}s_{N_S}^{\frac{1}{\sigma_N}}ef_{N_S}^{\frac{\sigma_N-1}{\sigma_N}}+ \tag{A-15}$$

$$-\gamma_{N_S}\left(\frac{NY_{S,t}\left(j\right)}{NY_{S,t-1}\left(j\right)}-1\right)Y_t\frac{1}{NY_{S,t-1}\left(j\right)}+\beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{N_S}\left(\frac{NY_{S,t+1}\left(j\right)}{NY_{S,t}\left(j\right)}-1\right)Y_{t+1}\frac{NY_{S,t+1}\left(j\right)}{NY_{S,t}\left(j\right)^2}.$$

In steady state the above conditions correspond to (28) and (30)-(33), respectively.

Exporting and Importing Firms

The typical exporting firm will set the exporting price $P_{X,t}(j)$, so as to maximize the expected discounted value of future profits, taking as given the adjustment cost (34), the exchange rate S_t and the world demand for good j $EXP_t(j)=\left(\frac{P_{X,t}(j)}{P_{X,t}}\right)^{-\theta_{EXP}}EXP_t$. At the optimum and imposing symmetry, the price of goods sold in the foreign market obeys to the following law of motion:

$$\left[\left(1-\theta_{EXP}\right)\frac{S_tP_{X,t}}{P_t}+\theta_{EXP}\right]EXP_t+ \tag{A-16}$$

$$-\gamma_{EXP}\left[\frac{\Pi_{EXP,t}}{\left(\Pi_{t-1}^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}-1\right]\frac{\Pi_{EXP,t}}{\left(\Pi_{t-1}^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}EXP_t+$$

$$+\gamma_{EXP}\beta E_t\frac{\lambda_{t+1}^R}{\lambda_t^R}\left[\frac{\Pi_{EXP,t+1}}{\left(\Pi_t^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}-1\right]\frac{\Pi_{EXP,t+1}}{\left(\Pi_t^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}EXP_{t+1}=0,$$

where $\Pi_{EXP,t}=P_{X,t}/P_{X,t-1}$. In steady state the above condition becomes (35).

The importing firm will set its price in local currency as a markup over the import price of intermediate goods produced abroad given the demand $IMP_t(j)=\left(\frac{P_{M,t}(j)}{P_t^M}\right)^{-\theta_{IMP}}IMP_t$ and the adjustment cost function. At the optimum, we have:

$$\left[\left(1-\theta_{IMP}\right)\frac{P_{M,t}}{P_t}+\left(1-\tau_{IMP,t}\right)\frac{S_tP_t^*}{P_t}\theta_{IMP}\right]IMP_t+ \tag{A-17}$$

$$-\gamma_{IMP}\left(\frac{\Pi_{IMP,t}}{\Pi_{t-1}^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}}-1\right)\frac{\Pi_{IMP,t}}{\Pi_{t-1}^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}}IMP_t+$$

$$+\gamma_{IMP}\beta E_t\frac{\lambda_{t+1}^R}{\lambda_t^R}\left(\frac{\Pi_{IMP,t+1}}{\Pi_t^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}}-1\right)\frac{\Pi_{IMP,t+1}}{\Pi_t^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}}IMP_{t+1}=0,$$

where $\Pi_{IMP,t}=P_{M,t}/P_{M,t-1}$.

Solution to the Final Good Producers Problem

The typical final good producer i will set the price $P_{E,t}(i)$, so as to maximize the expected discounted value of future profits, taking as given the adjustment cost function, the price of

intermediate goods and the demand for good i, $E_t(i) = \left(\frac{P_{E,t}(i)}{P_{E,t}}\right)^{-\theta_E} E_t$. At the optimum and imposing symmetry, the price of goods sold in the foreign market obeys to the following law of motion:

$$\begin{aligned} &\left[(1-\theta_E)\frac{P_{E,t}}{P_t} + \theta_E MC_{E,t}\right] E_t + \\ &-\gamma_E \left(\frac{\Pi_t^E}{\Pi_{t-1}^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} - 1\right) Y_t \frac{\Pi_t^E}{\Pi_{t-1}^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} + \\ &+\gamma_E \beta \frac{\lambda_{t+1}^R}{\lambda_t^R} \left(\frac{\Pi_{t+1}^E}{\Pi_t^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} - 1\right) \frac{\Pi_{t+1}^E}{\Pi_t^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} Y_{t+1} = 0 \end{aligned} \tag{A-18}$$

where $\Pi_{E,t} = P_{E,t}/P_{E,t-1}$.

Appendix B

1 Euler Equation of the Ricardian Households

$$\lambda_t^R = \beta E_t \lambda_{t+1}^R \frac{R_t}{\Pi_{t+1}}$$

2 Lagrangian Multiplier of the Ricardian Households

$$\frac{\left[\left(\omega_G^R\right)^{1/\theta_G}\left(C_t^R\right)^{(\theta_G-1)/\theta_G}+(1-\omega_G^R)^{1/\theta_G}\left(Y_{G,t}^R\right)^{(\theta_G-1)/\theta_G}\right]^{\frac{1}{\theta_G-1}}\left(\omega_G^R\right)^{1/\theta_G}\left(C_t^R\right)^{-\frac{1}{\theta_G}}}{\tilde{C}_t^R - h_{C^R}\widetilde{C}_{t-1}^R} = (1+\tau_t^C)\frac{P_{C,t}}{P_t}\lambda_t^R$$

3 Adjusted Consumption of the Ricardian Households

$$\tilde{C}_t^R = \left[\left(\omega_G^R\right)^{1/\theta_G}\left(C_t^R\right)^{(\theta_G-1)/\theta_G} + (1-\omega_G^R)^{1/\theta_G}\left(Y_{G,t}^R\right)^{(\theta_G-1)/\theta_G}\right]^{\theta_G/(\theta_G-1)}$$

4 Consumption of the Non Ricardian Households

$$C_t^{NR} = \frac{P_t}{(1+\tau_t^C)P_{C,t}}\left[\begin{array}{c}\left(1-\tau_t^{N_A}-\tau_{h,t}^{W^{N_A}}\right)\frac{s_{N_A}}{s_{NR}}WR_t^{N_A}N_{A,t} - TAX_t^{NR}+\\ +Tr_t^{NR}+\left(1-\tau_t^{L_L}-\tau_{h,t}^{W^{L_L}}\right)\frac{\lambda^{L_L}s_{L_L}}{s_{NR}}WR_t^{L_L}L_{L,t}+\\ -\frac{\lambda^{L_L}s_{L_L}}{s_{NR}}\frac{\gamma_{W^{L_L}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{WR_t^{L_L}}{WR_{t-1}^{L_L}}\Pi_t-1\right)^2 Y_t\end{array}\right]$$

5 Lagrangian Multiplier of Non Ricardian Households

$$\frac{\left[\left(\omega_G^{NR}\right)^{1/\theta_G}\left(C_t^{NR}\right)^{(\theta_G-1)/\theta_G}+(1-\omega_G^R)^{1/\theta_G}\left(Y_{G,t}^{NR}\right)^{(\theta_G-1)/\theta_G}\right]^{\frac{1}{\theta_G-1}}\left(\omega_G^{NR}\right)^{1/\theta_G}\left(C_t^{NR}\right)^{-\frac{1}{\theta_G}}}{\tilde{C}_t^{NR} - h_{C^{NR}}\widetilde{C}_{t-1}^{NR}} = (1+\tau_t^C)\frac{P_{C,t}}{P_t}\lambda_t^{NR}$$

6 Adjusted Consumption of the Non Ricardian Households

$$\tilde{C}_t^{NR} = \left[\left(\omega_G^{NR}\right)^{1/\theta_G}\left(C_t^{NR}\right)^{(\theta_G-1)/\theta_G} + (1-\omega_G^{NR})^{1/\theta_G}\left(Y_{G,t}^{NR}\right)^{(\theta_G-1)/\theta_G}\right]^{\theta_G/(\theta_G-1)}$$

7 Aggregate Consumption

$$C_t = s_{NR}C_t^{NR} + (1-s_{NR})C_t^R$$

8 Wage Equation of Self-Employed Labor Workers

$$\begin{array}{l}(\sigma_{N_S}-1)\,\lambda_t^R\left(1-\tau_t^{N_S}-\tau_{h,t}^{W^{N_S}}\right)WR_t^{N_S}N_{S,t} = \omega_{N_S}\sigma_{N_S}\left(1-N_{S,t}\right)^{-\upsilon_{N_S}}N_{S,t}+\\ \quad -\lambda_t^R\gamma_{W^{N_S}}\left(\frac{WR_t^{N_S}}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_{t-1}^{N_S}}\Pi_t-1\right)Y_t\frac{WR_t^{N_S}}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_{t-1}^{N_S}}\Pi_t+\\ \quad +\beta\lambda_{t+1}^R\gamma_{W^{N_S}}\left(\frac{WR_{t+1}^{N_S}}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_t^{N_S}}\Pi_{t+1}-1\right)Y_{t+1}\frac{WR_{t+1}^{N_S}}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_t^{N_S}}\Pi_{t+1}\end{array}$$

9 Wage Equation of Skilled Employees

$$\begin{aligned}
&(\sigma_{L_H}-1)\,\lambda_t^R\left(1-\tau_t^{L_H}-\tau_{h,t}^{W^{L_H}}\right)WR_t^{L_H}L_{H,t}=\omega_{L_H}\sigma_{L_H}\left(1-L_{H,t}\right)^{-\upsilon_{L_H}}L_{H,t}+\\
&\quad-\lambda_t^R\gamma_{W^{L_H}}\left(\frac{WR_t^{L_H}}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_{t-1}^{L_H}}\Pi_t-1\right)Y_t\frac{WR_t^{L_H}}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_{t-1}^{L_H}}\Pi_t+\\
&\quad+\beta\lambda_{t+1}^R\gamma_{W^{L_H}}\left(\frac{WR_{t+1}^{L_H}}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_t^{L_H}}\Pi_{t+1}-1\right)Y_{t+1}\frac{WR_{t+1}^{L_H}}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_t^{L_H}}\Pi_{t+1}
\end{aligned}$$

10 Wage Equation of Unskilled Employees

$$\begin{aligned}
&(\sigma_{L_L}-1)\left[(1-I^{NR}\lambda^{L_L})\lambda_t^R+I^{NR}\lambda^{L_L}\lambda_t^{NR}\right]\left(1-\tau_t^{L_L}-\tau_{h,t}^{W^{L_L}}\right)WR_t^{L_L}L_{L,t}=\\
&\quad+\omega_{L_L}\sigma_{L_L}\left(1-L_{L,t}\right)^{-\upsilon_{LL}}L_{L,t}+\\
&\quad-\left[(1-I^{NR}\lambda^{L_L})\lambda_t^R+I^{NR}\lambda^{L_L}\lambda_t^{NR}\right]\gamma_{W^{L_L}}\left(\frac{WR_t^{L_L}}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_{t-1}^{L_L}(h_{L_L})}\Pi_t-1\right)Y_t\frac{WR_t^{L_L}}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_{t-1}^{L_L}}\Pi_t+\\
&\quad+\beta\left[(1-I^{NR}\lambda^{L_L})\lambda_{t+1}^R+I^{NR}\lambda^{L_L}\lambda_{t+1}^{NR}\right]\gamma_{W^{L_L}}\left(\frac{WR_{t+1}^{L_L}}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_t^{L_L}}\Pi_{t+1}-1\right)Y_{t+1}\frac{WR_{t+1}^{L_L}}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}WR_t^{L_L}}\Pi_{t+1}
\end{aligned}$$

11 Supply of Atypical Labor Services

$$\frac{1}{\lambda_t^{NR}}=WR_t^{N_A}\left(1-N_{A,t}\right)^{\upsilon_{N_A}}\frac{1-\tau_t^{N_A}-\tau_{h,t}^{W^{N_A}}}{\omega_{N_A}}$$

12 Demand of Skilled Labor as Employees

$$\begin{aligned}
&WR_t^{L_H}\left(1-sub_t^{L_H}+\tau_{f,t}^{W^{L_H}}\right)=\alpha_L\left(1-\alpha_G\right)MC_t\frac{X_t}{L_{CES,t}-OH^L}sx_{L_H}^{\frac{1}{\sigma_L}}\left(ef_{L_H}\right)^{\frac{\sigma_L-1}{\sigma_L}}\left(\frac{L_{CES,t}}{LY_{H,t}}\right)^{\frac{1}{\sigma_L}}+\\
&\quad-\gamma_{L_H}\left(\frac{LY_{H,t}}{LY_{H,t-1}}-1\right)Y_t\frac{1}{LY_{H,t-1}}+\\
&\quad+\beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{L_H}\left(\frac{LY_{H,t+1}}{LY_{H,t}}-1\right)Y_{t+1}\frac{LY_{H,t+1}}{LY_{H,t}^2}
\end{aligned}$$

13 Demand of Unskilled Labor as Employees

$$\begin{aligned}
&WR_t^{L_L}\left(1-sub_t^{L_L}+\tau_{f,t}^{W^{L_L}}\right)=\alpha_L\left(1-\alpha_G\right)MC_t\frac{X_t}{L_{CES,t}-OH^L}sx_{L_L}^{\frac{1}{\sigma_L}}\left(ef_{L_L}\right)^{\frac{\sigma_L-1}{\sigma_L}}\left(\frac{L_{CES,t}}{LY_{L,t}}\right)^{\frac{1}{\sigma_L}}+\\
&\quad-\gamma_{L_L}\left(\frac{LY_{L,t}}{LY_{L,t-1}}-1\right)Y_t\frac{1}{LY_{L,t-1}}+\\
&\quad+\beta\frac{\lambda_{t+1}^R}{\lambda_T^R}\gamma_{L_L}\left(\frac{LY_{L,t+1}}{LY_{L,t}}-1\right)Y_{t+1}\frac{LY_{L,t+1}}{LY_{L,t}^2}
\end{aligned}$$

14 Demand of Self-Employed Labor

$$\begin{aligned}
&WR_t^{N_S}\left(1+\tau_{f,t}^{W_{N_S}}\right)=\alpha_N\left(1-\alpha_G\right)MC_t\frac{Y_t}{N_{CES,t}-OH^N}sx_{N_S}^{\frac{1}{\sigma_N}}\left(ef_{N_S}\right)^{\frac{\sigma_N-1}{\sigma_N}}\left(\frac{N_{CES,t}}{NY_{S,t}}\right)^{\frac{1}{\sigma_N}}+\\
&\quad-\gamma_{N_S}\left(\frac{NY_{S,t}}{NY_{S,t-1}}-1\right)Y_t\frac{1}{NY_{S,t-1}}+\\
&\quad+\beta\frac{\lambda_{t+1}^R}{\lambda_T^R}\gamma_{N_S}\left(\frac{NY_{S,t+1}}{NY_{S,t}}-1\right)Y_{t+1}\frac{NY_{S,t+1}}{NY_{S,t}^2}
\end{aligned}$$

15 Demand of Atypical Labor

$$\begin{aligned}
&WR_t^{N_A}\left(1-sub_t^{N_A}+\tau_{f,t}^{W^{N_A}}\right)=\alpha_N\left(1-\alpha_G\right)MC_t\frac{Y_t}{N_{CES,t}-OH^N}sx_{N_A}^{\frac{1}{\sigma_N}}\left(ef_{N_A}\right)^{\frac{\sigma_N-1}{\sigma_N}}\left(\frac{N_{CES,t}}{NY_{A,t}}\right)^{\frac{1}{\sigma_N}}+\\
&\quad-\gamma_{N_A}\left(\frac{NY_{A,t}}{NY_{A,t-1}}-1\right)Y_t\frac{1}{NY_{A,t-1}}+
\end{aligned}$$

$$+\beta\frac{\lambda^R_{t+1}}{\lambda^R_T}\gamma_{N_A}\left(\frac{NY_{A,t+1}}{NY_{A,t}}-1\right)Y_{t+1}\frac{NY_{A,t+1}}{NY^2_{A,t}}$$

16 Equilibrium in the Labor Market, Unskilled Employees

$$LY_{L,t}=s_{L_L}L_{L,t}$$

17 Equilibrium in the Labor Market, Skilled Employees

$$LY_{H,t}=s_{L_H}L_{H,t}$$

18 Equilibrium in the Labor Market, Self-Employed Workers

$$NY_{S,t}=s_{N_S}N_{S,t}$$

19 Equilibrium in the Labor Market, Atypical Workers

$$NY_{A,t}=s_{N_A}N_{A,t}$$

20 Labor Aggregate

$$LN_t=s_{L_L}L_{L,t}+s_{L_H}L_{H,t}+s_{N_S}N_{S,t}+s_{N_A}N_{A,t}$$

21 Production Function of the Intermediate-Goods Producers

$$Y_t=A_t\left[\left(L_{CES,t}-OH^L_t\right)^{\alpha_L}\left(N_{CES,t}-OH^N_t\right)^{\alpha_N}\left(u^K_tK_t\right)^{1-\alpha_L-\alpha_N}\right]^{1-\alpha_G}\left(K^P_{G,t}\right)^{\alpha_G}$$

22 Employees Labor CES Aggregate

$$L_{CES,t}=\left[sy_{L_L}^{\frac{1}{\sigma_L}}\left(ef_{L_L}LY_{L,t}\right)^{\frac{\sigma_L-1}{\sigma_L}}+sy_{L_H}^{\frac{1}{\sigma_L}}\left(ef_{L_H}LY_{H,t}\right)^{\frac{\sigma_L-1}{\sigma_L}}\right]^{\frac{\sigma_L}{\sigma_L-1}}$$

23 Self-Employed and Atypical Labor CES Aggregate

$$N_{CES,t}=\left[sy_{N_S}^{\frac{1}{\sigma_N}}\left(ef_{N_S}NY_{S,t}\right)^{\frac{\sigma_N-1}{\sigma_N}}+sy_{N_A}^{\frac{1}{\sigma_N}}\left(ef_{N_A}NY_{A,t}\right)^{\frac{\sigma_N-1}{\sigma_N}}\right]^{\frac{\sigma_N}{\sigma_N-1}}$$

24 Physical Capital Accumulation Equation

$$K_{t+1}=\left(1-\delta_K\right)K_t+I_t$$

25 Investment Equation

$$q_t-1=\gamma_I\left(\frac{I_t}{K_t}-\delta_K\right)-tcr^K_t$$

26 Tobin's Q

$$q_t = \beta E_t \frac{\lambda^R_{t+1}}{\lambda^R_t} \frac{\Pi^I_{t+1}}{\Pi_{t+1}} \left[(1-\tau^K_{t+1}) r^K_{t+1} u^K_{t+1} + \tau^K_{t+1} u^K_{t+1} \delta_K + q_{t+1}(1-\delta_K)\right] +$$
$$-\beta E_t \frac{\lambda^R_{t+1}}{\lambda^R_t} \frac{\Pi^I_{t+1}}{\Pi_{t+1}} \left[\frac{\gamma_I}{2}\left(\frac{I^R_{t+1}}{K^R_{t+1}} - \delta_K\right)^2 - \gamma_I \left(\frac{I^R_{t+1}}{K^R_{t+1}} - \delta_K\right) \frac{I^R_{t+1}}{K^R_{t+1}} + \gamma_{u^K_1}\left(u^K_{t+1} - 1\right) + \frac{\gamma_{u^K_2}}{2}\left(u^K_{t+1} - 1\right)^2\right]$$

27 Demand of Capital

$$r^k_t u^K_t = \frac{P_t}{P^I_t}(1-\alpha_G)(1-\alpha_L-\alpha_N) MC_t \frac{Y_t}{K_t}$$

28 Capital Utilization

$$(1-\tau^K_t) r^K_t + \tau^K_t \delta_K - \gamma_{u^K_1} - \gamma_{u^K_2}\left(u^K_t - 1\right) = 0$$

29 Real Profits of Intermediate Goods Producers

$$PRO_t = Y_t - WR^{L_L}_t \left(1 - sub^{L_L}_t + \tau^{W^{L_L}}_{f,t}\right) LY_{L,t} - WR^{L_H}_t \left(1 - sub^{L_H}_t + \tau^{W^{L_H}}_{f,t}\right) LY_{H,t} +$$
$$-WR^{N_S}_t \left(1 + \tau^{W_{N_S}}_{f,t}\right) NY_{S,t} - WR^{N_A}_t \left(1 - sub^{N_A}_t + \tau^{W^{N_A}}_{f,t}\right) NY_{A,t} +$$
$$-\frac{P^I_t}{P_t} r^K_t u^K_t K_t - \frac{\gamma_p}{2}\left(\frac{\Pi_t}{\Pi^{\kappa_P}_{t-1}\overline{\Pi}^{1-\kappa_P}} - 1\right)^2 Y_t - \frac{\gamma_{L_H}}{2}\left(\frac{LY_{H,t}}{LY_{H,t-1}} - 1\right)^2 Y_t +$$
$$-\frac{\gamma_{L_L}}{2}\left(\frac{LY_{L,t}}{LY_{L,t-1}} - 1\right)^2 Y_t - \frac{\gamma_{N_S}}{2}\left(\frac{NY_{S,t}}{NY_{S,t-1}} - 1\right)^2 Y_t - \frac{\gamma_{N_A}}{2}\left(\frac{NY_{A,t}}{NY_{A,t-1}} - 1\right)^2 Y_t$$

30 Inflation Equation

$$Y_t - \gamma_p \left(\frac{\Pi_t}{\Pi^{\kappa_P}_{t-1}\overline{\Pi}^{1-\kappa_P}} - 1\right) Y_t \frac{\Pi_t}{\Pi^{\kappa_P}_{t-1}\overline{\Pi}^{1-\kappa_P}} + \beta\gamma_p E_t \frac{\lambda^R_{t+1}}{\lambda^R_t}\left(\frac{\Pi_{t+1}}{\Pi^{\kappa_P}_t \overline{\Pi}^{1-\kappa_P}} - 1\right) Y_{t+1} \frac{\Pi_{t+1}}{\Pi^{\kappa_P}_t \overline{\Pi}^{1-\kappa_P}} = (1 - MC_t)\theta_Y Y_t$$

31 Accumulation of Public Capital

$$K^G_{G,t} = (1-\delta_G) K^G_{G,t-1} + I^G_{G,t} \text{ and } K^P_{G,t} = (1-\delta_G) K^P_{G,t-1} + I^P_{G,t}$$

32 Flow Budget Constraint of the Government

$$B_t = R_{t-1} B_{t-1} + P_{C,t} C^G_t + P_{C,t} G^U_t + P_{I,t}\left(I^G_{G,t} + I^P_{G,t}\right) + P_t Tr_t +$$
$$-P_t TAX_t - P_t\left(LTAX_t + CTAX_t + KTAX_t\right) + P_t SUB_t + W^{L_L}_t L^G_t$$

33 Transfers

$$Tr_t = s_{NR} Tr^{NR}_t + (1 - s_{NR}) Tr^R_t$$

34 Labor Taxes and Social Contributions

$$LTAX_t = s_{L_L} L_{L_L,t} WR^{L_L}_t \left(\tau^{L_L}_t + \tau^{W_{L_L}}_{h,t} + \tau^{W_{L_L}}_{f,t}\right) + s_{L_H} L_{L_H,t} WR^{L_H}_t \left(\tau^{L_H}_t + \tau^{W_{L_H}}_{h,t} + \tau^{W_{L_H}}_{f,t}\right) +$$
$$+ s_{N_S,t} L_{N_S,t} WR^{N_S}_t \left(\tau^{N_S}_t + \tau^{W_{N_s}}_{h,t} + \tau^{W_{N_S}}_{f,t}\right) + s_{N_A} L_{N_A,t} WR^{N_A}_t \left(\tau^{N_A}_t + \tau^{W_{N_A}}_{h,t} + \tau^{W_{N_A}}_{f,t}\right)$$

35 Consumption Taxes

$$TVAT_t = \tau_t^C \frac{P_{C,t}}{P_t} \left[s_{NR} C_t^{NR} + (1 - s_{NR}) C_t^R \right]$$

36 Capital Taxes Net of Tax Credit

$$KTAX_t = \frac{P_t^I}{P_t} \tau_t^K \left(r_t^K - \delta^K \right) u_t^K K_t - tcr_t^K \frac{P_t^I}{P_t} I_t$$

37 Fiscal Rule

$$P_t TAX_t = P_t \overline{TAX} + T_B B_{t-1} + T_D D_t + T_Y P_t \left(Y_t - Y_{t-1} \right)$$

38 Lump-Sum Taxes Levied on Ricardian Households

$$TAX_t^R = \left(1 - s_{TAX}^{NR} \right) TAX_t$$

39 Lump-Sum Taxes Levied on Non Ricardian Households

$$TAX_t^{NR} = s_{TAX}^{NR} TAX_t$$

40 Labor Subsidies

$$SUB_t = sub_t^{L_L} s_{L_L} L_{L,t} WR_t^{L_L} + sub_t^{L_H} s_{L_H} L_{H,t} WR_t^{L_H} + sub_t^N s_{N_A} N_{A,t} WR_t^{N_A}$$

41 Government Deficit

$$\begin{aligned} D_t = {} & (R_{t-1} - 1) B_{t-1} + P_{C,t} G_t + P_{C,t} G_t^U + P_{I,t} \left(I_{G,t}^G + I_{G,t}^P \right) + P_t Tr_t + \\ & - P_t TAX_t - P_t \left(LTAX_t + CTAX_t + KTAX_t \right) + P_t SUB_t + W_t^{L_L} L_t^G \end{aligned}$$

42 Resource Constraint of the Economy

$$\begin{aligned} Y_t = {} & \frac{P_t^C}{P_t} \left(C_t + G_t + G_t^U \right) + \frac{P_t^I}{P_t} \left(I_t + I_{G,t}^G + I_{G,t}^P \right) + \frac{S_t P_{X,t}}{P_t} EXP_t - \frac{P_{M,t}}{P_t} IMP_t + \\ & + \frac{\gamma_p}{2} \left(\frac{\Pi_t}{\Pi_{t-1}^{\kappa_P} \overline{\Pi}^{1-\kappa_P}} - 1 \right)^2 Y_t + \frac{\gamma_I}{2} \frac{P_t^I}{P_t} \left(\frac{I_t}{K_t} - \delta_K \right)^2 K_t + \frac{\gamma_{L_H}}{2} \left(\frac{LX_{H,t}}{LX_{H,t-1}} - 1 \right)^2 Y_t + \\ & + \frac{\gamma_{L_L}}{2} \left(\frac{LY_{L,t}}{LY_{L,t-1}} - 1 \right)^2 Y_t + \frac{\gamma_{N_S}}{2} \left(\frac{NY_{S,t}}{NY_{S,t-1}} - 1 \right)^2 Y_t + \frac{\gamma_{N_A}}{2} \left(\frac{NY_{A,t}}{NY_{A,t-1}} - 1 \right)^2 Y_t + \\ & + \frac{\gamma_{W^{L_L}}}{2} \left(\frac{1}{\Pi_{t-1}^{\kappa_W} \overline{\Pi}^{1-\kappa_W}} \frac{WR_t^{L_L}}{WR_{t-1}^{L_L}} \Pi_t - 1 \right)^2 Y_t + \frac{\gamma_{W^{L_H}}}{2} \left(\frac{1}{\Pi_{t-1}^{\kappa_W} \overline{\Pi}^{1-\kappa_W}} \frac{WR_t^{L_H}}{WR_{t-1}^{L_H}} \Pi_t - 1 \right)^2 Y_t + \\ & + \frac{\gamma_{W^{N_S}}}{2} \left(\frac{1}{\Pi_{t-1}^{\kappa_W} \overline{\Pi}^{1-\kappa_W}} \frac{WR_t^{N_S}}{WR_{t-1}^{N_S}} \Pi_t - 1 \right)^2 Y_t + \\ & + \frac{\gamma_{IMP}}{2} \frac{P_{M,t}}{P_t} \left(\frac{\Pi_t^{IMP}}{\Pi_{t-1}^{\kappa_{IMP}} \overline{\Pi}^{1-\kappa_{IMP}}} - 1 \right)^2 IMP_t + \frac{\gamma_{EXP}}{2} \frac{S_t P_{X,t}}{P_t} \left(\frac{\Pi_t^{EXP}}{\left(\Pi_{t-1}^* \right)^{\kappa_{EXP}} \left(\overline{\Pi}^* \right)^{1-\kappa_{EXP}}} - 1 \right)^2 EXP_t \\ & + \frac{P_t^I}{P_t} \left[\gamma_{u_1^K} \left(u_t^K - 1 \right) + \frac{\gamma_{u_2^K}}{2} \left(u_t^K - 1 \right)^2 \right] K_t + WR_t^{L_L} L_t^G \end{aligned}$$

43 Interest Rate Rule

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}} \right)^{\iota_r} \left[\left(\frac{\Pi_t}{\overline{\Pi}} \right)^{\iota_\pi} \left(\frac{Y_t}{Y_{t-1}} \right)^{\iota_y} \left(\frac{S_t}{\overline{S}} \right)^{\iota_s} \right]^{1-\iota_r} u_t^R$$

44 Imports Demand

$$IMP_t = \alpha_{IMP}\left(\frac{P_{M,t}}{P_{C,t}}\right)^{-\sigma_{IMP}}(C_t + I_t + G_t + I^G_{G,t} + I^P_{G,t})$$

45 Exports Demand

$$EXP_t = \alpha_{EXP}\left(\frac{P_{X,t}}{P^*_{C,t}}\right)^{-\sigma_{EXP}} WD_t$$

46 Import Price Inflation

$$(1-\theta_{IMP})\frac{P_{M,t}}{P_t}IMP_t - \gamma_{IMP}\left(\frac{\Pi^{IMP}_t}{\Pi^{\kappa_{IMP}}_{t-1}\overline{\Pi}^{1-\kappa_{IMP}}} - 1\right)IMP_t\frac{\Pi^{IMP}_t}{\Pi^{\kappa_{IMP}}_{t-1}\overline{\Pi}^{1-\kappa_{IMP}}} + \frac{S_tP^*_t}{P_t}\theta_{IMP}IMP_t +$$
$$+\beta\gamma_{IMP}E_t\frac{\lambda^R_{t+1}}{\lambda^R_t}\left(\frac{\Pi^{IMP}_{t+1}}{\Pi^{\kappa_{IMP}}_t\overline{\Pi}^{1-\kappa_{IMP}}} - 1\right)IMP_{t+1}\frac{\Pi^{IMP}_{t+1}}{\Pi^{\kappa_{IMP}}_t\overline{\Pi}^{1-\kappa_{IMP}}} = 0$$

47 Export Price Inflation

$$(1-\theta_{EXP})\frac{S_tP_{X,t}}{P_t}EXP_t - \gamma_{EXP}\left(\frac{\Pi^{EXP}_t}{(\Pi^*_{t-1})^{\kappa_{EXP}}(\overline{\Pi}^*)^{1-\kappa_{EXP}}} - 1\right)EXP_t\frac{\Pi^{EXP}_t}{(\Pi^*_{t-1})^{\kappa_{EXP}}(\overline{\Pi}^*)^{1-\kappa_{EXP}}} + \theta_{EXP}EXP_t +$$
$$+\beta E_t\frac{\lambda^R_{t+1}}{\lambda^R_t}\gamma_{EXP}\left(\frac{\Pi^{EXP}_{t+1}}{(\Pi^*_t)^{\kappa_{EXP}}(\overline{\Pi}^*)^{1-\kappa_{EXP}}} - 1\right)EXP_{t+1}\frac{\Pi^{EXP}_{t+1}}{(\Pi^*_t)^{\kappa_{EXP}}(\overline{\Pi}^*)^{1-\kappa_{EXP}}} = 0$$

48 Domestic Consumption Price Index

$$P_{C,t} \equiv \left[(1-\alpha_{IMP})P_t^{1-\sigma_{IMP}} + \alpha_{IMP}P^{1-\sigma_{IMP}}_{M,t}\right]^{\frac{1}{1-\sigma_{IMP}}}$$

50 Euler Equation Related to Foreign Assets

$$S_t\lambda^R_t = \beta E_t\lambda^R_{t+1}\frac{R^*_t+\rho^F_t}{\Pi_{t+1}}S_{t+1}$$

51 Foreign Assets Net Position in Real Terms

$$BR^F_t = \frac{R^*_{t-1}+\rho^F_{t-1}}{\Pi_t}\frac{S_t}{S_{t-1}}BR^F_{t-1} + \frac{S_tP_{X,t}}{P_t}EXP_t - \frac{P_{M,t}}{P_t}IMP_t$$

52 Risk Premium

$$\rho^F_t = -\varphi^F(e^{BR^F_t - BR^F} - 1)$$

53 CPI Inflation

$$\Pi^C_t = \frac{P_{C,t}}{P_{C,t-1}}$$

54 Investment Goods Price Level

$$P_{I,t} = P_{C,t}$$

55 Investment Goods Inflation

$$P_{I,t} = \Pi^I_t P_{I,t-1}$$

56 Imported Good Price Level

$$P_{M,t} = \Pi_t^{IMP} P_{M,t-1}$$

57 Domestic Final Good Price Level

$$P_t = \Pi_t P_{t-1}$$

58 Foreign Final Good Price Level

$$P_t^* = \Pi_t^* P_{t-1}^*$$

59 Foreign Consumption Price Index

$$P_{C,t}^* = \Pi_t^{C^*} P_{C,t-1}^*$$

60 Export Price

$$P_{X,t} = \Pi_t^{EXP} P_{X,t-1}$$

61 Public Good Production

$$Y_{G,t} = A_t^G \left[(1-\gamma_G-\gamma_{LG})^{1/\alpha_{PA}} \left(K_{G,t}^G\right)^{\frac{\alpha_{PA}-1}{\alpha_{PA}}} + (\gamma_G)^{1/\alpha_{PA}} \left(\kappa_g G_t\right)^{\frac{\alpha_{PA}-1}{\alpha_{PA}}} + (\gamma_{LG})^{1/\alpha_{PA}} \left(L_{G,t} - OH_t^{L_G}\right)^{\frac{\alpha_{PA}-1}{\alpha_{PA}}} \right]^{\frac{\alpha_{PA}}{\alpha_{PA}-1}},$$

Appendix C

Gradual Implementation

In this Appendix we report some extra results. In particular, Tables C-1 – C-4 we show the macroeconomic impact of the structural reforms considered in Section 4 under the assumption of a gradual implementation of the policy measures. Reforms of the PA are assumed to be implemented over a 5-year time horizon

Table C-1: Rationalization of Public Spending - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	without tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.086	-0.035	-0.066	-0.078	-0.078	-0.065
consumption	0.706	0.866	0.916	0.955	0.984	1.071
consumption R	0.803	0.984	1.044	1.088	1.122	1.220
consumption NR	0.198	0.247	0.250	0.259	0.267	0.291
investments	0.161	0.056	0.064	0.086	0.106	0.192
labor	-0.012	-0.063	-0.116	-0.141	-0.147	-0.158
labor - unskilled workers	-0.019	-0.063	-0.139	-0.175	-0.183	-0.196
labor - skilled workers	-0.017	-0.048	-0.113	-0.161	-0.178	-0.196
labor - atypical workers	-0.015	-0.125	-0.170	-0.179	-0.184	-0.196
labor - self-employed workers	0.013	0.005	0.009	0.009	0.009	0.013
terms of trade	0.688	0.975	0.995	1.032	1.063	1.136
real deficit/GDP ratio	-0.220	-0.327	-0.670	-0.863	-1.056	-4.333
	with labor income tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.115	0.025	0.100	0.182	0.207	0.247
consumption	0.792	1.009	1.190	1.310	1.357	1.473
consumption R	0.904	1.152	1.369	1.508	1.561	1.694
consumption NR	0.211	0.261	0.254	0.274	0.289	0.317
investments	0.125	0.031	0.106	0.182	0.227	0.397
labor	0.027	0.036	0.155	0.265	0.286	0.282
labor - unskilled workers	0.034	0.075	0.228	0.349	0.360	0.345
labor - skilled workers	0.107	0.275	0.757	1.195	1.321	1.355
labor - atypical workers	-0.024	-0.150	-0.213	-0.223	-0.227	-0.242
labor - self-employed workers	0.018	0.017	0.040	0.058	0.064	0.073
terms of trade	0.702	0.948	0.788	0.741	0.757	0.808
real deficit/GDP ratio	-0.178	-0.199	-0.262	-0.371	-0.470	-1.964

Table C-2: Improving of Public Procurement - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.047	0.031	0.110	0.155	0.180	0.272
consumption	0.353	0.535	0.910	1.027	1.058	1.161
consumption R	0.398	0.597	1.012	1.138	1.173	1.294
consumption NR	0.123	0.207	0.380	0.447	0.452	0.465
investments	0.186	0.220	0.467	0.591	0.685	1.027
labor	0.003	-0.001	0.024	0.033	0.031	0.027
labor - unskilled workers	0.000	-0.005	0.003	0.004	0.000	-0.008
labor - skilled workers	-0.001	-0.004	-0.001	0.001	-0.001	-0.008
labor - atypical workers	-0.003	-0.035	-0.008	-0.003	-0.005	-0.014
labor - self-employed workers	0.024	0.052	0.137	0.172	0.177	0.195
terms of trade	0.315	0.469	0.574	0.602	0.585	0.511
real deficit/GDP ratio	-0.144	-0.280	-0.705	-0.930	-1.141	-4.693

Table C-3: Improvement in the Overall Productivity Level of the Public Sector - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	without tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.005	-0.044	-0.104	-0.125	-0.131	-0.143
consumption	0.254	0.355	0.519	0.559	0.563	0.572
consumption R	0.296	0.417	0.626	0.674	0.678	0.689
consumption NR	0.037	0.031	-0.038	-0.043	-0.042	-0.037
investments	-0.135	-0.161	-0.100	-0.108	-0.117	-0.145
labor	-0.017	-0.050	-0.110	-0.139	-0.144	-0.147
labor - unskilled workers	-0.019	-0.053	-0.127	-0.168	-0.174	-0.177
labor - skilled workers	-0.016	-0.041	-0.104	-0.153	-0.168	-0.177
labor - atypical workers	-0.026	-0.083	-0.158	-0.172	-0.174	-0.177
labor - self-employed workers	0.001	-0.003	-0.010	-0.014	-0.015	-0.017
terms of trade	0.134	0.148	-0.091	-0.085	-0.072	-0.039
real deficit/GDP ratio	-0.101	-0.198	-0.507	-0.659	-0.805	-3.285
	with labor income tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.034	0.016	0.064	0.137	0.156	0.172
consumption	0.340	0.497	0.786	0.907	0.928	0.968
consumption R	0.395	0.583	0.942	1.085	1.109	1.155
consumption NR	0.050	0.045	-0.031	-0.025	-0.018	-0.009
investments	-0.166	-0.182	-0.056	-0.010	0.007	0.062
labor	0.022	0.050	0.163	0.269	0.291	0.294
labor - unskilled workers	0.034	0.085	0.242	0.359	0.371	0.366
labor - skilled workers	0.108	0.282	0.768	1.205	1.333	1.376
labor - atypical workers	-0.034	-0.107	-0.198	-0.215	-0.215	-0.220
labor - self-employed workers	0.007	0.009	0.022	0.036	0.040	0.044
terms of trade	0.148	0.123	-0.286	-0.365	-0.368	-0.355
real deficit/GDP ratio	-0.059	-0.068	-0.091	-0.158	-0.209	-0.878

Table C-4: Simplification of the Administrative Framework

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.146	0.327	0.977	1.048	1.061	1.135
consumption	0.336	0.542	1.028	1.149	1.171	1.252
consumption R	0.410	0.686	1.360	1.526	1.552	1.647
consumption NR	-0.054	-0.211	-0.707	-0.823	-0.826	-0.817
investments	-0.047	0.003	0.331	0.435	0.511	0.787
labor	-0.060	-0.160	-0.394	-0.491	-0.503	-0.508
labor - unskilled workers	-0.046	-0.122	-0.298	-0.405	-0.421	-0.427
labor - skilled workers	-0.037	-0.096	-0.245	-0.369	-0.407	-0.427
labor - atypical workers	-0.116	-0.310	-0.745	-0.831	-0.834	-0.840
labor - self-employed workers	-0.038	-0.105	-0.283	-0.347	-0.346	-0.333
terms of trade	0.064	-0.094	-0.890	-0.937	-0.951	-1.013
real deficit/GDP ratio	-0.072	-0.117	-0.263	-0.334	-0.408	-1.687

Table C-5: Permanent 1% of GDP Increase in Public Consumption G_t^U

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	-0.032	0.094	0.217	0.261	0.273	0.291
consumption	-0.702	-0.937	-1.253	-1.340	-1.356	-1.400
consumption R	-0.813	-1.091	-1.492	-1.597	-1.615	-1.664
consumption NR	-0.125	-0.133	-0.004	0.004	-0.001	-0.018
investments	0.202	0.290	0.172	0.179	0.190	0.218
labor	0.035	0.114	0.244	0.307	0.319	0.328
labor - unskilled workers	0.043	0.120	0.283	0.372	0.386	0.395
labor - skilled workers	0.035	0.093	0.232	0.340	0.374	0.395
labor - atypical workers	0.055	0.197	0.351	0.382	0.386	0.395
labor - self-employed workers	-0.007	0.003	0.015	0.023	0.025	0.027
terms of trade	-0.443	-0.574	-0.127	-0.149	-0.183	-0.268
real deficit/GDP ratio	0.258	0.473	1.154	1.497	1.829	7.469

Table C-6: Permanent 1% of GDP Increase in Public Consumption G_t

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	-0.033	0.086	0.199	0.242	0.253	0.270
consumption	-0.684	-0.930	-1.291	-1.365	-1.380	-1.425
consumption R	-0.793	-1.083	-1.538	-1.626	-1.644	-1.693
consumption NR	-0.116	-0.126	0.000	0.002	-0.002	-0.019
investments	0.193	0.278	0.167	0.169	0.179	0.203
labor	0.031	0.103	0.222	0.281	0.292	0.302
labor - unskilled workers	0.039	0.111	0.264	0.349	0.362	0.371
labor - skilled workers	0.032	0.087	0.216	0.319	0.351	0.371
labor - atypical workers	0.049	0.182	0.327	0.359	0.363	0.372
labor - self-employed workers	-0.012	-0.010	-0.018	-0.015	-0.013	-0.011
terms of trade	-0.422	-0.547	-0.125	-0.134	-0.166	-0.248
real deficit/GDP ratio	0.255	0.473	1.164	1.508	1.842	7.524

Table C-7: Permanent 1% of GDP Increase in Public Employment L_t^G

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.024	0.083	0.206	0.254	0.268	0.301
consumption	-0.290	-0.492	-0.953	-1.016	-1.012	-0.997
consumption R	-0.347	-0.595	-1.177	-1.254	-1.249	-1.231
consumption NR	0.009	0.046	0.218	0.228	0.229	0.227
investments	0.409	0.419	0.281	0.300	0.331	0.437
labor	0.031	0.081	0.191	0.250	0.259	0.262
labor - unskilled workers	0.036	0.093	0.229	0.310	0.321	0.323
labor - skilled workers	0.028	0.073	0.188	0.283	0.311	0.323
labor - atypical workers	0.051	0.132	0.286	0.322	0.323	0.323
labor - self-employed workers	-0.005	-0.011	-0.022	-0.019	-0.016	-0.010
terms of trade	0.004	0.114	0.693	0.720	0.704	0.654
real deficit/GDP ratio	0.149	0.349	0.985	1.283	1.565	6.380

Table C-8: Permanent 1% of GDP Increase in Public Investments

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.177	0.083	0.554	1.431	1.952	2.876
consumption	0.122	-0.039	-0.406	-0.146	0.150	1.068
consumption R	0.130	-0.066	-0.522	-0.209	0.142	1.213
consumption NR	0.082	0.102	0.196	0.180	0.187	0.312
investments	-0.139	-0.226	-0.251	0.147	0.477	1.786
labor	0.027	0.009	0.015	-0.041	-0.104	-0.246
labor - unskilled workers	0.014	0.013	0.024	-0.019	-0.090	-0.265
labor - skilled workers	0.007	0.007	0.012	-0.026	-0.087	-0.264
labor - atypical workers	0.073	0.020	0.056	-0.025	-0.097	-0.263
labor - self-employed workers	0.011	-0.014	-0.058	-0.126	-0.160	-0.165
terms of trade	0.215	0.342	0.107	-1.092	-1.719	-2.434
real deficit/GDP ratio	0.008	0.244	0.860	0.949	1.037	3.674

Table C-9: Permanent 1% of GDP Shift from Public Consumption to Public Investments

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.225	0.005	0.359	1.193	1.702	2.611
consumption	0.746	0.869	0.883	1.219	1.534	2.500
consumption Ricardian	0.846	0.992	1.015	1.419	1.790	2.915
consumption non-Ricardian	0.221	0.223	0.194	0.176	0.189	0.330
investments	-0.367	-0.489	-0.409	-0.011	0.308	1.591
labor	-0.003	-0.090	-0.200	-0.313	-0.386	-0.534
labor - unskilled workers	-0.024	-0.095	-0.232	-0.358	-0.440	-0.621
labor - skilled workers	-0.024	-0.077	-0.198	-0.336	-0.426	-0.620
labor - atypical workers	0.027	-0.155	-0.263	-0.374	-0.449	-0.619
labor - self-employed workers	0.024	-0.003	-0.036	-0.106	-0.141	-0.147
terms of trade	0.729	0.868	0.223	-0.968	-1.563	-2.200
real deficit/GDP ratio	-0.231	-0.223	-0.299	-0.548	-0.790	-3.807

Appendix D

The Role of Public Capital in the Production Function

In this Appendix we report some of our simulation results assuming a lower output elasticity to public capital. In particular, α_G is reduced from 0.14 to 0.07. As we can see the results of the simulations are robust to this different parametrization. As expected, the major differences are observed when we consider policy changes involving variations in public capital.

Table D-1: Rationalization of Public Spending - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	without tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.054	-0.051	-0.084	-0.092	-0.089	-0.072
consumption	0.906	1.112	1.092	1.089	1.088	1.092
consumption R	1.043	1.274	1.247	1.245	1.245	1.249
consumption NR	0.214	0.291	0.302	0.297	0.295	0.293
investments	0.262	0.128	0.122	0.139	0.154	0.205
labor	-0.023	-0.082	-0.142	-0.163	-0.165	-0.165
labor - unskilled workers	-0.028	-0.081	-0.171	-0.203	-0.205	-0.204
labor - skilled workers	-0.022	-0.061	-0.139	-0.188	-0.200	-0.204
labor - atypical workers	-0.044	-0.164	-0.206	-0.205	-0.205	-0.204
labor - self-employed workers	0.013	0.009	0.010	0.009	0.009	0.012
terms of trade	0.780	1.162	1.202	1.190	1.180	1.149
real deficit/GDP ratio	-0.674	-0.709	-0.782	-0.952	-1.163	-4.752
	with labor income tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.092	0.038	0.123	0.183	0.204	0.246
consumption	1.011	1.322	1.414	1.450	1.462	1.490
consumption R	1.167	1.526	1.631	1.672	1.686	1.719
consumption NR	0.219	0.287	0.313	0.324	0.326	0.327
investments	0.240	0.150	0.197	0.251	0.289	0.418
labor	0.032	0.057	0.164	0.226	0.238	0.242
labor - unskilled workers	0.055	0.121	0.247	0.294	0.296	0.295
labor - skilled workers	0.148	0.365	0.825	1.127	1.206	1.232
labor - atypical workers	-0.063	-0.203	-0.253	-0.248	-0.248	-0.248
labor - self-employed workers	0.019	0.024	0.047	0.060	0.064	0.072
terms of trade	0.756	1.025	0.953	0.901	0.878	0.821
real deficit/GDP ratio	-0.188	-0.228	-0.300	-0.403	-0.503	-2.077

Table D-2: Improving of Public Procurement - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.070	0.133	0.152	0.181	0.207	0.304
consumption	0.762	1.057	1.075	1.094	1.112	1.181
consumption R	0.868	1.190	1.193	1.214	1.235	1.318
consumption NR	0.222	0.384	0.476	0.485	0.486	0.489
investments	0.558	0.503	0.557	0.661	0.749	1.065
labor	0.021	0.038	0.032	0.026	0.026	0.028
labor - unskilled workers	0.013	0.023	0.009	-0.005	-0.007	-0.008
labor - skilled workers	0.004	0.007	0.002	-0.004	-0.006	-0.008
labor - atypical workers	0.020	0.022	-0.011	-0.011	-0.011	-0.013
labor - self-employed workers	0.057	0.117	0.164	0.174	0.178	0.196
terms of trade	0.427	0.659	0.687	0.647	0.612	0.490
real deficit/GDP ratio	-0.647	-0.741	-0.839	-1.028	-1.261	-5.178

Table D-3: Improvement in the Overall Productivity Level of the Public Sector - 0.5% of GDP Reduction of Production Cost in the Public Provision of Goods and Services

	without tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	-0.084	-0.079	-0.120	-0.138	-0.144	-0.159
consumption	0.474	0.644	0.616	0.605	0.598	0.579
consumption R	0.582	0.776	0.743	0.731	0.724	0.701
consumption NR	-0.076	-0.028	-0.029	-0.035	-0.036	-0.040
investments	0.042	-0.034	-0.063	-0.081	-0.096	-0.148
labor	-0.038	-0.076	-0.132	-0.151	-0.153	-0.153
labor - unskilled workers	-0.032	-0.075	-0.154	-0.183	-0.184	-0.182
labor - skilled workers	-0.023	-0.056	-0.125	-0.169	-0.180	-0.182
labor - atypical workers	-0.084	-0.145	-0.185	-0.184	-0.184	-0.182
labor - self-employed workers	-0.005	-0.005	-0.011	-0.015	-0.016	-0.019
terms of trade	-0.275	-0.089	-0.041	-0.036	-0.034	-0.024
real deficit/GDP ratio	-0.506	-0.555	-0.607	-0.735	-0.897	-3.654
	with labor income tax reduction					
	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	-0.044	0.011	0.088	0.139	0.151	0.161
consumption	0.573	0.844	0.929	0.959	0.966	0.972
consumption R	0.700	1.016	1.115	1.149	1.157	1.165
consumption NR	-0.068	-0.029	-0.015	-0.006	-0.004	-0.004
investments	0.021	-0.013	0.011	0.031	0.040	0.066
labor	0.018	0.064	0.177	0.240	0.252	0.255
labor - unskilled workers	0.051	0.128	0.266	0.316	0.319	0.318
labor - skilled workers	0.148	0.371	0.841	1.148	1.228	1.255
labor - atypical workers	-0.101	-0.180	-0.228	-0.225	-0.225	-0.225
labor - self-employed workers	0.001	0.011	0.027	0.037	0.039	0.041
terms of trade	-0.290	-0.211	-0.276	-0.314	-0.326	-0.341
real deficit/GDP ratio	-0.014	-0.063	-0.114	-0.177	-0.226	-0.938

Table D-4: Simplification of the Administrative Framework

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	1.208	1.253	1.161	1.156	1.174	1.253
consumption	0.965	1.369	1.291	1.296	1.308	1.359
consumption R	1.272	1.768	1.704	1.714	1.729	1.791
consumption NR	-0.588	-0.656	-0.800	-0.827	-0.830	-0.829
investments	0.583	0.466	0.479	0.562	0.633	0.889
labor	-0.173	-0.305	-0.458	-0.505	-0.511	-0.510
labor - unskilled workers	-0.077	-0.171	-0.360	-0.431	-0.437	-0.437
labor - skilled workers	-0.055	-0.129	-0.293	-0.399	-0.427	-0.437
labor - atypical workers	-0.460	-0.726	-0.852	-0.849	-0.850	-0.851
labor - self-employed workers	-0.125	-0.216	-0.307	-0.319	-0.316	-0.302
terms of trade	-1.365	-1.037	-0.942	-0.973	-1.002	-1.104
real deficit/GDP ratio	-0.291	-0.362	-0.345	-0.410	-0.500	-2.062

Table D-5: Permanent 1% of GDP Increase in Public Investments

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.409	0.308	0.668	1.066	1.303	1.757
consumption	-0.503	-0.755	-0.731	-0.680	-0.592	-0.091
consumption R	-0.680	-0.945	-0.906	-0.839	-0.733	-0.149
consumption NR	0.396	0.206	0.161	0.125	0.120	0.207
investments	-0.602	-0.328	-0.167	0.060	0.255	1.069
labor	0.037	-0.003	-0.053	-0.147	-0.214	-0.347
labor - unskilled workers	0.018	0.008	-0.013	-0.095	-0.162	-0.309
labor - skilled workers	0.006	0.000	-0.023	-0.092	-0.155	-0.308
labor - atypical workers	0.130	0.046	-0.004	-0.097	-0.158	-0.296
labor - self-employed workers	-0.014	-0.098	-0.239	-0.382	-0.460	-0.538
terms of trade	1.231	0.393	-0.274	-0.912	-1.235	-1.513
real deficit/GDP ratio	0.937	1.015	1.081	1.254	1.492	5.870

Table D-6: Permanent 1% of GDP Shift from Public Consumption to Public Investments

	Year 1	Year 2	Year 5	Year 10	Year 15	Long run
GDP	0.263	0.142	0.442	0.807	1.034	1.467
consumption	0.867	0.797	0.747	0.781	0.859	1.330
consumption Ricardian	0.996	0.909	0.855	0.905	1.000	1.548
consumption non-Ricardian	0.214	0.225	0.196	0.151	0.143	0.224
investments	-0.375	-0.355	-0.232	-0.031	0.143	0.879
labor	-0.034	-0.154	-0.313	-0.444	-0.515	-0.644
labor - unskilled workers	-0.045	-0.143	-0.326	-0.464	-0.533	-0.674
labor - skilled workers	-0.040	-0.113	-0.277	-0.434	-0.518	-0.673
labor - atypical workers	-0.030	-0.253	-0.379	-0.470	-0.531	-0.663
labor - self-employed workers	-0.006	-0.078	-0.217	-0.365	-0.444	-0.526
terms of trade	0.780	0.590	-0.016	-0.648	-0.970	-1.243
real deficit/GDP ratio	-0.238	-0.218	-0.272	-0.385	-0.510	-2.314

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