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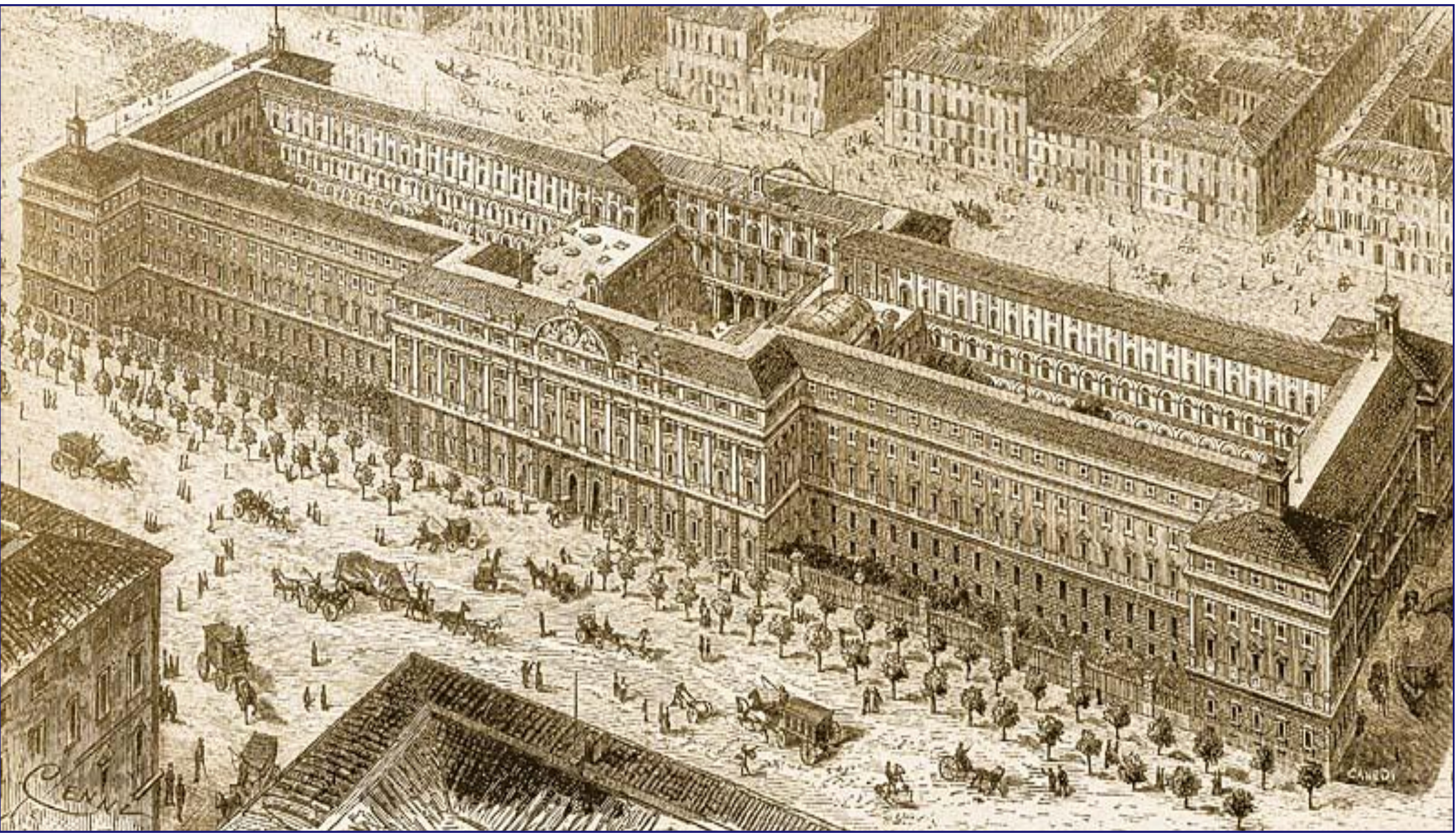

Working Papers

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IGEM II: a New Variant of the Italian General Equilibrium Model

Barbara Annicchiarico[*], Fabio Di Dio[‡], Francesco Felici[§]

Abstract

This paper provides a full technical description of a variant of the Italian General Equilibrium Model (IGEM), a dynamic general equilibrium model used as a laboratory for policy analysis at the Department of the Italian Treasury. This version of IGEM presents four specific key features: (i) imperfectly competitive final good sector; (ii) involuntary unemployment; (iii) a business tax bearing on firms; (iv) market frictions in the labor market of atypical workers.

The paper presents some simulation scenarios of structural and fiscal reforms.

JEL Classification: E27, E30, E60.

Keywords: Dynamic General Equilibrium Model, Quantitative Policy Analysis, Simulation Analysis, Italy.

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1 Introduction

In this paper we present an extension of IGEM, the dynamic general equilibrium (DGE) model for the Italian economy, entirely developed at the Department of Treasury of the Italian Ministry of the Economy and Finance (see Annicchiarico et al. 2013a, 2015). The present paper incorporates several parts of Annicchiarico et al. (2013a) and amends the original paper only in those parts presenting the extensions and the simulation results.

Notably, IGEM has been designed to study the impact and the propagation mechanism of temporary shocks, evaluate the impact of alternative structural reform scenarios and analyze the effects of single policy interventions and fiscal consolidation packages in Italy. In particular, this extension of the model has four key features: (i) imperfectly competitive final good sector; (ii) involuntary unemployment; (iii) a business tax bearing on firms;[1] (iv) market frictions in the labor market of atypical workers.

IGEM belongs to the class of large scale DGE models used for policy analysis and the construction of complex reform scenarios. These models, indeed, represent a useful tool of analysis for the study of the macroeconomic of structural reforms, since they embody several market imperfections and sources of inefficiencies that reforms aim to reduce and alleviate. In addition, the explicit modelling of real and nominal rigidities and of delayed adjustments allow to study the potential effects of policy interventions from a dynamic perspective, distinguishing between impact effects, short and medium run dynamics and long run impact. However, it is not until recently that these models have been used for the analysis of the macroeconomic impact of structural reforms. Earlier contributions in this direction include Bayoumi et al. (2004) and Everaert and Schule (2006) who employ variants of the International Monetary Fund's Global Economy Model, Roeger et al. (2008, 2009), D'Auria et al. (2009), Varga et al. (2014) who use QUEST III as a laboratory for several policy experiments for the EU countries, Forni et al. (2010) who analyze the effects of increasing competition in the service sector in Italy, employing a two-region currency union DGE model, Lusinyan and Muir (2013) who in a variant of the IMF's Global Integrated Monetary and Fiscal model (GIMF) analyze the macroeconomic impact of a comprehensive package of reforms in the labor and in the goods markets for the Italian economy, Annicchiarico et al. (2013b) who study the effects of structural reforms in the labor and in the product markets using the European Commission's model QUEST III in the version adapted for the Italian economy.

Consistently with the so called "New Neoclassical Synthesis" (see Goodfriend and King 1997) IGEM presents a large variety of nominal and real frictions influencing the short and the medium term behavior of the economy, while neoclassical features prevail in the long run, where output is determined by technology, preferences and the supply of factor inputs (capital and labor). What distinguishes IGEM from other large scale DGE models is the presence of a labor market where different contract types coexist,[2] so to better describe the Italian

[1] This tax on business is meant to map the IRAP (Imposta regionale sulle attività produttive).

[2] On the structure of the Italian labor market, see Boeri and Garibaldi (2007), Duranti (2009), Ichino et al.

economy, whose labor market is strongly heterogeneous. Notably, the dualism of the Italian labor market consists in its separation into a primary sector and a secondary sector.[3] The former is characterized by union coverage, strong job security protection, high firing costs, while the latter is dominated by little or no union coverage, weak security protection and low firing costs. In IGEM, households with no access to financial markets are mainly identified with workers belonging to this secondary labor market, while the remaining households supply labor inputs into the primary market. Self-employed workers, instead, are modeled as an additional category which is somehow transversal to both markets. The main parameters governing the supply of labor inputs have been estimated using a microsimulation model named EconLav, in which the behavioral responses of workers are explicitly modeled making use of the information gathered from different statistical sources.[4] Clearly, when exploring the dynamic properties of the model, this heterogeneity in the labor market, coupled with a high degree of real and nominal rigidities, will reveal to be essential in explaining the transmission mechanisms and the effects on employment and income of the business cycle and of different policy interventions.

In this paper we construct various reform scenarios, recently advocated in economic and policy circles as a means to promote growth, such as product market reforms, mapped onto the model by decreasing the markups and (ex ante) budget neutral tax shifts from business and labor to consumption.

The remainder of this paper is as follows. Section 2 provides a non-technical overview of IGEM and discusses the general structure, some key model properties and the updates. In Section 3 we present a detailed and technical description of the new structure of the model. Section 4 describes the parametrization and the solution strategy. Section 5 considers several applications and presents some simulation scenarios of structural reforms designed to illustrate some specific features of IGEM. Section six concludes.

2 An Overview of IGEM

The skeleton of the model consists of an open economy taking as given the world interest rate, world prices and world demand with six types of economic agents: firms, households, unions, a foreign sector and monetary and fiscal authorities adopting rule-based stabilization policies. Several adjustment costs on nominal and real variables enable IGEM to capture the typical persistence of macroeconomic variables and mimic their empirical dynamics in response to shocks. Specifically, the model features two nominal frictions, convex costs on price and wage adjustment *à la* Rotemberg (1982), and five sources of real rigidities, investment and labor

(2005), Lucidi and Kleinknecht (2010).

[3]This feature of the models has been fruitfully used in simulating the impact of the recent Jobs Act. See the National Reform Programme 2015, available for download at: http://ec.europa.eu/europe2020/europe-2020-in-your-country/italia/national-reform-programme/index_en.htm

[4]EconLav is one of the microsimulation tools available at the Department of Treasury of the Italian Ministry of the Economy and Finance. Starting from a detailed description of the fiscal rules and benefit schemes, EconLav is able to represent the behavioral responses of agents to several policy changes. For details see http://www.dt.tesoro.it/en/analisi_programmazione_economico_finanziaria/modellistica/

adjustment costs, variable capital utilization, external habit in consumption, and imperfect competition in product and labor markets. All these frictions are necessary to create plausible short-run dynamics, consistently with what it is observed in the data.

The economy presents four types of firms: (i) a continuum of monopolistically competitive firms each of which producing a single tradable differentiated intermediate goods by using labor and physical capital as factor inputs; (ii) a continuum of monopolistically competitive exporting firms transforming domestic intermediate goods into exportable goods using a linear technology; (iii) a continuum of monopolistically competitive importing firms transforming foreign intermediate goods into importable goods using a linear technology; (iv) a continuum of monopolistically competitive firms combining domestically produced intermediate goods with imported intermediate goods into a final non-tradable good. Domestic producers of intermediate tradeable goods face competition from importers and have to price their products in the domestic market, so as to achieve maximum profits. Similarly, exporters and importers seek to maximize profits by setting prices.

As already emphasized, one of the key features of IGEM consists in a detailed representation of the labor market, designed to capture the main dualism of the Italian labor market characterized by a primary sector with higher protection, better working conditions, superior opportunities for promotion, higher pays, and a secondary sector with poor protection, limited promotion opportunities, lower pays. The labor force of the model, in fact, is divided in three different categories: (i) employees (skilled and unskilled) with a stable contract of employment and strong protection; (ii) atypical workers who have flexible working patterns and weak employment protection; (iii) self-employed workers and professionals who may supply work under contracts for services. Hiring and firing those who are qualified as employees entail high adjustment costs.[5] Similarly, the degree of nominal wage stickiness is much higher for employees, as well as their market power. By contrast, atypical workers who often fail to qualify for employment protection rights, have low hiring and firing costs and weak market power.[6] Together with self-employed workers, they represent the more volatile component of the workforce, more subject to the effects of the business cycle fluctuations. In our model, this heterogeneity in the labor market allows us to include a large set of fiscal instruments into the model, opening up to the possibility of exploring the effects of several fiscal and structural reforms aimed at increasing employment, favoring social inclusion and reducing inequalities.

This new version of IGEM is extended to allow for unemployment, as proposed by Galí (2011a, b). Notably this approach represents a parsimonious way of introducing unemployment into a dynamic general equilibrium model. Yet with this simple extension the model is now able to determine the behavior of unemployment conditional on the shocks and on the policy

[5] It should be noted that IGEM does not break down the economy into a shadow and an official economy. As a matter of fact, the dualism of the labor market characterizes the official Italian economy itself. For a study on the effects of fiscal reforms on the Italian economy, accounting for the presence of an undeground sector with irregular labor, see Annicchiarico and Cesaroni (2016).

[6] In the previous version of IGEM atypical workers supplied their labor services in a perfectly competitive market.

interventions put in place.

Households consume the final non-tradeable goods supplied by perfectly competitive firms, supply labor and rent out capital to firms. As in Galí et al. (2007) and Forni et al. (2009) IGEM incorporates two types of households: the Ricardian households who have access to financial markets, accumulate physical capital and financial assets and are so able to smooth out their consumption profile in response to shocks (i.e. they manage to keep their lifetime consumption as smooth as possible) and the non Ricardian households who cannot trade in financial markets and accumulate capital, so that as in Campbell and Mankiw (1989), they simply consume their after-tax disposable income (the so called "hand to mouth" consumers). In our model this heterogeneity of households is strictly related to that considered in the labor market. In fact, it is assumed that Ricardian households supply labor services as employees and as self-employed workers, while non Ricardian consumers supply labor services as atypical workers and as unskilled employees.[7] Intuitively, workers with stable contracts have an easy access to credit, while atypical workers with flexible labor patterns are more likely to be liquidity constrained. Similarly, some low income workers are likely to be liquidity constrained.

Monopolistic trade unions set wages of skilled and unskilled subordinate workers, so as to maximize households' expected utility. Market power introduces a wedge between the real wage rate and the marginal rate of substitution between leisure and consumption. Further, self-employed and professionals are assumed to work on their own under the tutelage of the professional orders (or registers). Hence, despite this category of workers are not covered by the legal and trade-union protections afforded to employees and are paid by their clients or customers, they have some market power in setting their remuneration.

The monetary authority controls the nominal interest rate and responds to inflation and output variations. The model allows for a variety of different reaction functions to be incorporated (active v. passive interest rate rules, current, backward or forward rules).

The government issues nominal debt in the form of interest-bearing bonds. Public consumption and investments, interest payments on outstanding public debt, transfers to households and subsidies to firms are financed by taxes on capital, labor, consumption and business, by social security contributions and/or by issuance of new bonds. To ensure that the fiscal budget constraint is met, the fiscal authority is assumed to adopt a fiscal rule responding to public debt.

The foreign sector is modeled as exogenous. In details, Italy faces an exogenous world rate and takes as given world demand and world prices on tradeable goods. The development of the net foreign asset position depends on the current account surplus and so on the decisions of firms, households and government. Finally, the transmission mechanism from internal to external variables is further complicated by the assumption that Italian exporting and importing firms have some market power in the prices they set, so that the net external position will depend on conditions in both financial and goods markets.

[7]More precisely, in this model, the category of workers labeled as "atypical" also includes a small fraction of self-employed workers (the young) who may be little different, as no less dependent economically on their work for subsistence than strictly speaking atypical workers. This is also meant to capture the phenomenon of the false independent work.

3 The Model

The economy is populated by households, unions, final and intermediate goods producing firms, a foreign sector and a monetary and a fiscal authority. As already emphasize, the core of the model consists in neoclassical model, augmented to include a large assortment of real and nominal frictions in the spirit of the so called "New Neoclassical Synthesis", several market imperfections, a dual labor market and a foreign sector. In what follows we outline in detail the behavior of the different types of agents and characterize the decentralized equilibrium and the aggregate resource constraint of economy.

3.1 Population Structure and Households

There is a continuum of households in the space $[0,1]$. There are two types of households differing in 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. 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.

3.1.1 Ricardian Households

The representative Ricardian household derives utility from consumption C^R of the final good (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:

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

where E_0 is the expectations operator conditional on information available at time 0, and $\beta \in (0,1)$ represents the subjective discount factor and $\ell^R \in \{L_L, L_H, N_S\}$ the index denoting the three different categories of workers. 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 $\overline{C}_{t-1}^R$ the lagged aggregate consumption of Ricardian households (taken as given by each household). The typical household derives disutility from labor according to the period utility functions V_{ℓ^R}.

In what follows we adopt the following standard functional forms:

$$u(C_t^R - h_{C^R}\overline{C}_{t-1}^R) = \log\left(C_t^R - h_{C^R}\overline{C}_{t-1}^R\right), \tag{4}$$

$$V_{\ell^R}(\ell_t^R) = \omega_{\ell^R}\tilde{s}_{\ell^R}\frac{\left(\ell_t^R\right)^{1+v_{\ell^R}}}{1+v_{\ell^R}}, \tag{5}$$

where ω_{ℓ^R} is a scale parameter measuring the disutility of labor, v_{ℓ^R} is the inverse of the Frisch elasticity of labor supply and $\tilde{s}_{\ell^R}$ denotes the share of time devoted by the typical Ricardian household to the working activity of kind ℓ^R.[8] Being each household endowed with one unit of time we have $\sum_{\ell^R}\tilde{s}_{\ell^R} = 1$.[9]

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:

$$K_{t+1}^R = (1-\delta_K)K_t^R + I_t^R, \tag{6}$$

where $0 < \delta_K < 1$ 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

$$\Gamma_I\left(I_t^R\right) = \frac{\gamma_I}{2}\left(\frac{I_t^R}{K_t^R} - \delta_K\right)^2, \quad \gamma_I > 0. \tag{7}$$

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

$$\Gamma_{u^K}\left(u_t^K\right) = \gamma_{u_1^K}\left(u_t^K - 1\right) + \frac{\gamma_{u_2^K}}{2}\left(u_t^K - 1\right)^2, \quad \gamma_{u_1^K}, \gamma_{u_2^K} > 0. \tag{8}$$

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

[8] In the previous version of IGEM preferences where such that the Frisch elasticity of labor supply was decreasing in the level of hours worked.

[9] It should be noted that from the economy's population structure we have: $\tilde{s}_{L_L} = \frac{(1-\lambda^{L_L})s_{L_L}}{1-s_{N_R}}$, $\tilde{s}_{L_H} = \frac{s_{L_H}}{1-s_{N_R}}$ 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 $1 - s_{NR} = s_{N_S} + s_{L_H} + (1-\lambda_{L_L})\,s_{L_L}$.

quadratic adjustment costs in terms of domestic production, Y_t, on nominal wage changes specific for each category of represented workers, $\Gamma_{W^{\ell^R}}(W_t^{\ell^R}/W_{t-1}^{\ell^R})Y_t$, $\Gamma_{W^{\ell^R}}(\bullet)$ being a quadratic function of $W_t^{\ell^R}/W_{t-1}^{\ell^R}$.

Finally, households receive dividends, PRO^R, from the intermediate goods firms, transfers 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 in nominal terms reads as:

$$\begin{aligned}(1+\tau_t^C)P_{C,t}C_t^R + B_t^R + S_t B_{F,t}^R + P_{I,t}I_t^R = \left(1-\tau_t^{\ell^R}-\tau_{h,t}^{W^{\ell^R}}\right)\sum_{\ell^R}\tilde{s}_{\ell^R}W_t^{\ell^R}\ell_t^R + \qquad (9)\\ +R_{t-1}B_{t-1}^R + (R_{t-1}^* + \rho_{t-1}^F)S_t B_{F,t-1}^R + \\ +\left(PRO_t^R + Tr_t^R - TAX_t^R\right)P_t \\ +\tau_t^K\delta_K P_{I,t}u_t^K K_t^R + tcr_t^K P_{I,t}I_t^R + \\ +(1-\tau_t^K)r_t^K P_{I,t}u_t^K K_t^R - P_{I,t}\Gamma_I\left(I_t^R\right)K_t^R + \\ -P_{I,t}\Gamma_{u^K}\left(u_t^K\right)K_t^R - P_t\sum_{\ell^R}\tilde{s}_{\ell^R}\Gamma_{W^{\ell^R}}(W_t^{\ell^R}/W_{t-1}^{\ell^R})Y_t,\end{aligned}$$

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.

3.1.2 Non Ricardian Households

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

$$U(C_t^{NR} - h_{C^{NR}}\overline{C}_{t-1}^{NR}) + \sum_{\ell^{NR}}V_{\ell^{NR}}(\ell_t^{NR}), \qquad (10)$$

where all variables are as in the previous section and the superscript NR stands for "non Ricardian". 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 (4) and (5). 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:

$$(1+\tau_t^C)P_{C,t}C_t^{NR} = \left(1-\tau_t^{\ell^{NR}}-\tau_{h,t}^{W^{\ell^{NR}}}\right)\sum_{\ell^{NR}}\tilde{s}_{\ell^{NR}}W_t^{\ell^{NR}}\ell_t^{NR}+ \quad (11)$$
$$-\sum_{\ell^{NR}}\tilde{s}_{\ell^{NR}}\Gamma_{W^{\ell^{NR}}}(W_t^{\ell^{NR}}/W_{t-1}^{\ell^{NR}})Y_t+P_t\left(Tr^{NR}-TAX_t^{NR}\right),$$

where Tr^{NR} and TAX^{NR} denote government transfers and lump-sum taxes and $\Gamma_{W^{\ell^{NR}}}(W_t^{\ell^{NR}}/W_{t-1}^{\ell^{NR}})Y_t$ denotes the nominal wage adjustment costs faced by non-Ricardian individuals in changing nominal wages, with $\Gamma_{W^{\ell^{NR}}}(\bullet)$ being a quadratic function of $W_t^{\ell^{NR}}/W_{t-1}^{\ell^{NR}}$.. See Appendix A for details.

3.2 Wage Setting, Willingness to Work and Unemployment

We assume that wage decisions for each labor type are by central authorities external to the households: 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 and atypical workers. The corresponding aggregate employment levels for each of the four category of workers is determined by firms labor demand decisions. In this sense, households take employment and wage as given.[10] See Appendix A for details.

3.2.1 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:

$$\Gamma_{W^{N_S}}(W_t^{N_S}(h_{N_S})/W_{t-1}^{N_S}(h_{N_S}))=\frac{\gamma_{W^{N_S}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{N_S}(h_{N_S})}{W_{t-1}^{N_S}(h_{N_S})}-1\right)^2Y_t, \quad (12)$$

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 $\kappa_W\in[0,1]$.

[10] In the former version of IGEM atypical workers were assumed to have no market power and supplied labor services taking wage as given.

In the symmetric steady-state equilibrium the wage equation, $N_{S,t}$ reads as:

$$\frac{W^{N_S}}{P} = \frac{\sigma_{N_S}}{\sigma_{N_S}-1}\frac{1}{1-\tau^{N_S}-\tau_h^{W^{N_S}}}\frac{\omega_{N_S}\left(N_s\right)^{\upsilon_{N_S}}}{\lambda^R}, \tag{13}$$

where λ^R is the Lagrange multiplier associated to the budget constraint (9) 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}.

We are now ready to introduce a measure of involuntary employment. Following Galí (2011a, 2011b) we assume that a household is willing to work as a self-employed if the following condition holds:

$$\left(1-\tau_t^{N_S}-\tau_{t,h}^{W^{N_S}}\right)\frac{W_t^{N_S}}{P_t} \geq \omega_{N_s}\frac{\left(N_{s,t}^s\right)^{\upsilon_{N_s}}}{\lambda_t^R}, \tag{14}$$

where N_s^s denotes the supply of labor-type N_s. The above conditions implies that individuals will participate to this labor market provided that the net real remuneration exceeds the corresponding marginal disutility of labor. A measure of unemployment immediately follows:

$$N_{s,t}^u = \frac{N_{s,t}^s - N_{s,t}}{N_{s,t}^s}, \tag{15}$$

where $N_{s,t}^u$ is to be interpreted as the unemployment rate.

From the above results it clear that the level of unemployment will be lower as a result of a reform able to reduce the wage markup.

3.2.2 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 $\Gamma_{W^{L_H}}(W_t^{L_H}(h_{L_H})/W_{t-1}^{L_H}(h_{L_H})) = \frac{\gamma_{W^{L_H}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{L_H}(h_{L_H})}{W_{t-1}^{L_H}(h_{L_H})}-1\right)^2 Y_t$, where $\gamma_{W^{L_H}} > 0$.

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

$$\frac{W^{L_H}}{P} = \frac{\sigma_{L_H}}{\sigma_{L_H}-1} \frac{1}{1-\tau^{L_H}-\tau_h^{W^{L_H}}} \frac{\omega_{L_H}}{\lambda^R (1-L_H)^{v_{L_H}}}. \tag{16}$$

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 $\frac{\sigma_{L_H}}{\sigma_{L_H}-1}$.

Also in this case, we assume that a household is willing to work as a skilled-employee provided that the following condition holds:

$$\left(1-\tau_t^{L_H}-\tau_{h,t}^{W^H}\right) \frac{W_t^{L_H}}{P_t} \geq \omega_{L_H} \frac{\left(L_{H,t}^s\right)^{v_{L_H}}}{\lambda_t^R}, \tag{17}$$

where $L_{H,t}^s$ denotes the supply of labor-type $L_{H,t}$. The above conditions implies that individuals will participate to this labor market provided that the net real remuneration exceeds the corresponding marginal disutility of labor. A measure of unemployment immediately follows:

$$L_{H,t}^u = \frac{L_{H,t}^s - L_{H,t}}{L_{H,t}^s}, \tag{18}$$

where $L_{H,t}^u$ is to be interpreted as the unemployment rate of skilled employees.

3.2.3 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, $\Gamma_{W^{L_L}}(W_t^{L_L}(h_{L_L})/W_{t-1}^{L_L}(h_{L_L})) = \frac{\gamma_{W^{L_L}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}} \frac{W_t^{L_L}(h_{L_L})}{W_{t-1}^{L_L}(h_{L_L})} - 1\right)^2 Y_t$, 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:

$$\frac{W^{L_L}}{P} = \frac{\sigma_{L_L}}{\sigma_{L_L}-1}\frac{1}{1-\tau^{L_L}-\tau_h^{W^{L_L}}}\frac{\omega_{L_L} L_L^{v_{LL}}}{[(1-\lambda^{L_L})\lambda^R + \lambda^{L_L}\lambda^{NR}]}, \tag{19}$$

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.[11] 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.

As done for the skilled workers, we can define the willingness to work as an unskilled worker for both categories of households and then find a measure of unemployment:

$$L_{L,t}^u = \frac{L_{L,t}^s - L_{L,t}}{L_{L,t}^s}, \tag{20}$$

where $L_{L,t}^u$ is to be interpreted as the unemployment rate of unskilled-employees and $L_{L,t}^s$ the corresponding supply.

3.2.4 Atypical Workers

As already mentioned, in this new version of IGEM, also for atypical workers we assume the existence of a continuum of differentiated labor inputs indexed by $h_{N_A} \in [0,1]$ supplied monopolistically by unions. For simplicity we assume that households are distributed uniformly across unions, hence aggregate demand of labor type $N_{A,t}(h_{N_{A,t}}) = \left(\frac{W_t^{N_A}(h_{N_A})}{W_t^{N_A}}\right)^{-\sigma_{N_A}} N_{A,t}$, where $\sigma_{NA} > 1$ is the elasticity of substitution between labor inputs, $W_t^{N_A}(h_{N_A})$ is the market-specific nominal retribution, $W_t^{N_A}$ is the wage index and $N_{A,t} = \int_0^1 N_{A,t}(h_{N_A})dh_{N_A}$ so to satisfy the time resource constraint.

The union sets $W_t^{N_A}(h_{N_{A,t}})$ in order to maximize households' expected utility (10), given the demand for its differentiated labor services and subject to a convex adjustment costs function:

$$\Gamma_{W^{N_A}}(W_t^{N_A}(h_{N_A})/W_{t-1}^{N_A}(h_{N_A})) = \frac{\gamma_{W^{N_A}}}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{N_A}(h_{N_A})}{W_{t-1}^{N_A}(h_{N_A})}-1\right)^2 Y_t, \tag{21}$$

where $\gamma_{W^{N_A}} > 0$ 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 $\kappa_W \in [0,1]$.

Proceeding as in the previous sections and recalling that by assumption only non Ricardian households supply labor services as atypical workers, we obtain the following wage equation for

[11] 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 $s_{NR}\frac{\lambda_{L_L}}{s_{NR}}s_{L_L}$.

the symmetric steady state:

$$\frac{W^{N_A}}{P} = \frac{\sigma_{N_A}}{\sigma_{N_A} - 1} \frac{1}{1 - \tau^{N_A} - \tau_h^{W^{N_A}}} \frac{\omega_{N_A} N_A^{\upsilon_{N_A}}}{\lambda^{NR}}. \tag{22}$$

where $\sigma_{N_A} > 1$ denoting the elasticity of substitution between differentiated labor services. From the willingness to work we also obtain a measure of involuntary unemployment:

$$N_{A,t}^u = \frac{N_{A,t}^s - N_{A,t}}{N_{A,t}^s}, \tag{23}$$

where $N_{A,t}^u$ is to be interpreted as the unemployment rate and $N_{A,t}^s$ the labor supply.

3.3 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 tradeable goods into exportable goods using a linear technology; (iii) a continuum of monopolistically competitive importing firms transforming foreign tradeable goods into importable goods using a linear technology; (iv) a continuum of monopolistically 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 typical firm problem.

3.3.1 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:

$$Y_t(j) = A_t \left[\left(L_{CES,t}(j) - OH_t^L\right)^{\alpha_L} \left(N_{CES,t}(j) - OH_t^N\right)^{\alpha_N} \left(u_t^K K_t(j)\right)^{1-\alpha_L-\alpha_N} \right]^{1-\alpha_G} KG_t^{\alpha_G}, \tag{24}$$

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 KG_t is the stock of government capital whose level depends on the public infrastructure investment decisions I_t^G and evolves as $KG_t = (1 - \delta_G)KG_{t-1} + I_t^G$, with δ_G being the depreciation rate. This productive role of government capital in the spirit of Barro (1990), creates a potentially positive linkage between government and output. Note that production exhibits decreasing returns to private inputs if the (complementary) government capital inputs do not expand in a parallel manner.

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

$$L_{CES,t} = \left[sy_{L_L}^{\frac{1}{\sigma_L}} \left(ef_{L_L} LY_{L,t} \right)^{\frac{\sigma_L - 1}{\sigma_L}} + sy_{L_H}^{\frac{1}{\sigma_L}} \left(ef_{L_H} LY_{H,t} \right)^{\frac{\sigma_L - 1}{\sigma_L}} \right]^{\frac{\sigma_L}{\sigma_L - 1}}, \tag{25}$$

$$N_{CES,t} = \left[sy_{N_S}^{\frac{1}{\sigma_N}} \left(ef_{N_S} NY_{S,t} \right)^{\frac{\sigma_N - 1}{\sigma_N}} + sy_{N_A}^{\frac{1}{\sigma_N}} \left(ef_{N_A} NY_{A,t} \right)^{\frac{\sigma_N - 1}{\sigma_N}} \right]^{\frac{\sigma_N}{\sigma_N - 1}}, \tag{26}$$

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 on wage setting.

The production function (24) with (25) and (26) 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.[12] 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.[13] Secondly, as already explained, the category of workers labeled as atypical, also includes a small fraction of self-employed workers (the young), so 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.

[12] This nesting structure of the production function is then motivated by the need of modeling the duality of the Italian labor market. However, we acknowledge that a functional form foreseeing a CES structure in skilled labor inputs, self-employed workers and a sub-CES bundle in atypical and unskilled workers, may well capture the imperfect substitutability between different labor inputs with more emphasis on skills and professional aspects rather than on the characteristics of the ongoing contract. Other nesting hypotheses will be considered in the future version of IGEM, since the quantitative effects of policy interventions on hours worked and labor remuneration of the single categories of workers can considerably change.

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

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}. We also assume that a business tax is in force which is based on the value added produced.[14] The business tax rate is denoted by $\tau_{Y,t}$.

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 (24), the demand schedule for variety j, $Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\theta_Y} Y_t$,[15] quadratic adjustment costs on price setting:

$$\Gamma_P(P_t(j)) = \frac{\gamma_P}{2}\left(\frac{1}{\Pi_{t-1}^{\kappa_P}\overline{\Pi}^{1-\kappa_P}}\frac{P_t\left(j\right)}{P_{t-1}\left(j\right)} - 1\right)^2 Y_t, \tag{27}$$

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:

$$\Gamma_{L_H}(LY_H(j)) = \frac{\gamma_{L_H}}{2}\left(\frac{LY_{H,t}\left(j\right)}{LY_{H,t-1}\left(j\right)} - 1\right)^2 Y_t, \tag{28}$$

$$\Gamma_{L_L}(LY_L(j)) = \frac{\gamma_{L_L}}{2}\left(\frac{LY_{L,t}\left(j\right)}{LY_{L,t-1}\left(j\right)} - 1\right)^2 Y_t, \tag{29}$$

$$\Gamma_{N_S}(NY_S(j)) = \frac{\gamma_{N_S}}{2}\left(\frac{NY_{S,t}\left(j\right)}{NY_{S,t-1}\left(j\right)} - 1\right)^2 Y_t, \tag{30}$$

$$\Gamma_{N_A}(NY_A(j)) = \frac{\gamma_{N_A}}{2}\left(\frac{NY_{A,t}\left(j\right)}{NY_{A,t-1}\left(j\right)} - 1\right)^2 Y_t, \tag{31}$$

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:

$$P = \frac{1}{1-\tau_Y}\frac{\theta_Y}{\theta_Y - 1}MC^N, \tag{32}$$

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

[14] This production tax is inteded to map the regional production tax (IRAP). The tax base is calculated from the difference between the value and costs of production excluding labor costs for permanet workers.

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

the degree of market power of intermediate-good producers) which, in turn, is decreasing in the elasticity of substitution θ_Y and increasing in the production tax rate τ_Y, that is $MC = \frac{\theta_Y - 1}{\theta_Y} (1 - \tau_Y)$. Clearly, in the absence of the business tax, the steady-state price markup will only depend on the elasticity of substitution between intermediate goods.[16] In this case, instead, the price markup is shown to be increasing in the business tax rate. In this sense, market power gives producers the possibility of shifting the burden of the business tax toward consumers. In what follows we will show that this feature of the model is not innocuous for our results.

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

$$(1 - \tau_{Y,t}) \frac{P_t^I}{P_t} u_t^K r_t^k = (1 - \alpha_G) (1 - \alpha_L - \alpha_N) MC_t \frac{Y_t}{K_t}. \tag{33}$$

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:

$$\frac{W^{L_L}}{P} \left(1 - sub^{L_L} + \tau_f^{W^{L_L}}\right) [I_{\tau_Y} (1 - \tau_{Y,t}) + (1 - I_{\tau_Y})] = \tag{34}$$
$$= \alpha_L (1 - \alpha_G) MC \frac{Y}{L_{CES} - OH^L} \left(\frac{L_{CES}}{LY_L}\right)^{\frac{1}{\sigma_L}} s_{L_L}^{\frac{1}{\sigma_L}} ef_{L_L}^{\frac{\sigma_L - 1}{\sigma_L}},$$

$$\frac{W^{L_H}}{P} \left(1 - sub^{L_H} + \tau_f^{W^{L_H}}\right) [I_{\tau_Y} (1 - \tau_{Y,t}) + (1 - I_{\tau_Y})] = \tag{35}$$
$$= \alpha_L (1 - \alpha_G) MC_t \frac{Y_t}{L_{CES,t} - OH_t^L} \left(\frac{L_{CES,t}}{LY_H}\right)^{\frac{1}{\sigma_L}} s_{L_H}^{\frac{1}{\sigma_L}} ef_{L_H}^{\frac{\sigma_L - 1}{\sigma_L}},$$

$$\frac{W^{N_A}}{P} \left(1 - sub^{N_A} + \tau_f^{W^{N_A}}\right) (1 - \tau_Y) = \tag{36}$$
$$= \alpha_N (1 - \alpha_G) MC \frac{Y_t}{N_{CES} - OH^N} \left(\frac{N_{CES}}{NY_A}\right)^{\frac{1}{\sigma_N}} s_{N_S}^{\frac{1}{\sigma_N}} ef_{N_S}^{\frac{\sigma_N - 1}{\sigma_N}},$$

$$\frac{W^{N_S}}{P} \left(1 + \tau_f^{W^{N_S}}\right) (1 - \tau_Y) = \tag{37}$$
$$= \alpha_N (1 - \alpha_G) MC \frac{Y}{N_{CES} - OH^N} \left(\frac{N_{CES}}{NY_S}\right)^{\frac{1}{\sigma_N}} s_{N_S}^{\frac{1}{\sigma_N}} ef_{N_S}^{\frac{\sigma_N - 1}{\sigma_N}},$$

where I_{τ_Y} is an index variable. If $I_{\tau_Y} = 1$ ($I_{\tau_Y} = 0$), then the labor costs on permanent workers

[16] Pro-competitive reforms in the production market are simulated by increasing the elasticity of substitution between pairs of intermediate goods varieties θ_Y.

can (cannot) be deduced from the tax base on business. Clearly, payroll taxes and subsidies introduce a further wedge between the wage rate and the marginal revenue of labor inputs.

3.3.2 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:

$$\Gamma_{P_X}(P_{X,t}(j)) = \frac{\gamma_{EXP}}{2}\left[\frac{1}{\left(\Pi^*_{t-1}\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}\frac{P_{X,t}(j)}{P_{X,t-1}(j)} - 1\right]^2 EXP_t, \tag{38}$$

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 (38), 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 $P_{X,t} = \left[\int_0^1 P_{X,t}(j)^{1-\theta_{EXP}} dj\right]^{\frac{1}{1-\theta_{EXP}}}$. In steady state the markup charged by exporting firms will be constant:

$$SP_X = \frac{\theta_{EXP}}{\theta_{EXP}-1}P. \tag{39}$$

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:

$$\Gamma_{P_M}(P_{M,t}(j)) = \frac{\gamma_{IMP}}{2}\left[\frac{1}{\Pi^{\kappa_{IMP}}_{t-1}\overline{\Pi}^{1-\kappa_{IMP}}}\frac{P_{M,t}(j)}{P_{M,t-1}(j)} - 1\right]^2 IMP_t, \tag{40}$$

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:

$$P_M = \frac{\theta_{IMP}}{\theta_{IMP-1}}SP^*. \tag{41}$$

3.3.3 Final-Good Firms

In this new version of IGEM we assume that also firms producing final non-tradable goods operate in monopolistically competitive markets. Final goods can be used for private and public consumption and for private and public investment. Final good producers are also subject to a production tax at a rate τ_E. This sector can be identified with the retail sector.

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

$$E_t(i) = \left[(1 - \alpha_{IMP})^{\frac{1}{\sigma_{IMP}}} (Y_{H,t}(i))^{\frac{\sigma_{IMP}-1}{\sigma_{IMP}}} + \alpha_{IMP}{}^{\frac{1}{\sigma_{IMP}}} (IMP_t(i))^{\frac{\sigma_{IMP}-1}{\sigma_{IMP}}} \right]^{\frac{\sigma_{IMP}}{\sigma_{IMP}-1}}, \tag{42}$$

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

$$Y_{H,t}(i) = \left[\int_0^1 Y_{H,t}(i,j)^{\frac{\theta_Y - 1}{\theta_Y}} dj \right]^{\frac{\theta_Y}{\theta_Y - 1}}, \tag{43}$$

$$IMP_t(j) = \left[\int_0^1 IMP_t(i,j)^{\frac{\theta_{IMP}-1}{\theta_{IMP}}} dj \right]^{\frac{\theta_{IMP}}{\theta_{IMP}-1}}, \tag{44}$$

where θ_Y, $\theta_{IMP} > 1$ denote the elasticities of substitution between the differentiated intermediate goods produced at home and abroad. The typical firm i faces a demand function for its own specific good of the type $E_t(i) = \left(\frac{P_{E,t}(i)}{P_{E,t}}\right)^{-\theta_E} E_t$, where $\theta_E > 1$ is the elasticity of substitution between differentiated goods, $P_{E,t}(i)$ is the price of good i, $P_{E,t}$ denotes the aggregate price index and E_t is the aggregate demand for final goods.

At the optimum, after having imposed symmetry across firms, as to simplify notation, we have the demand of intermediate domestic and imported goods:

$$Y_{H,t} = (1 - \alpha_{IMP}) \left(\frac{MC_{E,t}}{1 - \tau_{E,t}} \right)^{\sigma_{IMP}} E_t, \tag{45}$$

$$IMP_t = \alpha_{IMP} \left(\frac{MC_{E,t}}{1 - \tau_{E,t}} \right)^{\sigma_{IMP}} \left(\frac{P_{M,t}}{P_t} \right)^{-\sigma_{IMP}} E_t, \tag{46}$$

where $MC_{E,t}$ denotes marginal cost.

We assume the existence of a quadratic cost function on price adjustment:

$$\Gamma_{P_E}(P_{E,t}(i)) = \frac{\gamma_E}{2} \left[\frac{1}{\Pi_{t-1}^{\kappa_E} \overline{\Pi}^{1-\kappa_E}} \frac{P_{E,t}(i)}{P_{E,t-1}(i)} - 1 \right]^2 Y_t, \tag{47}$$

where $\gamma_E > 0$ and $\kappa_E \in [0, 1]$. The typical final good-producing firm will thus set the price

$P_{E,t}(i)$, so as to maximize the expected discounted value of future profits, taking as given the adjustment cost (47) and the demand function $E_t(i) = \left(\frac{P_{E,t}(i)}{P_{E,t}}\right)^{-\theta_E} E_t$.

In steady state the optimal pricing condition of the typical final produced firm is found to be:

$$P_E = \frac{\theta_E}{\theta_E - 1} MC_E^N. \quad (48)$$

3.4 Fiscal and Monetary Authorities

The government purchases final goods for consumption C_t^G and investment I_t^G, 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, capital and business, namely $LTAX_t$, $TVAT_t$, $KTAX_t$, $BTAX_t$, and issues nominal bonds B_t.

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

$$\begin{aligned} B_t &= R_{t-1}B_{t-1} + P_{C,t}C_t^G + P_{I,t}I_t^G + P_t Tr_t + \\ &\quad -P_t TAX_t - P_t\left(LTAX_t + TVAT_t + KTAX_t + IRAP_t\right) + P_t SUB_t, \end{aligned} \quad (49)$$

where

$$TAX_t = s_{NR}TAX_t^{NR} + (1 - s_{NR})TAX_t^R \quad (50)$$

$$Tr_t = s_{NR}Tr_t^{NR} + (1 - s_{NR})Tr_t^R, \quad (51)$$

$$\begin{aligned} LTAX_t &= s_{L_L}L_{L_L}WR^{L_L}\left(\tau_t^{L_L} + \tau_{h,t}^{W_{L_L}} + \tau_{f,t}^{W_{L_L}}\right) + \\ &\quad + s_{L_H}L_{L_H}WR^{L_H}\left(\tau_t^{L_H} + \tau_{h,t}^{W_{L_H}} + \tau_{f,t}^{W_{L_H}}\right) + \\ &\quad + s_{N_S}L_{N_S}WR^{N_S}\left(\tau_t^{N_S} + \tau_{h,t}^{W_{N_S}} + \tau_{f,t}^{W_{N_S}}\right) + \\ &\quad + s_{N_A}L_{N_A}WR^{N_A}\left(\tau_t^{N_A} + \tau_{h,t}^{W_{N_A}} + \tau_{f,t}^{W_{N_A}}\right), \end{aligned} \quad (52)$$

$$TVAT_t = \tau_t^C\left[s_{NR}C_t^{NR} + (1 - s_{NR})C_t^R\right], \quad (53)$$

$$KTAX_t = \tau_t^K\left(r_t^K - \delta^K\right)u_t^K K_t - tcrk_t\frac{P_{I,t}}{P_t}I_t, \quad (54)$$

$$\begin{aligned} BTAX_t &= \tau_{Y,t}Y_t + \\ &-\tau_{Y,t}\left[\left(1 + \tau_{f,t}^{N_S}\right)s_{N_S}L_{t,N_S}WR_t^{N_S} + \left(1 - sub_t^{N_A} + \tau_{f,t}^{W_A^N}\right)s_{N_A}L_{t,N_A}WR_t^{N_A}\right] + \\ &-\tau_{Y,t}\frac{P_{I,t}}{P_t}u_t^k r_t^k K_t + \\ &-I_{\tau_Y}\tau_{Y,t}\left[s_{L_L}L_{t,L_L}WR_t^{L_L}\left(1 - sub_t^{L_L} + \tau_t^{W^{L_L}}\right) + s_{L_H}L_{t,L_H}WR_t^{L_H}\left(1 - sub_t^{L_H} + \tau_t^{W^{L_H}}\right)\right], \end{aligned} \quad (55)$$

$$SUB_t = sub_t^{L_L}s_{L_L}L_LWR^{L_L} + sub_t^{L_H}s_{L_H}L_HWR^{L_H} + sub_t^{N_A}s_{N_A}N_AWR^{N_A}, \quad (56)$$

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):

$$P_t TAX_t = P_t \overline{TAX} + T_B \left(B_{t-1} - \overline{B}\right) + T_D D_t + T_Y P_t \left(Y_t - Y_{t-1}\right). \tag{57}$$

where T_B, T_D and T_Y are policy parameters, $\overline{TAX}$ and $\overline{B}$ are the long-run level of lump-sump taxation and of public debt, and D_t denotes the budget deficit:

$$\begin{aligned} D_t \;\; = \;\; & (R_{t-1} - 1)B_{t-1} + P_{C,t}C_t^G + P_{IG,t}I_t^G + P_t Tr_t + \\ & -P_t TAX_t - P_t \left(LTAX_t + CVAT_t + KTAX_t + BTAX_t\right) + P_t SUB_t. \end{aligned} \tag{58}$$

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

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}}\right)^{\iota_R} \left[\left(\frac{\Pi_t}{\Pi^T}\right)^{\iota_\Pi} \left(\frac{Y_t}{Y_{t-1}}\right)^{\iota_Y} \left(\frac{S_t}{S_{t-1}}\right)^{\iota_S}\right]^{1-\iota_R} \tag{59}$$

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

It should be noted that in order to isolate the effects of the tax experiments and policy reform scenarios, in what follows we switch off any possible feedback channels coming from the tax rule and the Taylor rule. For each scenario, in fact, we consider a deterministic simulation of 1,000 quarters, where the fiscal rule (57) and the Taylor rule (59) are neutralized for the first 400 quarters.

3.5 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:

$$C_t = (1 - s_{NR})C_t^R + s_{NR}C_t^{NR}. \tag{60}$$

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:

$$LY_{L,t} = s_{L_L} L_{L,t}, \tag{61}$$

$$LY_{H,t} = s_{L_H} L_{H,t}, \tag{62}$$

$$NY_{S,t} = s_{N_S} N_{S,t}, \tag{63}$$

$$NY_{A,t} = s_{N_A} N_{A,t}. \tag{64}$$

Aggregate capital accumulates as follows:

$$K_{t+1} = I_t + (1-\delta)K_t. \tag{65}$$

Since the final good can be used for private and public consumption and for private and public investments, we have:

$$P_{C,t} = P_{I,t} = P_{E,t} = \left[(1-\alpha_{IMP})P_t^{1-\sigma_{IMP}} + \alpha_{IMP}P_{M,t}^{1-\sigma_{IMP}}\right]^{\frac{1}{1-\sigma_{IMP}}}. \tag{66}$$

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

$$S_tB_{F,t} = \left(R_{t-1}^{*} + \rho_{t-1}^{F}\right)S_tB_{F,t-1} + S_tP_{X,t}EXP_t - P_{M,t}IMP_t, \tag{67}$$

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, $BR_t^F = S_tB_{F,t}/P_t$ 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:

$$\begin{aligned} Y_t \;=\; & \frac{P_t^C}{P_t}\left(C_t + C_t^G + I_t + I_t^G\right) + \frac{S_tP_{X,t}}{P_t}EXP_t - \frac{P_{M,t}}{P_t}IMP_t + \\ & + \Gamma_P(P_t) + \frac{P_{M,t}}{P_t}\Gamma_{P_M}(P_{M,t}) + \frac{S_tP_{X,t}}{P_t}\Gamma_{P_X}(P_{X,t}) + \frac{P_t^C}{P_t}\Gamma_{P_E}(P_{E,t}) \\ & + \Gamma_{L_H}(LY_H) + \Gamma_{L_L}(LY_L) + \Gamma_{N_A}(NY_A) + \Gamma_{N_S}(NY_S) + \\ & + \Gamma_{W^{L_H}}(W_t^{L_H}) + \Gamma_{W^{L_L}}(W_t^{L_L}) + \Gamma_{W^{N_S}}(W_t^{N_S}) + \Gamma_{W^{N_A}}(W_t^{N_A}) \\ & + \frac{P_t^I}{P_t}\Gamma_{u^K}\left(u_t^K\right) + \frac{P_t^I}{P_t}\Gamma_I\left(I_t^R\right). \end{aligned} \tag{68}$$

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

4 Parametrization and Model Solution

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 1a and 1b. We set the benchmark parameters in line with the existing literature. The discount factor β is equal to 0.99, so 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 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 $\alpha_L = \alpha_N = 0.35$. In this version we have opted to not consider the contribution of public capital on production and set $\alpha_G = 0$. 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). The elasticity of substitution in the final good sector, θ_E, is set at 2.65 consistently with a 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. 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 of 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 $s_{N_R} = 0.26$.It is worth noting that

the employment composition among regular, temporary and self-employees as a percentage of total employment in Italy has not changed over the last 13 years (see OECD 2016).

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. The tax rate in business, τ^{Y}, is set at 0.04 to reflect the average regional business tax that is levied on firms' revenues. 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.

IGEM is implemented in a TROLL platform which uses a Newton-type algorithm to solve non-linear deterministic models. The decision rules of the model are expressed in levels, because we are often interested in simulating the long-run effects of certain policy measures and see what happens in a new steady state. Notably, in the context of forward-looking models analyzing the effects of a permanent shock involving a new steady state requires solving a two-point boundary-problem, specifying the initial conditions for the predetermined variables as well as the terminal conditions for the forward looking variables.[17] While the determination of the initial conditions is straightforward, since these are invariants to shocks, the determination of the terminal conditions may be more difficult especially in large models. The more rigorous approach to solve this problem would make it necessary to derive the new steady state of the model and use the theoretical equilibrium values as terminal conditions, however, in some circumstances, this solution strategy can be taxing. Alternatively, one may opt to reformulate the problem so that the terminal conditions are invariant to policy changes, as proposed by Roeger and in't Veld (1999). In this paper we have opted for the latter strategy.[18]

[17] Deterministic simulations are generally carried out when studying the effects of structural and/or fiscal reforms involving permanent changes in some structural parameters and/or tax rates. For several examples of reform packages simulated adopting this solution method, see Roeger et al. (2008).

[18] This is usually the preferred strategy when dealing with large scale models. See Roeger et al. (2008) and (2009) for the QUEST III model.

5 Simulation Exercises

In this Section we undertake several 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 so as to simulate the implementation of structural and tax reforms. It is worth stressing that we will not deal with specific reform provisions that have been implemented or that Italian government is going to implement. In this respect, 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.

Our analysis considers four policy interventions: (i) 1% markup reduction in the final goods sector; (ii) 1% markup reduction in the intermediate goods sector; (iii) a balanced budget tax shift from the business to consumption (1% of output); (iv) a balanced budget shift from social security contributions bearing on firms to tax on consumption (1% of output).

As common practice in this kind of economic policy exercises, in order to consider the effects of the policy experiments in isolation, we switch off any possible feedback channels coming from the tax rule and the Taylor rule. For this reason, in each scenario, we consider a deterministic simulation of 1,000 quarters, where the fiscal rule and the interest rate rule are neutralized for the first 400 quarters.[19]

5.1 Results

Tables 2-5 report the effects of the policy interventions form the main macroeconomic variables. In particular, all effects are expressed in percentage deviations from the baseline, with the exception of the unemployment rates which, instead, are expressed in percentage point deviations from their baseline level.

We first quantify the potential macroeconomic impact of pro-competitive provisions involving the final good market and the intermediate good market, in turn. This policy area includes reform packages promoting market competition and favoring business and is mapped onto the model through a reduction of the price markup. In this way we are going to diminish the rents in favor of producers. In both simulations we only change the relevant markup, while all other parameters remain at their baseline values. Table 2 shows the impact of a markup reduction in the final good sector, which can be identified with the retail sector. As expected the effect on output is positive already after one year, while the terms of trade worsens. Consumption immediately increases, as a results of the major purchasing power of households. Labor of all categories of workers increases thanks to the improved economic conditions.

[19]It should be noted that in the context of deterministic simulations, policy rules can be safely neutralized without affecting the uniqueness and the stability properties of the rational expectations equilibrium. The Blanchard-Khan conditions, in fact, relevant for real determinacy, are computed on the basis of the initial steady state (i.e. the baseline) in which policy rules are operative and have the characteristics necessary to ensure stability and uniqueness of the equilibrium.

Table 3 shows the effects of a markup reduction of the same size now involving the intermediate good sector, which is identified with the manufacturing sector. Clearly, a lower markup implies an increase in output, consumption and investment. The unemployment rate decreases for all the categories of workers as a result of the higher level of economic activity induced by the lower level of inefficiency. The higher capital stock increases the marginal product of labor, yielding to a higher remuneration for all workers. The terms of trade deteriorates in response to the reform. This effect is simply the result of a decline in the export prices as a consequence of higher competition in the domestic economy. The negative effect on the terms of trade effect, in turn, mitigates the positive effect on consumption and investment stemming from the reforms. However, we notice that the overall impact is much larger in this second experiment. In the first case, in fact, major competition in the final good sector implies that part of this expansion is directed towards major imports.

Also, it is worth noticing that on impact labor and wages tend to increase for all the components of the labor force while the unemployment rate leaps up for atypical workers and consistently reduces for the others. This behaviour might be explained by the fact that in IGEM atypical workers are the most volatile component of labor and they thus tend to rapidly adjust their behaviour according to the policy reform implemented. In the case of price markup reforms the ameliorating economic conditions will greatly push up the participation (willingness) of atypical workers to the labour market and, as a consequence, the corresponding unemployment rate (as defined in equation 23) will move up. In the long run, instead, the higher Frisch elasticity set for atypical workers explains why labor tends to go higher than that for the other workers. In the long run, however, the unemployment rate of all categories of workers decreases thanks to the improved economic conditions.

We now consider two tax policy experiments. In particular we study the potential effects of two ex ante budget neutral tax shifts from business and labor to consumption.

Table 4 presents the case of a tax shift from business to consumption. Initially the effects are negative, since consumption declines as a result of the higher tax rate on consumption. The contraction of demand and the stickiness of prices explains the slight drop of output during the first year. After the second year, instead, the level of economic activity increases along with consumption, investment, employment and real wages. Intuitively, shifting the burden of taxation from business toward indirect taxes reduces distortions on output decisions. As we have seen, in fact, the tax on business increases the markup charged by producers.

Table 5 shows a fiscal experiment envisaging a shift from social security contributions to consumption. This is a so-called fiscal devaluation exercise. In particular, we cut the social security contribution payroll taxes borne by employers and increase consumption taxes so as to neutralize the budgetary effects. By cutting the employer-portion of social security contributions we are able to directly reduce labor cost, increasing labor demand and output. As expected, we observe a positive effect on investment, real wages and employment since thanks to the tax shift unit labor costs are now lower. The short run negative effects on aggregate consumption is to be ascribed to the fact that, while consumption of Ricardian households increases because of higher profits, the higher consumption tax rate will hurt non-Ricardian households, who will experience a drop in consumption because of their diminished net income. Put it differently, this tax policy involuntarily shifts the burden of taxation disproportionately to the side of non-Ricardian households who, in general, are more vulnerable and exposed to economic changes than Ricardian households. This redistributive effect is particularly strong in the short run, where adjustment costs prevent the immediate materialization of the positive effects of the tax reform. As in the previous case, the initial fall of consumption drives aggregate demand downward and so output. At later stages, however, aggregate consumption increases, thanks to the improved economic conditions and despite the worsening in the terms of trade due to the real exchange rate depreciation.

6 Conclusion

This paper presents an extension of IGEM, the Italian General Equilibrium Model used as simulation tool for economic policy analysis at the Department of the Italian Treasury. This version of IGEM presents four specific key features: (i) imperfectly competitive final good sector; (ii) involuntary unemployment; (iii) a business tax bearing on firms; (iv) market frictions in the labor market of atypical workers.

To illustrate the behavior of the model, we have undertaken four experiments with the aim of illustrating the implications of these new features. In particular, we have shown the effects of different pro-competitive reform scenarios and of budget neutral tax shifts.

It should be emphasized that the analysis carried out in this paper basically concerns the implications of unilateral reforms. Nonetheless, owing to the beggar-thy-neighbor nature of such policies, it would be worthwhile conducting similar experiments in the context of a multi-country model, accounting for the possible spillover effects across countries. A multi-country framework will also allows to design more complex scenarios and to describe monetary policy conduct and exchange rate behavior in a more realistic way. We leave this point for future extensions.

Finally, a word of caution is needed since the quantification of the economic impact of economic reforms represents an extremely difficult exercise. All results must be interpreted in the light of the model used that, although built up with the purpose of assessing the effects of structural reforms, only provides a stylized representation of the economy under study.

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Appendix A

Solution to the Households' Problem

Defining as λ_t^R the Lagrange multiplier associated to the budget constraint (9) expressed in real terms, and ξ_t to the capital accumulation equation (6), 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:

$$\frac{1}{C_t^R - h_{C^R}\overline{C}_{t-1}^R} = (1+\tau_t^C)\frac{P_{C,t}}{P_t}\lambda_t^R, \tag{A-1}$$

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

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

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

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

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

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 (10) given (11). 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:

$$\frac{1}{C_t^{NR} - h_{C^{NR}}\overline{C}_{t-1}^{NR}} = (1+\tau_t^C)\frac{P_{C,t}}{P_t}\lambda_t^{NR}, \tag{A-7}$$

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 (12). At the optimum and imposing symmetry across differentiated labor services supplied as self-employed we have that the following condition must hold:

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

In steady state, given symmetry, (A-8) boils down to (13).

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

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

which in steady state gives (**??**).

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

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

In steady state the above condition becomes (16).

The first-order condition for wage setting for the atypical workers, after having imposed symmetry is

$$
\begin{aligned}
0 = {} & \omega_{N_A}\sigma_{N_A}N_{A,t}^{1+\upsilon_{N_A}}+ \\
& -(\sigma_{N_A}-1)\,\lambda_t^{NR}\left(1-\tau_t^{N_A}-\tau_{h,t}^{W^{N_A}}\right)N_{A,t}\frac{W_t^{N_A}}{P_t} \\
& -\lambda_t^{NR}\gamma_{W^{N_A}}\left(\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{N_A}}{W_{t-1}^{N_S}}-1\right)\frac{1}{\Pi_{t-1}^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_t^{N_A}}{W_{t-1}^{N_S}}Y_t+ \\
& +\beta E_t\lambda_{t+1}^{NR}\gamma_{W^{N_A}}\left(\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{N_A}}{W_t^{N_S}}-1\right)\frac{1}{\Pi_t^{\kappa_W}\overline{\Pi}^{1-\kappa_W}}\frac{W_{t+1}^{N_A}}{W_t^{N_S}}Y_{t+1}.
\end{aligned}
\tag{A-11}
$$

In steady state the above condition becomes (22).

Solution to the Intermediate Good Producers Problem

Given technology, the adjustment costs on price setting (27) and on labor inputs (28)-(31) 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:

$$
\begin{aligned}
& \left[(1-\tau_{Y,t})(1-\theta_Y)+MC_t\theta_Y\right]Y_t+ \\
& -\gamma_P\left(\frac{\Pi_t}{\Pi_{t-1}^{\kappa_P}\overline{\Pi}^{1-\kappa_P}}-1\right)\frac{\Pi_t}{\Pi_{t-1}^{\kappa_P}\overline{\Pi}^{1-\kappa_P}}Y_t+ \\
& +\beta\gamma_P E_t\frac{\lambda_{t+1}^R}{\lambda_t^R}\left(\frac{\Pi_{t+1}}{\Pi_t^{\kappa_P}\overline{\Pi}^{1-\kappa_P}}-1\right)\frac{\Pi_{t+1}}{\Pi_t^{\kappa_P}\overline{\Pi}^{1-\kappa_P}}Y_{t+1}=0,
\end{aligned}
\tag{A-12}
$$

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

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

$$\frac{W_t^{L_H}}{P_t}\left(1-sub_t^{L_H}+\tau_{f,t}^{W^{L_H}}\right)\left[I_{\tau_Y}\left(1-\tau_{Y,t}\right)+\left(1-I_{\tau_Y}\right)\right]= \tag{A-14}$$
$$\alpha_L\left(1-\alpha_G\right)MC_t\left(j\right)\frac{Y_t\left(j\right)}{L_{CES,t}(j)-OH_t^L}\left(\frac{L_{CES,t}(j)}{LY_{H,t}(j)}\right)^{\frac{1}{\sigma_L}}s_{L_H}^{\frac{1}{\sigma_L}}ef_{L_H}^{\frac{\sigma_L-1}{\sigma_L}}+$$
$$-\gamma_{L_H}\left(\frac{LY_{H,t}\left(j\right)}{LY_{H,t-1}\left(j\right)}-1\right)Y_t\frac{1}{LY_{H,t-1}\left(j\right)}+\beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{L_H}\left(\frac{LY_{H,t+1}\left(j\right)}{LY_{H,t}\left(j\right)}-1\right)Y_{t+1}\frac{LY_{H,t+1}\left(j\right)}{LY_{H,t}\left(j\right)^2},$$

$$\frac{W_t^{N_A}}{P_t}\left(1-sub_t^{N_A}+\tau_{f,t}^{W^{N_A}}\right)\left(1-\tau_{Y,t}\right)= \tag{A-15}$$
$$\alpha_N\left(1-\alpha_G\right)MC_t\left(j\right)\frac{Y_t\left(j\right)}{N_{CES,t}(j)-OH_t^N}\left(\frac{N_{CES,t}(j)}{NY_{A,t}(j)}\right)^{\frac{1}{\sigma_N}}s_{N_S}^{\frac{1}{\sigma_N}}ef_{N_S}^{\frac{\sigma_N-1}{\sigma_N}}+$$
$$-\gamma_{N_A}\left(\frac{NY_{A,t}\left(j\right)}{NY_{A,t-1}\left(j\right)}-1\right)Y_t\frac{1}{NY_{A,t-1}\left(j\right)}+\beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{N_A}\left(\frac{NY_{A,t+1}\left(j\right)}{NY_{A,t}\left(j\right)}-1\right)Y_{t+1}\frac{NY_{A,t+1}\left(j\right)}{NY_{A,t}\left(j\right)^2}.$$

$$\frac{W_t^{N_S}}{P_t}\left(1+\tau_{f,t}^{W^{N_S}}\right)\left(1-\tau_{Y,t}\right)=\alpha_N\left(1-\alpha_G\right)MC_t\left(j\right)\frac{Y_t\left(j\right)}{N_{CES,t}(j)-OH_t^N}\left(\frac{N_{CES,t}(j)}{NY_{S,t}(j)}\right)^{\frac{1}{\sigma_N}}s_{N_S}^{\frac{1}{\sigma_N}}ef_{N_S}^{\frac{\sigma_N-1}{\sigma_N}}+ \tag{A-16}$$
$$-\gamma_{N_S}\left(\frac{NY_{S,t}\left(j\right)}{NY_{S,t-1}\left(j\right)}-1\right)Y_t\frac{1}{NY_{S,t-1}\left(j\right)}+\beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{N_S}\left(\frac{NY_{S,t+1}\left(j\right)}{NY_{S,t}\left(j\right)}-1\right)Y_{t+1}\frac{NY_{S,t+1}\left(j\right)}{NY_{S,t}\left(j\right)^2}.$$

In steady state the above conditions correspond to (32) and (34)-(37), 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 (38), 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:

$$\left[\left(1-\theta_{EXP}\right)\frac{S_tP_{X,t}}{P_t}+\theta_{EXP}\right]EXP_t+ \tag{A-17}$$
$$-\gamma_{EXP}\left[\frac{\Pi_{EXP,t}}{\left(\Pi_{t-1}^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}-1\right]\frac{\Pi_{EXP,t}}{\left(\Pi_{t-1}^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}EXP_t+$$
$$+\gamma_{EXP}\beta E_t\frac{\lambda_{t+1}^R}{\lambda_t^R}\left[\frac{\Pi_{EXP,t+1}}{\left(\Pi_t^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}-1\right]\frac{\Pi_{EXP,t+1}}{\left(\Pi_t^*\right)^{\kappa_{EXP}}\left(\overline{\Pi}^*\right)^{1-\kappa_{EXP}}}EXP_{t+1}=0,$$

where $\Pi_{EXP,t}=P_{X,t}/P_{X,t-1}$. In steady state the above condition becomes (39).

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 (40). At the optimum, we have:

$$\begin{aligned}
&\left[(1-\theta_{IMP})\frac{P_{M,t}}{P_t} + \frac{S_t P_t^*}{P_t}\theta_{IMP}\right] IMP_t + \\
&-\gamma_{IMP}\left(\frac{\Pi_{IMP,t}}{\Pi_{t-1}^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}} - 1\right)\frac{\Pi_{IMP,t}}{\Pi_{t-1}^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}} IMP_t + \\
&+\gamma_{IMP}\beta E_t \frac{\lambda_{t+1}^R}{\lambda_t^R}\left(\frac{\Pi_{IMP,t+1}}{\Pi_t^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}} - 1\right)\frac{\Pi_{IMP,t+1}}{\Pi_t^{\kappa_{IMP}}\overline{\Pi}^{1-\kappa_{IMP}}} IMP_{t+1} = 0,
\end{aligned} \tag{A-18}$$

where $\Pi_{IMP,t} = P_{M,t}/P_{M,t-1}$. In steady state the above condition simplifies to (41).

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 (47), 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:

$$\begin{aligned}
&\left[(1-\theta_E)\frac{P_{E,t}}{P_t} + \theta_E MC_{E,t}\right] E_t + \\
&-\gamma_E\left(\frac{\Pi_t^E}{\Pi_{t-1}^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} - 1\right) Y_t \frac{\Pi_t^E}{\Pi_{t-1}^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} + \\
&+\gamma_E\beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\left(\frac{\Pi_{t+1}^E}{\Pi_t^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} - 1\right)\frac{\Pi_{t+1}^E}{\Pi_t^{\kappa_E}\overline{\Pi}^{1-\kappa_E}} Y_{t+1} = 0
\end{aligned} \tag{A-19}$$

where $\Pi_{E,t} = P_{E,t}/P_{E,t-1}$. In steady state the above condition becomes (48).

Appendix B

Eq.1: The Euler equation of the Ricardian households

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

Eq.2: The Lagrangian multiplier of the Ricardian households

$$\lambda_t^R = \frac{P_t}{P_{C,t}} \frac{1}{(1+\tau_t^C)\left(C_t^R - h_{C^R} C_{t-1}^R\right)}$$

Eq.3: Consumption of the Non-Ricardian households

$$
\begin{aligned}
C_t^{NR} = &\frac{P_t}{\left(1+\tau_t^C\right)P_{C,t}}\left[\left(1-\tau_t^{N_A}-\tau_{h,t}^{W^{N_A}}\right)\frac{s_{N_A}}{s_{NR}}WR_t^{N_A}N_{A,t}-TAX_t^{NR}+Tr_t^{NR}\right]+\\
&+\frac{P_t}{\left(1+\tau_t^C\right)P_{C,t}}\left(1-\tau_t^{L_L}-\tau_{h,t}^{W^{L_L}}\right)\frac{I_{NR}\lambda^{L_L}s_{L_L}}{s_{NR}}WR_t^{L_L}L_{L,t}+\\
&-\frac{P_t}{\left(1+\tau_t^C\right)P_{C,t}}\frac{I_{NR}\lambda^{L_L}s_{L_L}}{s_{NR}}\frac{\gamma_{W^{L_L}}}{2}\left(\frac{WR_t^{L_L}}{indexation_t^W\times WR_{t-1}^{L_L}}\Pi_t-1\right)^2Y_t+\\
&-\frac{P_t}{\left(1+\tau_t^C\right)P_{C,t}}\frac{s_{NA}}{s_{NR}}\frac{\gamma_{W^{N_A}}}{2}\left(\frac{WR_t^{N_A}}{indexation_t^W\times WR_{t-1}^{N_A}}\Pi_t-1\right)^2Y_t
\end{aligned}
$$

Eq. 4: The Lagrangian multiplier of Non-Ricardian households

$$\lambda_t^{NR}=\frac{P_t}{P_{C,t}}\frac{1}{\left(1+\tau_t^C\right)\left(C_t^{NR}-h_{C^{NR}}C_{t-1}^{NR}\right)}$$

Eq. 5: Aggregate consumption

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

Eq. 6: Wage equation of self-employed labor services

$$
\begin{aligned}
&\left(\sigma_{N_S}-1\right)\lambda_t^R\left(1-\tau_t^{N_S}-\tau_{h,t}^{W^{N_S}}\right)WR_t^{N_S}N_{S,t}=\omega_{N_S}\sigma_{N_S}N_{S,t}^{1+v_{N_S}}+\\
&-\lambda_t^R\gamma_{W^{N_S}}\left(\frac{WR_t^{N_S}}{indexation_t^W\times WR_{t-1}^{N_S}}\Pi_t-1\right)Y_t\frac{WR_t^{N_S}}{indexation_t^W\times WR_{t-1}^{N_S}}\Pi_t+\\
&+\beta\lambda_{t+1}^R\gamma_{W^{N_S}}\left(\frac{WR_{t+1}^{N_S}}{indexation_{t+1}^W\times WR_t^{N_S}}\Pi_{t+1}-1\right)Y_{t+1}\frac{WR_{t+1}^{N_S}}{indexation_{t+1}^W\times WR_t^{N_S}}\Pi_{t+1}
\end{aligned}
$$

Eq.7: Wage equation of skilled employed workers

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

Eq. 8: Wage equation of unskilled employed workers

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

Eq. 9: The supply of atypical labor services

$$
\begin{aligned}
&(\sigma_{N_A}-1)\,\lambda_t^{NR}\left(1-\tau_t^{N_A}-\tau_{h,t}^{W^{N_A}}\right)WR_t^{N_A}N_{A,t}=\omega_{N_A}\sigma_{N_A}N_{A,t}^{1+\upsilon_{N_A}}+\\
&-\lambda_t^{NR}\gamma_{W^{N_A}}\left(\frac{WR_t^{N_A}}{indexation_t^{W}\times WR_{t-1}^{N_A}}\Pi_t-1\right)Y_t\frac{WR_t^{N_A}}{indexation_t^{W}\times WR_{t-1}^{N_A}}\Pi_t+\\
&+\beta\lambda_{t+1}^{NR}\gamma_{W^{N_A}}\left(\frac{WR_{t+1}^{N_A}}{indexation_{t+1}^{W}\times WR_t^{N_A}}\Pi_{t+1}-1\right)Y_{t+1}\frac{WR_{t+1}^{N_A}}{indexation_{t+1}^{W}\times WR_t^{N_A}}\Pi_{t+1}
\end{aligned}
$$

Eq. 10: labor aggregate

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

Eq. 11: The tradeable goods production function

$$Y_t=X_t$$

Eq. 12: Production function of the intermediate-goods producers

$$X_t=A_t\left[\left(L_{CES,t}-OH_t^{L}\right)^{\alpha_L}\left(N_{CES,t}-OH_t^{N}\right)^{\alpha_N}\left(u_t^{K}K_t\right)^{1-\alpha_L-\alpha_N}\right]^{1-I_x\alpha_G}KG_t^{\alpha_G}$$

Eq. 13: Employed labor CES aggregate

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

Eq. 14: Self-employed and atypical labor CES aggregate

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

Eq. 15: Real wage index of employed workers

$$WR_t^L = \begin{bmatrix} sx_{L_L}\left(WR_t^{L_L}(1 - sub_t^{L_L} + t_{f,t}^{W^{L_L}})\left[I_{\tau_Y}\left(1-\tau_{Y,t}\right)+\left(1-I_{\tau_Y}\right)\right]\right)^{1-\sigma_L}\left(ef_{L_L}\right)^{\sigma_L - 1} \\ +sx_{L_H}\left((1 - sub_t^{L_H} + t_{f,t}^{W^{L_H}})\left[I_{\tau_Y}\left(1-\tau_{Y,t}\right)+\left(1-I_{\tau_Y}\right)\right]WR_t^{L_H}\right)^{1-\sigma_L}\left(ef_{L_H}\right)^{\sigma_L - 1} \end{bmatrix}^{\frac{1}{1-\sigma_L}}$$

Eq. 16: Real wage index of self-employed and atypical workers

$$WR_t^N = \begin{Bmatrix} sx_{N_S}\left(WR_t^{N_S}\left(1+\tau_{f,t}^{W_{N_S}}\right)\left(1-\tau_{Y,t}\right)\right)^{1-\sigma_N}\left(ef_{N_S}\right)^{\sigma_N - 1} + \\ +sx_{N_A}\left[WR_t^{N_A}\left(1 - sub_t^{N_A} + \tau_{f,t}^{W^{N_A}}\right)\left(1-\tau_{Y,t}\right)\right]^{1-\sigma_N}\left(ef_{N_A}\right)^{\sigma_N - 1} \end{Bmatrix}^{\frac{1}{1-\sigma_N}}$$

Eq. 17: The demand of skilled employed labor

$$\begin{gathered} WR_t^{L_H}\left(1 - sub_t^{L_H} + \tau_{f,t}^{W^{L_H}}\right)\left[I_{\tau_Y}\left(1-\tau_{Y,t}\right)+\left(1-I_{\tau_Y}\right)\right] = \\ \alpha_L\left(1 - I_X\alpha_G\right)MC_t\frac{X_t}{L_{CES,t}-OH^L}sx_{L_H}^{\frac{1}{\sigma_L}}\left(ef_{L_H}\right)^{\frac{\sigma_L-1}{\sigma_L}}\left(\frac{L_{CES,t}}{LX_{H,t}}\right)^{\frac{1}{\sigma_L}} + \\ -\gamma_{L_H}\left(\frac{LX_{H,t}}{LX_{H,t-1}}-1\right)Y_t\frac{1}{LX_{H,t-1}} + \\ +\beta\frac{\lambda_{t+1}^R}{\lambda_t^R}\gamma_{L_H}\left(\frac{LX_{H,t+1}}{LX_{H,t}}-1\right)Y_{t+1}\frac{LX_{H,t+1}}{LX_{H,t}^2} \end{gathered}$$

Eq. 18: The demand of unskilled employed labor

$$\begin{gathered} WR_t^{L_L}\left(1 - sub_t^{L_L} + \tau_{f,t}^{W^{L_L}}\right)\left[I_{\tau_Y}\left(1-\tau_{Y,t}\right)+\left(1-I_{\tau_Y}\right)\right] = \\ \alpha_L\left(1 - I_X\alpha_G\right)MC_t\frac{X_t}{L_{CES,t}-OH^L}sx_{L_L}^{\frac{1}{\sigma_L}}\left(ef_{L_L}\right)^{\frac{\sigma_L-1}{\sigma_L}}\left(\frac{L_{CES,t}}{LX_{L,t}}\right)^{\frac{1}{\sigma_L}} + \\ -\gamma_{L_L}\left(\frac{LX_{L,t}}{LX_{L,t-1}}-1\right)Y_t\frac{1}{LX_{L,t-1}} + \\ +\beta\frac{\lambda_{t+1}^R}{\lambda_T^R}\gamma_{L_L}\left(\frac{LX_{L,t+1}}{LX_{L,t}}-1\right)Y_{t+1}\frac{LX_{L,t+1}}{LX_{L,t}^2} \end{gathered}$$

Eq. 19: The demand of self-employed labor

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

Eq. 20:The demand of atypical labor

$$
\begin{aligned}
WR_t^{N_A}\left(1-sub_t^N+\tau_{f,t}^{W^{N_A}}\right)(1-\tau_{Y,t}) = \\
\alpha_N\left(1-I_X\alpha_G\right)MC_t\frac{X_t}{N_{CES,t}-OH^N}sx_{N_A}^{\frac{1}{\sigma_N}}\left(ef_{N_A}\right)^{\frac{\sigma_N-1}{\sigma_N}}\left(\frac{N_{CES,t}}{NX_{A,t}}\right)^{\frac{1}{\sigma_N}}+ \\
-\gamma_{N_A}\left(\frac{NX_{A,t}}{NX_{A,t-1}}-1\right)Y_t\frac{1}{NX_{A,t-1}}+ \\
+\beta\frac{\lambda_{t+1}^R}{\lambda_T^R}\gamma_{N_A}\left(\frac{NX_{A,t+1}}{NX_{A,t}}-1\right)Y_{t+1}\frac{NX_{A,t+1}}{NX_{A,t}^2}
\end{aligned}
$$

Eq. 21: Equilibrium in the labor market, unskilled employed workers

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

Eq. 22: Equilibrium in the labor market, skilled employed workers

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

Eq. 23: Equilibrium in the labor market, self-employed workers

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

Eq. 24: Equilibrium in the labor market, atypical workers

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

Eq. 25: Real wage

$$WR_t = \frac{WR_t^{N_A}NX_{A,t}+WR_t^{N_S}NX_{S,t}+WR_t^{L_L}LX_{L,t}+WR_t^{L_H}LX_{H,t}}{LN_t}$$

Eq. 26: Physical capital accumulation equation

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

Eq. 27: The investment equation

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

Eq. 28: The Tobin's q

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

Eq. 29: The demand of capital

$$(1-\tau_{Y,t})\, r_t^k u_t^K = \frac{P_t}{P_t^I}(1 - I_X \alpha_G)(1-\alpha_L-\alpha_N)\, MC_t \frac{X_t}{K_t}$$

Eq. 30: The inflation equation

$$\begin{gathered}
(1-\tau_{Y,t})(1-\theta_Y)\, Y_t + \\
-\gamma_{px}\left(\frac{\Pi_t}{indexation_t^P} - 1\right) Y_t \frac{\Pi_t}{indexation_t^P} + \\
+\beta\gamma_{px} E_t \frac{\lambda_{t+1}^R}{\lambda_t^R}\left(\frac{\Pi_{t+1}}{indexation_{t+1}^P} - 1\right) Y_{t+1}\frac{\Pi_{t+1}}{indexation_{t+1}^P} + \\
+MC_t \theta_Y Y_t = 0
\end{gathered}$$

Eq. 31: Real profits

$$
\begin{array}{c}
PRO_t = (1-\tau_{Y,t})\,Y_t + \\
-\left[I_{\tau_Y}(1-\tau_{Y,t}) + (1-I_{\tau_Y})\right]\left[\begin{array}{c} WR_t^{L_L}\left(1-sub_t^{L_L}+\tau_{f,t}^{W^{L_L}}\right)LX_{L,t} \\ +WR_t^{L_H}\left(1-sub_t^{L_H}+\tau_{f,t}^{W^{L_H}}\right)LX_{H,t}\end{array}\right] + \\
-WR_t^{N_S}(1-\tau_{Y,t})\left(1+\tau_{f,t}^{W_{N_S}}\right)NX_{S,t} - WR_t^{N_A}(1-\tau_{Y,t})\left(1-sub_t^{N}+\tau_{f,t}^{W^{N_A}}\right)NX_{A,t} + \\
-(1-\tau_{Y,t})\frac{P_t^I}{P_t}r_t^K u_t^K K_t - \frac{\gamma_{px}}{2}\left(\frac{\Pi_t}{indexation_t^P}-1\right)^2 Y_t + \\
-\frac{\gamma_{L_H}}{2}\left(\frac{LX_{H,t}}{LX_{H,t-1}}-1\right)^2 Y_t - \frac{\gamma_{L_L}}{2}\left(\frac{LX_{L,t}}{LX_{L,t-1}}-1\right)^2 Y_t + \\
-\frac{\gamma_{N_S}}{2}\left(\frac{NX_{S,t}}{NX_{S,t-1}}-1\right)^2 Y_t - \frac{\gamma_{N_A}}{2}\left(\frac{NX_{A,t}}{NX_{A,t-1}}-1\right)^2 Y_t
\end{array}
$$

Eq. 32: Accumulation of public capital

$$KG_{t+1} = IG_t + (1-\delta_{KG})\,KG_t$$

Eq. 33: The flow budget constraint of the government in real terms NEW

$$
\begin{aligned}
BR_t \quad = \quad & \frac{R_{t-1}}{\Pi_t}BR_{t-1} + \frac{P_t^C}{P_t}G_t + \frac{P_t^I}{P_t}IG_t + Tr_t + \\
& -TAX_t - (LTAX_t + TVAT_t + KTAX_t + PROTAX_t + BTAX_t) + \\
& +SUB_t
\end{aligned}
$$

Eq. 34: Transfers

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

Eq. 35: Labor taxes

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

Eq. 36: Consumption taxes

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

Eq. 37: Capital taxes net of tax credit

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

Eq. 38: Fiscal rule

$$TAX_t = \overline{TAX} + T_B BR_{t-1} + T_D DR_t + T_Y \left(Y_t - \overline{Y} \right)$$

Eq. 39: Lump-sum taxes levied on Ricardian households

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

Eq. 40: Lump-sum taxes levied on Non-Ricardian households

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

Eq. 41: Real deficit

$$\begin{aligned} DR_t \quad = \quad & \frac{R_{t-1} - 1}{\Pi_t} BR_{t-1} + \frac{P_t^C}{P_t} G_t + \frac{P_t^I}{P_t} IG_t + \\ & + Tr_t - TAX_t + \\ & - \left(LTAX_t + CTAX_t + KTAX_t + PROTAX_t + BTAX_t \right) + SUB_t \end{aligned}$$

Eq. 42: Business tax

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

Eq. 43: Resource constraint of the economy

$$\begin{aligned}
Y_t \; = \; & \frac{P_t^C}{P_t}(G_t + C_t) + \frac{P_t^I}{P_t}(I_t + IG_t) + \frac{S_t P_{X,t}}{P_t} EXP_t - \frac{P_{M,t}}{P_t} IMP_t \\
& + \frac{\gamma_{px}}{2}\left(\frac{\Pi_t}{indexation_t^P} - 1\right)^2 Y_t + \frac{\gamma_I}{2}\frac{P_t^I}{P_t}\left(\frac{I_t}{K_t} - \delta_K\right)^2 K_t + \frac{\gamma_{L_H}}{2}\left(\frac{LX_{H,t}}{LX_{H,t-1}} - 1\right)^2 Y_t + \\
& + \frac{\gamma_{L_L}}{2}\left(\frac{LX_{L,t}}{LX_{L,t-1}} - 1\right)^2 Y_t + \frac{\gamma_{N_S}}{2}\left(\frac{NX_{S,t}}{NX_{S,t-1}} - 1\right)^2 Y_t + \frac{\gamma_{N_A}}{2}\left(\frac{NX_{A,t}}{NX_{A,t-1}} - 1\right)^2 Y_t + \\
& + s_{L_L}\frac{\gamma_{W^{L_L}}}{2}\left(\frac{WR_t^{L_L}}{indexation_t^W \times WR_{t-1}^{L_L}}\Pi_t - 1\right)^2 Y_t + \\
& + s_{L_H}\frac{\gamma_{W^{L_H}}}{2}\left(\frac{WR_t^{L_H}}{indexation_t^W \times WR_{t-1}^{L_H}}\Pi_t - 1\right)^2 Y_t + \\
& s_{N_S}\frac{\gamma_{W^{N_S}}}{2}\left(\frac{WR_t^{N_S}}{indexation_t^W \times WR_{t-1}^{N_S}}\Pi_t - 1\right)^2 Y_t \\
& + s_{N_A}\frac{\gamma_{W^{N_A}}}{2}\left(\frac{WR_t^{N_A}}{indexation_t^W \times WR_{t-1}^{N_A}}\Pi_t - 1\right)^2 Y_t \\
& + \frac{\gamma_{IMP}}{2}\frac{P_{M,t}}{P_t}\left(\frac{\Pi_t^{IMP}}{indexation_t^{IMP}} - 1\right)^2 IMP_t + \frac{\gamma_{EXP}}{2}\frac{S_t P_{X,t}}{P_t}\left(\frac{\Pi_t^{EXP}}{indexation_t^{EXP}} - 1\right)^2 EXP_t \\
& + \frac{P_t^I}{P_t}\left[\gamma_{u_1^K}\left(u_t^K - 1\right) + \frac{\gamma_{u_2^K}}{2}\left(u_t^K - 1\right)^2\right] K_t + \frac{\gamma_E}{2}\frac{P_t^C}{P_t}\left(\frac{\Pi_t^C}{indexation_t^{P^C}} - 1\right)^2 Y_t
\end{aligned}$$

Eq. 44: Taylor rule

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

Eq. 45: Indexation - Prices

$$indexation_t^P = \Pi_{t-1}^{\kappa_p}\overline{\Pi}^{1-\kappa_p}$$

Eq. 46: Indexation - Wages

$$indexation_t^W = \Pi_{t-1}^{\kappa_W} \overline{\Pi}^{1-\kappa_W}$$

Eq. 47: Welfare function of Ricardian Household

$$\begin{aligned} Welfare_t^R &= \log\left(C_t^R - h_{C^R}\overline{C}_{t-1}^R\right) + \frac{s_{N_S}}{1-s_{NR}}\omega_{N_s}\left(N_{s,t}\right)^{v_{N_s}} + \\ &+ \frac{(1-I^{NR}\lambda^{L_L})s_{L_L}}{1-s_{NR}}\omega_{L_L}L_{L,t}^{v_{L_L}} + \\ &\frac{s_{L_H}}{1-s_{NR}}\omega_{L_H}\left(L_{H,t}\right)^{v_{L_H}} + \beta E_t Welfare_{t+1}^R \end{aligned}$$

Eq. 48: Welfare function of Non-Ricardian Household

$$Welfare_t^{NR} = \log(C_t^{NR} - h_{C^{NR}}\overline{C}_{t-1}^{NR}) + \frac{s_{N_A}}{s_{NR}}\omega_{N_A}N_{A,t}^{v_{N_A}} + I^{NR}\lambda^{L_L}\frac{s_{L_L}}{s_{NR}}\omega_{L_L}L_{L,t}^{v_{L_L}} + \beta E_t Welfare_{t+1}^{NR}$$

Eq. 49: Total welfare

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

Eq. 50 Final good production function

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

Eq. 51: Imports demand

$$IMP_t = \alpha_{IMP}\left(\frac{MC_{E,t}}{1-\tau_{E,t}}\right)^{\sigma_{IMP}}\left(\frac{P_{M,t}}{P_t}\right)^{-\sigma_{IMP}}E_t$$

Eq. 52: Domestic demand of internal production

$$Y_{H,t} = (1-\alpha_{IMP})\left(\frac{MC_{E,t}}{1-\tau_{E,t}}\right)^{\sigma_{IMP}}E_t$$

Eq. 53: CPI inflation dynamics

$$\frac{P_{C,t}}{P_t}E_t - \theta_E \frac{P_{C,t}}{P_t}E_t +$$
$$-\gamma_{pe}\left(\frac{\Pi_t^C}{indexation_t^p} - 1\right) Y_t \frac{\Pi_t^C}{indexation_t^p} +$$
$$+\gamma_e \beta \frac{\lambda_{t+1}^R}{\lambda_t^R}\left(\frac{\Pi_{t+1}^C}{indexation_{t+1}^p} - 1\right)\frac{\Pi_{t+1}^c}{indexation_{t+1}^p} Y_{t+1} + \theta_E MC_{E,t} E_t = 0$$

Eq. 54: CPI

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

Eq. 55: Indexation

$$indexation_t^{P^C} = \Pi_{t-1}^{\kappa_p} \overline{\Pi}^{1-\kappa_p}$$

Eq. 56: Exports demand

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

Eq. 57: Imported good price level

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

Eq. 58: Domestic final good price level

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

Eq. 59: Foreign final good price level

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

Eq. 60: Foreign consumption price index

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

Eq. 61: Exchange rate (non-linear UIP)

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

Eq. 62: Trade balance as a share of GDP

$$TBY_t = \left(\frac{S_t P_{X,t}}{P_t} EXP_t - \frac{P_{M,t}}{P_t} IMP_t \right) / Y_t$$

Eq. 63: Terms of trade

$$TOT_t = \frac{S_t P_{X,t}}{P_{M,t}}$$

Eq. 64: Real exchange rate

$$RER = \frac{S_t P_t^{C*}}{P_t^C}$$

Eq. 65: Current account

$$CA_t = \frac{S_t P_{X,t}}{P_t} EXP_t - \frac{P_{M,t}}{P_t} IMP_t + \frac{\left(R_{t-1}^* - 1 + rpbrf_{t-1}\right)}{\Pi_t} \frac{S_t}{S_{t-1}} BR_{t-1}^F$$

Eq. 66: Foreign assets net position in real terms

$$BR_t^F = \frac{R_{t-1}^* + rpbrf_{t-1}}{\Pi_t} \frac{S_t}{S_{t-1}} BR_{t-1}^F + \frac{S_t P_{X,t}}{P_t} EXP_t - \frac{P_{M,t}}{P_t} IMP_t$$

Eq. 67: Risk premium

$$rpbrf_t = -\varphi^F (e^{BR_t^F - BR^F} - 1)$$

Eq. 68: Investement goods price level

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

Eq. 69: Investement goods inflation

$$\Pi_t^I = \frac{P_{I,t}}{P_{I,t-1}}$$

Eq. 70: Export price

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

Eq. 71: Import price inflation

$$\lambda_t^R \left[\begin{array}{c} (1-\theta_{IMP}) \frac{P_{M,t}}{P_t} IMP_t + \\ -\gamma_{IMP} \left(\frac{\Pi_t^{IMP}}{indexation_t^{IMP}} - 1 \right) IMP_t \frac{\Pi_t^{IMP}}{indexation_t^{IMP}} + (1-\tau_{IMP,t}) \frac{S_t P_t^*}{P_t} \theta_{IMP} IMP_t \end{array} \right] +$$

$$+\beta \gamma_{IMP} E_t \lambda_{t+1}^R \left(\frac{\Pi_{t+1}^{IMP}}{indexation_{t+1}^{IMP}} - 1 \right) IMP_{t+1} \frac{\Pi_{t+1}^{IMP}}{indexation_{t+1}^{IMP}} = 0$$

Eq. 72: Export price inflation

$$\lambda_t^R \left[\begin{array}{c} (1-\theta_{EXP}) \frac{S_t P_{X,t}}{P_t} EXP_t + \\ -\gamma_{EXP} \left(\frac{\Pi_t^{EXP}}{indexation_t^{EXP}} - 1 \right) EXP_t \frac{\Pi_t^{EXP}}{indexation_t^{EXP}} + (1-\tau_{IMP,t}) \theta_{EXP} EXP_t \end{array} \right] +$$

$$+\beta E_t \lambda_{t+1}^R \gamma_{EXP} \left(\frac{\Pi_{t+1}^{EXP}}{indexation_{t+1}^{EXP}} - 1 \right) EXP_{t+1} \frac{\Pi_{t+1}^{EXP}}{indexation_{t+1}^{EXP}} = 0$$

Eq. 73: Import price indexation

$$indexation_t^{IMP} = \left(\Pi_{t-1}^{IMP}\right)^{\kappa_{IMP}} \left(\overline{\Pi}^*\right)^{1-\kappa_{IMP}}$$

Eq. 74: Export price indexation

$$indexation_t^{EXP} = \left(\Pi_{t-1}^{EXP}\right)^{\kappa_{EXP}} \left(\overline{\Pi}\right)^{1-\kappa_{EXP}}$$

Eq. 75: Capital utilization

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

Eq. 76: Subsidies

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

Eq. 77: Tax on profits

$$PROTAX_t = \tau_t^{PRO} PRO_t$$

Eq. 78: Willingness to work - Self-employed

$$\left(1-\tau_t^{N_S}-\tau_{h,t}^{W^{N_S}}\right)WR_t^{N_S}=\omega_{N_s}\frac{\left(N_{s,t}^s\right)^{v_{N_s}}}{\lambda_t^R}$$

Eq. 79: Unemployment - Self-employed

$$N_{s,t}^u=\frac{N_{s,t}^s-N_{s,t}}{N_{s,t}^s}$$

Eq. 80: Willingness to work - Skilled employees

$$\left(1-\tau_t^{L_H}-\tau_{h,t}^{W^H}\right)WR_t^{L_H}=\omega_{L_H}\frac{\left(L_{H,t}^s\right)^{v_{L_H}}}{\lambda_t^R}$$

Eq. 81: Unemployment - Skilled employees

$$L_{H,t}^u=\frac{L_{H,t}^s-L_{H,t}}{L_{H,t}^s}$$

Eq. 82: Willingness to work NR- Unskilled employees

$$\left(1-\tau_t^{L_L}-\tau_{h,t}^{W^L}\right)WR_t^{L_L}=\omega_{L_L}\frac{(L_L^s(NR))^{v_{L_L}}}{\lambda_t^{NR}}$$

Eq. 83: Willingness to work R- Unskilled employees

$$\left(1-\tau_t^{L_L}-\tau_{h,t}^{W^L}\right)WR_t^{L_L}=\omega_{L_L}\frac{\left(L_{L,t}^s(R)\right)^{v_{L_L}}}{\lambda_t^R}$$

Eq. 84: Willingness to work- Unskilled employees

$$L_{L,t}^s=I^{NR}\lambda^{L_L}L_{L,t}^s(NR)+(1-I^{NR}\lambda^{L_L})L_{L,t}^s(R)$$

Eq. 85: Unemployment - Unskilled employees

$$L_{L,t}^u=\frac{L_{L,t}^s-L_{L,t}}{L_{L,t}^s}$$

Eq. 86: Willingness to work - Atypical

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

Eq. 87: Unemployment - Atypical

$$N_{A,t}^u=\frac{N_{A,t}^s-N_{A,t}}{N_{A,t}^s}$$

Eq. 88: Unemployment

$$UNEMP_t=\frac{s_{L_L}L_{L,t}^s+s_{L_H}L_{H,t}^s+s_{N_A}N_{A,t}^s+s_{N_S}N_{S,t}^s-\left(s_{L_L}L_{L,t}+s_{L_H}L_{H,t}+s_{N_A}N_{A,t}+s_{N_S}N_{S,t}\right)}{s_{L_L}L_{L,t}^s+s_{L_H}L_{H,t}^s+s_{N_A}N_{A,t}^s+s_{N_S}N_{S,t}^s}$$

Eq. 89: Domestic absorption

$$P_tY_{H,t}=P_tY_t-S_tP_{X,t}EXP_t$$

Table1a: Parametrization

Parameter	Description	Value
β	Discount factor	0.99
δ_K	Depreciation rate of K	0.025
δ_G	Depreciation rate of K^G	0.025
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
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
h_{C^R}	Habit parameter, Ricardian households	0.7
$h_{C^{NR}}$	Habit parameter, non-Ricardian households	0.3
θ_E	Elasticity of substitution between final goods	2.65
θ_Y	Elasticity of substitution between domestic intermediate goods	5
θ_{EXP}	Elasticity of substitution between exported intermediate goods	5
θ_{IMP}	Elasticity of substitution between imported intermediate goods	5
σ_{IMP}	Elasticity of substitution between domestic and foreign intermediate varieties	1.1
κ_P	Price backward indexation	1
κ_W	Wage backward indexation	1
Π	Steady-state inflation	1

Table 1b: Parametrization

Parameter	Description	Value
s_{L_H}	Share of skilled employees	0.11
s_{N_S}	Share of self-employed	0.21
s_{N_A}	Share of atypical workers	0.26
s_{N_R}	Share of non Ricardian households	0.26
σ_L	Elasticity of substitution, skilled and unskilled employees	1.4
σ_N	Elasticity of substitution, atypical and self-employed workers	1.4
σ_{L_H}	Elasticity of substitution, skilled employees	2.65
σ_{L_L}	Elasticity of substitution, unskilled employees	2.65
σ_{N_s}	Elasticity of substitution, self-employed workers	2.65
υ_{L_H}	Preference parameter, skilled employees	8.01
υ_{L_L}	Preference parameter, unskilled employees	8.36
υ_{N_A}	Preference parameter, atypical workers	12.76
υ_{N_s}	Preference parameter, self-employed workers	8.00
τ^C	Tax rate of consumption	0.17
τ^K	Tax rate on physical capital	0.33
τ^Y	Tax rate on business	0.04
τ^{L_L}	Average tax rate on unskilled employees	0.24
$\tau_h^{W^{L_L}}$	Social contributions on unskilled employees	0.09
$\tau_f^{W^{L_L}}$	Contributions levied on firms, unskilled employees	0.33
τ^{L_H}	Average tax rate on skilled employees	0.27
$\tau_h^{W^{L_H}}$	Social contributions on skilled employees	0.09
$\tau_f^{W^{L_H}}$	Contributions levied on firms, skilled employees	0.33
τ^{N_S}	Average tax rate on self-employed	0.26
$\tau_h^{W_{N_s}}$	Social contributions on self-employed	0.09
$\tau_f^{W_{N_s}}$	Contributions levied on firms, self-employed	0.00
τ^{N_A}	Average tax rate on atypical workers	0.24
$\tau_h^{W_{N_A}}$	Social contributions on atypical workers	0.09
$\tau_f^{W_{N_A}}$	Contributions levied on firms, atypical workers	0.27

Table 2: Macroeconomic Impact of 1% Markup Reduction in the Final Good Sector

Years	1	2	3	4	5	10	20
Output	0.03	0.11	0.13	0.15	0.17	0.25	0.35
Consumption	0.67	1.46	1.54	1.55	1.58	1.64	1.74
Investment	0.09	0.41	0.31	0.34	0.36	0.46	0.63
Labor	0.01	0.03	0.05	0.07	0.09	0.16	0.23
Labor - unskilled workers	0.01	0.04	0.06	0.08	0.10	0.18	0.26
Labor - skilled workers	0.01	0.03	0.04	0.06	0.07	0.13	0.21
Labor - self-employed workers	0.01	0.03	0.05	0.06	0.08	0.12	0.15
Labor - atypical workers	0.01	0.03	0.05	0.07	0.08	0.16	0.29
Real wages - total	0.27	-0.04	0.00	0.03	0.02	0.04	0.07
Real wages - unskilled workers	0.27	-0.04	0.00	0.02	0.02	0.03	0.06
Real wages - skilled workers	0.27	-0.04	0.00	0.02	0.02	0.04	0.08
Real wages - self-employed workers	0.27	-0.03	0.01	0.04	0.04	0.08	0.14
Real wages - atypical workers	0.27	-0.04	-0.01	0.01	0.01	0.01	0.01
Unemployment rate - total	-0.66	-1.03	-0.91	-0.92	-0.95	-1.05	-1.16
Unemployment rate - unskilled workers	-0.74	-1.12	-0.99	-1.01	-1.04	-1.15	-1.28
Unemployment rate - skilled workers	-0.74	-1.11	-0.98	-0.99	-1.02	-1.12	-1.24
Unemployment rate - self-employed workers	-0.73	-1.11	-0.98	-0.99	-1.01	-1.09	-1.16
Unemployment rate - atypical workers	0.11	-0.06	-0.05	-0.06	-0.08	-0.15	-0.27
Terms of trade	-0.14	-0.17	-0.04	-0.07	-0.10	-0.20	-0.31

Table 3: Macroeconomic Impact of 1% Markup Reduction in the Intermediate Good Sector

Years	1	2	3	4	5	10	20
Output	0.18	0.45	0.63	0.81	0.96	1.58	2.27
Consumption	0.40	1.17	1.39	1.53	1.67	2.24	2.98
Investment	-0.12	0.29	0.28	0.36	0.45	0.84	1.50
Labor	0.15	0.39	0.61	0.81	0.99	1.68	2.40
Labor - unskilled workers	0.17	0.45	0.69	0.91	1.11	1.87	2.62
Labor - skilled workers	0.12	0.30	0.47	0.64	0.79	1.45	2.24
Labor - self-employed workers	0.17	0.42	0.64	0.84	1.01	1.62	2.11
Labor - atypical workers	0.11	0.29	0.46	0.62	0.77	1.43	2.32
Real wages - total	0.43	0.07	0.09	0.12	0.12	0.16	0.25
Real wages - unskilled workers	0.42	0.05	0.07	0.09	0.09	0.12	0.21
Real wages - skilled workers	0.42	0.06	0.07	0.10	0.11	0.16	0.28
Real wages - self-employed workers	0.43	0.07	0.10	0.14	0.16	0.27	0.51
Real wages - atypical workers	0.42	0.04	0.05	0.07	0.07	0.08	0.10
Unemployment rate - total	-0.68	-1.44	-1.61	-1.85	-2.10	-3.05	-4.12
Unemployment rate - unskilled workers	-0.77	-1.57	-1.75	-2.01	-2.27	-3.29	-4.45
Unemployment rate - skilled workers	-0.74	-1.50	-1.65	-1.89	-2.13	-3.08	-4.22
Unemployment rate - self-employed workers	-0.76	-1.54	-1.70	-1.94	-2.18	-3.07	-3.97
Unemployment rate - atypical workers	0.17	-0.26	-0.41	-0.56	-0.71	-1.36	-2.22
Terms of trade	0.19	-0.04	-0.14	-0.37	-0.57	-1.32	-2.07

Table 4: Macroeconomic Impact of a Tax Shift from the Business to Consumption - 1% of Output

Years	1	2	3	4	5	10	20
Output	-0.06	0.16	0.23	0.30	0.38	0.63	0.84
Consumption	-0.55	0.45	0.60	0.63	0.70	0.93	1.15
Investment	-0.70	0.11	-0.06	-0.03	0.02	0.18	0.43
Labor	0.07	0.21	0.33	0.43	0.52	0.85	1.08
Labor - unskilled workers	0.13	0.35	0.54	0.70	0.83	1.28	1.57
Labor - skilled workers	0.08	0.22	0.35	0.46	0.56	0.96	1.31
Labor - self-employed workers	0.00	0.05	0.09	0.12	0.16	0.29	0.34
Labor - atypical workers	0.02	0.06	0.11	0.15	0.20	0.40	0.69
Real wages - total	0.89	-0.04	-0.05	-0.01	-0.03	-0.03	0.03
Real wages - unskilled workers	0.91	0.00	0.01	0.06	0.06	0.09	0.16
Real wages - skilled workers	0.91	0.01	0.02	0.08	0.07	0.12	0.22
Real wages - self-employed workers	0.91	0.02	0.04	0.11	0.11	0.20	0.38
Real wages - atypical workers	0.90	-0.01	-0.01	0.04	0.03	0.02	0.03
Unemployment rate - total	-1.29	-2.72	-2.64	-2.73	-2.86	-3.24	-3.52
Unemployment rate - unskilled workers	-1.53	-3.03	-2.97	-3.09	-3.24	-3.70	-4.03
Unemployment rate - skilled workers	-1.51	-2.97	-2.89	-2.98	-3.12	-3.54	-3.87
Unemployment rate - self-employed workers	-1.48	-2.89	-2.76	-2.82	-2.91	-3.19	-3.33
Unemployment rate - atypical workers	0.84	-0.07	-0.10	-0.12	-0.17	-0.38	-0.66
Terms of trade	0.10	-0.23	-0.05	-0.16	-0.26	-0.57	-0.80

Table 5: Macroeconomic Impact of a Fiscal Devaluation - 1% of Output

Years	1	2	3	4	5	10	20
Output	-0.04	0.26	0.38	0.50	0.62	1.05	1.49
Consumption	-0.44	0.78	1.00	1.08	1.20	1.62	2.09
Investment	-0.84	0.07	-0.10	-0.05	0.02	0.26	0.67
Labor	0.13	0.35	0.54	0.72	0.88	1.46	1.97
Labor - unskilled workers	0.19	0.49	0.75	0.98	1.18	1.86	2.39
Labor - skilled workers	0.12	0.31	0.49	0.66	0.81	1.41	2.01
Labor - self-employed workers	0.01	0.07	0.13	0.19	0.24	0.46	0.60
Labor - atypical workers	0.14	0.38	0.59	0.80	0.99	1.76	2.67
Real wages - total	0.99	-0.06	-0.08	-0.05	-0.08	-0.12	-0.07
Real wages - unskilled workers	1.02	0.02	0.03	0.09	0.09	0.13	0.22
Real wages - skilled workers	1.03	0.02	0.04	0.10	0.10	0.17	0.31
Real wages - self-employed workers	1.03	0.04	0.07	0.14	0.15	0.27	0.51
Real wages - atypical workers	1.02	0.01	0.01	0.07	0.06	0.07	0.10
Unemployment rate - total	-1.48	-3.14	-3.12	-3.29	-3.50	-4.20	-4.86
Unemployment rate - unskilled workers	-1.73	-3.47	-3.47	-3.66	-3.89	-4.66	-5.36
Unemployment rate - skilled workers	-1.71	-3.40	-3.35	-3.51	-3.72	-4.44	-5.13
Unemployment rate - self-employed workers	-1.66	-3.28	-3.18	-3.28	-3.44	-3.95	-4.35
Unemployment rate - atypical workers	0.79	-0.37	-0.57	-0.74	-0.93	-1.70	-2.58
Terms of trade	0.16	-0.23	-0.08	-0.25	-0.40	-0.93	-1.39

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