Reforms in DSGE models: too sensitive for policy analysis [§]

Olfa Alouini[*], Benoit Campagne[†], Aurélien Poissonnier[‡]

31st March 2015

Abstract

We use the two country DSGE model of the Euro area *MELEZE* developed at Insee to shed a new light on two standard exercises: structural and fiscal reforms evaluations. The main features of the model compare with standard tools developed in international institutions and central banks. Within a range of acceptable calibrations for the elasticities in the utility function, the share of *non Ricardian* consumers, and trade openness, the effect on output of a goods or labour market deregulation can be as different as 10 p.p. stronger or weaker. Similarly, depending on the specification of fiscal and monetary authorities, we present public spending fiscal multipliers ranging from 0.7 to 1.3. Therefore, our results advocate for the extensive use of sensitivity analyses for policy purposes.

JEL-code: E10, E62, F45

Keywords: fiscal multipliers, structural reforms, DSGE model, monetary union

[*]European Commission

[†]Insee-DESE & Crest-LMA

[‡]Insee-DESE & Crest-LMA & École Polytechnique

[§]The authors would like to thank Jean-Guillaume Sahuc (Banque de France) for his fruitful discussion and advice. This paper reflects the opinions of the authors and do not necessarily express the views of the French National Institute for Statistics and Economics Studies (Insee) or the European Commission.

1 Introduction

The evaluation of fiscal and structural reforms has become not only a standard but indispensable exercise in the DSGE literature and in policy-making publications and reports. Institutions such as the IMF, the European Commission, the OECD, the ECB, and many central banks have now developed and refined their own tools and are capable of conducting such analyses in different contexts.

The effects of structural reforms have been documented by D'Auria et al. (2009) for EU member states and for Italy by Annicchiarico et al. (2013) both in the R&D version of the Quest III model. The IMF or the OECD have also conducted their own evaluations for Europe (Bayoumi et al., 2004; Everaert and Schule, 2006, 2008; Cacciatore et al., 2012).

Fiscal reforms or consolidation have also been assessed through DSGE models. In the European context some work was conducted on the Quest III model (Vogel, 2012). (Coenen et al., 2008) investigate labor tax reforms in the New Area Wide Model (NAWM). (Clinton et al., 2011) provide similar insights in the case of an international model (GIMF). (Coenen et al., 2012) give an extensive review of the size of fiscal multipliers in the main institutional models.

The recurrence and the systematic use of DSGEs today therefore raises the question of their actual capabilities. Whereas their qualitative behaviours have largely improved and now properly describe economic data, their quantitative accuracy is still debated among economists (see for instance (Schorfheide, 2011) for a summary of current DSGE weaknesses).

We study the results' dependency of fiscal and structural simulations to various specifications in our DSGE model to assess their capability to provide meaningful quantitative insights. In particular, we focus on crucial calibrated utility parameters and on fiscal and monetary authorities modelling choices. We also study policy schemes based on welfare analyses both at the steady state and along the transitional paths.

The model MELEZE used in this paper (Campagne and Poissonnier, 2015) features the standard modelling choices of the two country monetary union literature. The core of the model for each country is inspired by (Christiano et al., 2005) and (Smets and Wouters, 2003, 2005, 2007): firms and consumers maximize their objective (utility or profit) by interacting on the goods, labor and capital markets with both prices and wages rigidities introducing neo-Keynesian features in the model à la (Erceg et al., 2000). The model also integrates risk free assets to ensure an intertemporal trade-off and real rigidities on the capital market. In addition, our model builds on academic works studying monetary and fiscal policies in monetary unions (Galí and Monacelli, 2008; Benigno, 2004; Corsetti et al., 2010) by introducing capital markets.

We also introduce *non Ricardian* households as advocated by (Mankiw, 2000), a feature which is crucial for the reaction of private consumption to public spending (Galí et al., 2007), and therefore *a priori* crucial to the size of fiscal multipliers. In addition, we introduce government spending in the utility function, to generate Edgeworth complementarity/substitutability between private and public consumption as advocated by (Fève and Sahuc, 2013).

Moreover, we introduce in our model public and private debts exchanged on a union wide financial market both at steady state and out of equilibrium. Beyond public debt, the government uses public spending to stimulate and monitor economic activity. It can also exogenously modify its fiscal policy along different axes: lump-sum transfers and taxes on consumption, labour, capital income or dividends. As detailed below, we depart from traditional budget rules behaviours used in the literature, and derive a forward-looking optimizing behaviour for the government.

All these modelling elements are generally embedded in large scale models developed in central banks and international institutions among which are GEM at the IMF (Bayoumi et al., 2004), NAWM at the ECB (Coenen et al., 2008) or in open economy EAGLE (Gomes et al., 2012), QUEST III at the European Commission (Ratto et al., 2009) and its R&D version (Roeger et al., 2008). Whereas these models sometimes also consider both tradable and non-tradable goods, heterogeneous agents on the labour market, or endogenous growth, we choose to simplify our model and do not consider these additions. The outcome is a model tractable enough to be fully linearised by hand. We are also able to solve for the steady state of the real variables in levels and carefully account for all the steady state restrictions imposed on the parameters of the model.

We replicate two different settings: France against the rest of the Eurozone, and a symmetric calibration for the Euro area. We carefully calibrate our model based on the standard DSGE literature and as to match National Accounts data for endogenous variables.

In a first section, we study the long-term impact of mark-up reforms in both the labour and goods markets. In particular, we provide with a detailed analysis of the underlying mechanisms implying gains in production in the long-term. Our results compare with stylized facts obtained (Blanchard and Giavazzi, 2003).

Comparing numerical simulations with those conducted in (Everaert and Schule, 2006) gives very diverging results regarding the size of output gains. Whereas the absence in our model of additional rigidities and of a distinction between tradable and non-tradable goods may partially explain these differences, we show that the quantification of deregulation gains is uncertain and crucially relies on the

calibration of the model. For calibrations of the households' utility, the degree of trade openness and the share of non-Ricardian agents within the common literature range, we generate variations in output up to 10 p.p. stronger or weaker than our baseline scenario. In particular, the Frisch elasticity accounts for most of this variability.

In a second section, we study the effect of temporary or permanent fiscal reforms. We simulate increases in public spending, transfers or decreases in various tax rates calibrated to 1% of pre-stimulus output. The resulting fiscal multipliers are compared to the main existing DSGE models based on the results provided in (Coenen et al., 2012), and to the French macroeconometric model Mésange developed at Insee (Klein and Simon, 2010). We find that our model gives comparable multipliers for temporary shocks but highlight that these measures of the fiscal multipliers crucially depend on their timing and the way both fiscal and monetary authorities commit or react to the stimulus.

All in all, public spending fiscal multipliers can range from 0.7 to 1.3. Cuts on distorting tax rates provides lower multipliers, and can even be negative in particular cases (corporate income taxes and labour income taxes) when the government adjusts its spending to limit the induced deficit. Coordination across countries leads to larger fiscal multipliers.

In response to permanent spending shocks financed though lump-sum transfers, our model provides weaker long-term multipliers yet comparable to (Coenen et al., 2012) results. This weaker response stems from the negative wealth effect implied by the necessary financing fall in transfers.

In all, our results raise questions on the ability for current quantitative DSGE models to provide accurate quantitative estimates for economic policies. On a less pessimistic note, in the conduct of policy analysis, one should therefore be very cautious to properly assess the dependency of the results to the specification of the model, and provide detailed sensitivity tests.

The rest of the paper is organised as follows: in Section 2, we present the main agents' behavioural equations. In Section 3, we give a short presentation of the calibration of the model for France. Section 4 and 5, respectively study mark-up reforms in the labour and goods market, and the size of fiscal multipliers in our model. The non-technical reader may skip Section 2, whereas the very technical one may refer to the forthcoming companion paper.

2 Outline of the model: MELEZE

This section gives a short presentation of the main features of the model namely: a neo-Keynesian model of two countries in monetary union, comparing with standard tools developed in international

institutions and central banks. This exogenous growth model includes both *Ricardian* and *non Ricardian* agents, optimizing firms and governments. Nominal rigidities are added on price and wages in a Calvo manner, and real rigidities are introduced on labour and goods with monopolistic competition, and on capital though adjustment costs. A more detailed description of the model, the first order conditions, of their steady state and linearisation is given in a companion paper (Campagne and Poissonnier, 2015).

Table 8 and 9 at the end of the paper give the full description of the model notations. As much as possible, we keep standard notations throughout this paper (C for consumption, W for wage...). A superscript $i \in \{1, 2\}$ whether on an aggregate or on a parameter refers to the country. Subscripts are used to specify an operation related to the variable (e.g. habit on consumption or labour), in particular C^i_j refers to consumption in country i of good j produced in country j. Upper-case letters refer to aggregates while lower-case letters refer per GDP unit aggregates or sometimes when we want to emphasize individual variables (wage, labour supply and output). Throughout, τ is the index for a generic household and ε the index for a generic firm. R and NR superscripts relates to *Ricardian* households and *non Ricardian* households.

2.1 Households

The model consists of two countries populated by a continuum of households. Households τ in $[0 \dots n\mathbb{N}]$ live in country 1 whereas households τ in $[n\mathbb{N} \dots \mathbb{N}]$ live in country 2. For tractability we also denote $n^1 = n$ and $n^2 = 1 - n$.

Consumption and investment

First, in each country, a fraction $(1 - \mu^i)$ of these households is assumed to be *Ricardian*, that is not financially constrained. These agents hold financial assets, capital which they lend to domestic firms, and shares in both real and financial intermediation firms. As such, these *Ricardian* households arbitrage between consumption and savings, capital and financial assets, as well as between consumption and leisure today.

Each *Ricardian* household τ maximises his intertemporal utility, non separable in private consump-

tion, labour and public spending:

$$\begin{aligned}
&\max E_t \sum_{T=t}^{\infty} {\beta^i}^{T-t} \mathcal{U}_T^{R,i}(\tau)\mathcal{V}_T^{R,i}(\tau)\mathcal{W}_T^i \\
&\text{with } \mathcal{U}_t^{R,i}(\tau) = \frac{1}{1-\sigma_c^i}\left[\left(C^{R,i}(\tau,t)\left(\frac{C_{t-1}^i}{n^i\mathbb{N}}\right)^{-h_c^i}\right)^{1-\eta}\right]^{1-\sigma_c^i} \\
&\mathcal{V}_t^{R,i}(\tau) = \left[1-\kappa^i(1-\sigma_c^i)\left(l^{R,i}(\tau,t)\left(\frac{L_{t-1}^i}{n^i\mathbb{N}}\right)^{-h_l^i}\right)^{1+\sigma_l^i}\right]^{\sigma_c^i} \\
&\mathcal{W}_t^i = \left[\left(G_t^i\left(G_{t-1}^i\right)^{-h_g^i}\right)^{\eta}\right]^{1-\sigma_c^i}
\end{aligned} \tag{2.1}$$

subject to the budget constraint;:

$$\begin{aligned}
FA_T^i(\tau) = &\left(R_{T-1} - \psi(\frac{FA_{T-1}^i}{P_{T-1}^i \bar{Y}^i Tr_{T-1}})\right) FA_{T-1}^i(\tau) + w_T^i(\tau) l_T^{R,i}(\tau) \\
&- CPI_T^i(1+\nu_T^{c,i})C_T^{R,i}(\tau) + (1-\nu_T^{D,i})D_T^i(\tau) + (1-\nu_T^{FD,i})\mathrm{FD}_T^i(\tau) \\
&+ \Phi_T^i(\tau) + (1-\nu_T^{K,i})CPI_T^i r_T^{K,i} K_{T-1}^i(\tau) - CPI_T^i(1+\nu_T^{c,i})I_T^i(\tau)
\end{aligned} \tag{2.2}$$

$$K_T^i(\tau) = (1-\delta)K_{T-1}^i(\tau) + \epsilon_T^{i,I}\left[1-\mathcal{S}\left(\frac{I_T^i(\tau)}{I_{T-1}^i(\tau)}\right)\right] I_T^i(\tau) \tag{2.3}$$

where E_t, β^i are respectively the expectation at time t operator and the discount factor; σ_c^i is the inverse intertemporal elasticity of substitution; κ the weight assigned to labour in the utility function and σ_l^i the inverse of the Frisch elasticity. h_c^i, h_l^i are the external habit formation (on per capita level) parameters on consumption and labour. $C_t^{R,i}(\tau)$ and $l_t^{R,i}(\tau)$ are respectively the consumption and labour supply of agent τ in country i; $w_t^i(\tau)$ correspond to the wage. $FA_t^i(\tau)$ is the asset holdings at the end of period t while FA_t^i is country i aggregate level of private financial assets; r_t is the interest rate set by the monetary authority in the union; ψ is a debt elastic interest premium[1]. D_t^i are the dividends paid by the firm to its owners, whereas FD_t^i are equivalently the dividends paid by the financial sector. $\Phi^i(\tau,t)$ is a lump-sum transfer from the government. Lastly, $\nu_t^{c,i}$ and $\nu_t^{k,i}$ are the tax rate on consumption or value-added tax (VAT) and on capital income revenues.

In the capital accumulation equation, $I_t^i(\tau)$ is the investment level with an adjustment cost[2] $\mathcal{S}\left(\frac{I_T^i(\tau)}{I_{T-1}^i(\tau)}\right)$

[1] As advocated in (Schmitt-Grohé and Uribe, 2003), this premium is mostly introduced to ensure the closing of open economy models.

[2] See (Christiano et al., 2005; Smets and Wouters, 2003, 2005, 2007). We assume that $\mathcal{S}(1) = 0$, $\mathcal{S}'(1) = 0$ and $\mathcal{S}''(1) > 0$.

depending on previous period level of investment, and $K_t^i(\tau)$ is the capital stock of *Ricardian* households depreciating at rate δ. As a result, households pay for the full investment allotment $I_T^i(\tau)$ and a share $\mathcal{S}\left(\frac{I_T^i(\tau)}{I_{T-1}^i(\tau)}\right)$ is lost in the installation process. $\epsilon_T^{i,I}$ represents an exogenous shock to this cost.

Note that investment goods aggregate both domestic and foreign goods, but installed capital is assumed to be immobile across countries. As a result, the returns on capital do not equalize across countries.

The first order conditions yield the following Euler equation, investment decision and Tobin's Q:

$$\beta^i E_t \left\{ \frac{\mathcal{U}'^{R,i}_{t+1}(\tau)\mathcal{V}^{R,i}_{t+1}(\tau)\mathcal{W}^i_{t+1}}{\mathcal{U}'^{R,i}_{t}(\tau)\mathcal{V}^{R,i}_{t}(\tau)\mathcal{W}^i_{t}} \frac{R_t - \psi\left(\frac{FA_t^i}{P_t^i \bar{Y}^i Tr_t}\right)}{\Pi^{c,i}_{t+1}\frac{1+\nu^{c,i}_{t+1}}{1+\nu^{c,i}_{t}}} \right\} = 1 \tag{2.4}$$

$$\begin{aligned} 1 =& q_t^i(\tau)\epsilon_t^{i,I}\left(1 - \mathcal{S}\left(\frac{I_t^i(\tau)}{I_{t-1}^i(\tau)}\right) - \mathcal{S}'\left(\frac{I_t^i(\tau)}{I_{t-1}^i(\tau)}\right)\frac{I_t^i(\tau)}{I_{t-1}^i(\tau)}\right) \\ &+ \beta^i E_t\left\{\frac{\mathcal{U}'^{R,i}_{t+1}(\tau)\mathcal{V}^{R,i}_{t+1}(\tau)\mathcal{W}^i_{t+1}}{\mathcal{U}'^{R,i}_{t}(\tau)\mathcal{V}^{R,i}_{t}(\tau)\mathcal{W}^i_{t}} q_{t+1}^i(\tau)\epsilon_{t+1}^{i,I}\mathcal{S}'\left(\frac{I_{t+1}^i(\tau)}{I_t^i(\tau)}\right)\left(\frac{I_{t+1}^i(\tau)}{I_t^i(\tau)}\right)^2\right\} \end{aligned} \tag{2.5}$$

$$q_t^i(\tau) = \beta^i E_t\left\{\frac{\mathcal{U}'^{R,i}_{t+1}(\tau)\mathcal{V}^{R,i}_{t+1}(\tau)\mathcal{W}^i_{t+1}}{\mathcal{U}'^{R,i}_{t}(\tau)\mathcal{V}^{R,i}_{t}(\tau)\mathcal{W}^i_{t}}\left(q_{t+1}^i(\tau)(1-\delta) + \frac{(1-\nu^{k,i}_{t+1})r^{k,i}_{t+1}}{1+\nu^{c,i}_{t+1}}\right)\right\} \tag{2.6}$$

where $\Pi^{c,i}_{t+1}$ is the inflation of the consumption price index in country i.

On the opposite, the remaining fraction μ^i of *non Ricardian* households are financially constrained and do not hold any assets nor shares in domestic real or financial firms. As in (Campbell and Mankiw, 1989), these *non Ricardian* agents follow a rule-of-thumb given by their budget constraint:

$$W_t^{NR,i}(\tau)L_t^{NR,i}(\tau) + \Phi_t^{NR,i}(\tau) = CPI_t^i(1+\nu_t^{c,i})C_t^{NR,i}(\tau) \tag{2.7}$$

Labour supply and wage setting

Labour is assumed immobile across countries and both types of households provide labour on monopolistically competitive market. An employment agency aggregates labour supplied and provides firms with an homogeneous bundle. The relationship between total demand for labour and each household supply is a function of the demanded wage over aggregate wage (Equation 2.8). In this context,

households are paid with a markup over their marginal productivity.

$$l_t^i(\tau) = \left(\frac{w_t^i(\tau)}{W_t^i} \right)^{-\theta_w^i} \frac{L_t^i}{n^i \mathbb{N}} \tag{2.8}$$

In addition, wage stickiness introduced through a Calvo wage setting, each households resetting its wage with an exogenous probability $(1 - \xi_w^i)$.

Linearising the first order conditions around the steady state yields the following wage Phillips curve, with $X \in \{R, NR\}$:

$$\begin{aligned}
&\widehat{RW}_t^{X,i} - \widehat{RW}_{t-1}^{X,i} + (\hat{\Pi}_t^{c,i} - \gamma_w^i \hat{\Pi}_{t-1}^{c,i}) = \\
&\tilde{\beta}^i (1+g) \left(\widehat{RW}_{t+1}^{X,i} - \widehat{RW}_t^{X,i} + \left(\hat{\Pi}_{t+1}^{c,i} - \gamma_w^i \hat{\Pi}_t^{c,i} \right) \right) \\
&+ \frac{(1 - \tilde{\beta}^i \xi_w^i (1+g))(1-\xi_w^i)}{\xi_w^i (1 + \theta_w^i ((1+\sigma_l^i)(1+\mathcal{B}^{X,i}) - 1))} \left[-\widehat{RW}_t^{X,i} - \hat{L}_t^{X,i} + (1+\sigma_l^i)(1+\mathcal{B}^{X,i})(\hat{L}_t^{X,i} - h_l^i \hat{L}_{t-1}^i) + \hat{C}_t^{X,i} \right].
\end{aligned} \tag{2.9}$$

with $\mathcal{B}^{X,i}$ a function of the parameters of the model depending on the household's type, $\tilde{\beta}^i$ a function of β^i, g the exogenous growth rate of TFP, θ_w^i the elasticity of labour demand to wages. RW_t^i corresponds to the real wage defined as $W_t^i / CPI_t^i (1 + \nu_t^{c,i})$.

As the consumption of *Ricardian* and *non Ricardian* households differ, two symmetric Phillips curves for two different wages coexist.

2.2 Firms

Demand for production factors

Firms produce partially substitutable goods from labour and capital. They hire domestic labour at cost $W_t^i(1 + \nu_t^{w,i})$, $\nu_t^{w,i}$ being the payroll tax rate. Firms hire both types of households indistinctly. In addition, firms rent capital $K_t^{d,i}(\varepsilon)$ from households at cost $r^{k,i}$[3]. We assume installation delays so that at market equilibrium and on aggregate $K_t^{d,i} = K_{t-1}^i$.

[3]The price of capital is by construction the same as investment, which is identical to the price of consumption as we assume that both goods are identical. This is also equivalent to assume a perfectly competitive investment good sector with a one-to-one technology from consumption goods to investment goods. This implies that in nominal the cost of capital equals $r_t^{k,i} K_t^{d,i}(\varepsilon) CPI_t^i$.

Each firm ε produces $y_t^i(\varepsilon)$ from a standard constant returns to scale production function :

$$y_t^i(\varepsilon) = \left(\zeta_t^i L_t^i(\varepsilon)\right)^{1-\alpha} \left(K_t^{d,i}(\varepsilon)\right)^{\alpha} \tag{2.10}$$

$$\text{with cost } W_t^i(1+\nu_t^{w,i})L_t^i(\varepsilon) + r_t^{k,i} CPI_t^i K_t^{d,i}(\varepsilon), \tag{2.11}$$

where ζ^i is the exogenous total factor productivity in country i and α is the share of capital in value added. The arbitrage condition between labour and capital demand yields:

$$\frac{1-\alpha}{\alpha} = \frac{W_t^i(1+\nu_t^{w,i})L_t^i(\varepsilon)}{r_t^{k,i}K_t^{d,i}(\varepsilon)CPI_t^i} \quad \text{and on aggregate} \quad \frac{1-\alpha}{\alpha} = \frac{W_t^i(1+\nu_t^{w,i})L_t^i}{r_t^{k,i}K_{t-1}^i CPI_t^i} \tag{2.12}$$

Price setting

Partial substitutability allows firm to price a markup over their marginal cost. We assume a *Calvo* price setting. Firm ε reset its price $\tilde{P}_t^i(\varepsilon)$ with an exogenous probability $(1-\xi_i)$ and maximises its expected profit until the next price setting possibility, subject to the production factor optimization, the production function, as well as the demand function (Equation 2.13) and a price indexation rule.[4]

$$y_t^i(\varepsilon) = \left(\frac{p_t^i(\varepsilon)}{P_t^i}\right)^{-\theta^i} \frac{Y_t^i}{p^i \mathbb{P}} \tag{2.13}$$

After linearisation of the first order condition, we obtain a standard New-Keynesian price Phillips curve:

$$\hat{\Pi}_t^i - \gamma^i \hat{\Pi}_{t-1}^i = \tilde{\beta}^i(1+g)\left(\hat{\Pi}_{t+1}^i - \gamma^i \hat{\Pi}_t^i\right) + \frac{(1-\tilde{\beta}^i\xi^i(1+g))(1-\xi^i)}{\xi^i}\widehat{RMC}_t^i \tag{2.14}$$

where inflation depends positively on past indexed inflation, future anticipated inflation, relative prices and wages, taxes, total output in country i and negatively on productivity shocks through the real marginal cost of production.

2.3 Fiscal Authorities

In MELEZE, we introduce public expenditure in the utility function which calls for an optimizing behaviour of the government inspired by a simplified version of the Ramsey policy: the government maximizes the utility derived by households from public spending subject to its transfers/tax revenues budget constraint.

[4] This price indexation is necessary in a model with steady state inflation

In the absence of public production or employment in the model, we capture all dimensions of public intervention (provision of public goods, individualized consumption, etc.) through public expenditures. We assume that government expenditure is persistent (the welfare state cannot be dramatically reshaped overnight).

Under the reasonable assumption that the government cannot distinguish households within the same sub-group, the objective of the government writes:

$$\max_{G_T^i, PA_T^i} E_t \sum_{T=t}^{\infty} {\beta_g^i}^{T-t} \mathcal{W}(G_T^i, G_{T-1}^i) \Omega_T(C_T^{R,i}, C_T^{NR,i}, C_{T-1}^i, L_T^{R,i}, L_T^{NR,i}, L_{T-1}^i) \tag{2.15}$$

$$\text{with } \mathcal{W}(G_T^i, G_{T-1}^i) = \left(G_t^i \left(G_{t-1}^i \right)^{-h_g^i} \right)^{\eta(1-\sigma_c^i)} \tag{2.16}$$

$$\begin{aligned} \text{s.t. } PA_t^i = (R_{t-1} - \psi^g(\frac{PA_{t-1}^i}{P_{t-1}^i \bar{Y}^i Tr_{t-1}}))PA_{t-1}^i + \nu_t^{w,i} W_t^i L_t^i + \nu_t^{k,i} r_t^{k,i} CPI_t^i K_{t-1}^i \\ + \nu_t^{c,i} CPI_t^i (C_t^i + I_t^i) + \nu_t^{D,i} D_t^i + \nu_t^{FD,i} FD_t^i - P_t^i G_t^i - \Phi_t^i. \end{aligned} \tag{2.17}$$

where Ω_T denotes a weighted average between the two types of households utility from consumption and labour supply. PA_t^i denotes the nominal public assets of country i at the end of period t, and Φ_t^i are nominal transfers to households.

The discount factor of the government need not be equal to that of households. On the one hand, the government, as an institution, is longer lived than its citizens and for this reason could put a higher weight on future utility than households do. On the other hand, as political entities aimed at satisfying voters and wining elections, governments may also put a higher weight on the near future.

The previous program yields the following Euler equation for government consumption,

$$E_t \beta_g^i \frac{\mathcal{W}_{1,t+1}\Omega_{t+1} + \beta_g^i E_{t+1} \mathcal{W}_{2,t+2}\Omega_{t+2}}{\mathcal{W}_{1,t}\Omega_t + \beta_g^i E_t \mathcal{W}_{2,t+1}\Omega_{t+1}} \frac{R_t - \psi^g\left(pa_t^i\right) - pa_t^i \psi^{g'}\left(pa_t^i\right)}{\Pi_{t+1}^i} = 1 \tag{2.18}$$

The real interest rate for governments differs from that of households because their consumptions are priced differently, governments buying exclusively domestic production. Also the atomicity hypothesis made for households relative to the asset market does not hold for governments and their debt premium may differ (ψ versus ψ^g).

As an alternative to this choice of modelling, we also implement a standard budget rule adjusting government expenditures in accordance to a debt target to ensure the long-run solvability of the

government. This budget rule is adapted from (Corsetti et al., 2010) and is as follows:

$$G_t^i = (1 - \Psi_{gg})\bar{G}^i + \Psi_{gg} G_{t-1}^i + \Psi_{gy}(Y_{t-1}^i - \bar{Y}^i) + \Psi_{gd}\frac{PA_t^i}{P_t^i} + \varepsilon_{g,t}^i \tag{2.19}$$

where $\bar{Y}^i$ denotes the steady state level of output. Depending on the sign of Ψ_{gy}, this rule can be pro-, contra- or a-cyclical.

2.4 Central bank

The central bank sets the nominal interest rate R_t common to both countries through a Taylor rule (Taylor, 1993), where it reacts smoothly to both inflation of the consumption price index and to the output gap.

$$R_t = R_{t-1}^{\rho}\left(R^*\left(\frac{\Pi_t^{union}}{\Pi^*}\right)^{r_\pi}\left(Y_t^{union}\right)^{r_y}\right)^{1-\rho} \tag{2.20}$$

3 Steady state and calibration

In the present model, growth is exogenous. In the long run, all real variables grow at the same rate, that of TFP common to both countries. At steady state, we assume that inflation equals the central bank's target, which induce that all prices grow at the steady state inflation rate. The law of one price holds (each individual good as the same price in both countries), however, domestic biases in preferences induce aggregate price distortions at steady state and within the cycle so that the terms of trade do not equalize to one. A full description of the steady state, the associated relationships and the calibration is given in the companion paper (Campagne and Poissonnier, 2015).

Carefully taking into account all steady state relationships between variables, we calibrate the model as to match the standard literature on DSGEs[5] for structural parameters and National Accouting data for endogenous variables. In particular, we model the situation of France in the Euro area. Tables 1 and 2 presents actual data for France and the Euro Area and their corresponding values at steady state, along with the values of the corresponding structural parameters.

The specific calibration of the share of *non Ricardian* agents μ^i, the share of imports in private consumption α^i and the specification of the households' utility (σ_c^i and σ_l^i) is discussed in the subsequent sections when testing for the sensitivity of the model to these parameters.

[5](Trabandt and Uhlig, 2011),(Roeger et al., 2008), (Martin and Philippon, 2014), (Smets and Wouters, 2002), (Annicchiarico et al., 2013), (Vogel, 2012), (Coenen et al., 2012), (Eggertsson et al., 2014), (Ratto et al., 2009), (Everaert and Schule, 2008), (Bayoumi et al., 2004), (Hø j et al., 2007), (Kaplan et al., 2014), (Bussiere et al., 2011), European Commission's Quest III R&D model for France

	DATA		MELEZE	
	EA (12) - FR	FR	EA (12) - FR	FR
Output in 2000 (GDP)*	5458	1485	5332	1470
Output in 2000 (Value added)*	4901	1333		
Output in 2000 (VA excl Financial)*	4656	1278	4651	1278
Output per capita average growth rate**	1.12%	1.46%	1.2%	1.2%
Working age population in 2000 ***	110,3	25,7	110,3	25,7
Hours worked per week and working age capita (since 2000)	34.5	34.3	31.9	36.5
Gross Op. Surplus to VA	48%	40%	46%	46%
GOS (non financial) to VA	49%	40%		
Gross wages to VA	52%	57%	54%	54%
Gross wages (non financial) to VA	51%	56%		
Nominal 3 month Euribor**	3.8%	-	4.0%	4.0%
Inflation (CPI)**	2.0%	1.6%	2.0%	2.0%
Inflation (GDP deflator)**	1.8%	1.5%		
Private consumption to GDP ratio	57%	55%	58%	58%
Public consumption to GDP ratio	19%	23%	22%	23%
Investment to GDP ratio	22%	21%	20%	19%
GFCF to Capital ratio	-	7.42%	9%	9%
Trade balance	2%	1%	0%	0%
Imports from Euro area partner (relative to France GDP)	12%	12%	12%	12%
PPP (GDP, since 2002)	1.00	1.07	1.00	1.07
PPP (CPI, since 2003)	1.00	1.06	1.00	1.05
Public debt	-51%	-37%	-51%	-37%
Private assets (S14+S15)**	129%	130%		
including firms (S1-S13)**	34%	41%	50%	41%
Net financial position (S2)**	17%	-3%	1%	-3%
Tax revenue	40%	44%	37%	40%
Implicit tax rate on consumption	20%	20%	20%	20%
Consumption tax income	11%	11%	13%	13%
Implicit tax rate on labour	38%	39%	38%	39%
Labour tax income	21%	22%	18%	18%
Capital tax income	8%	10%	7%	8%
Transfers	16%	17%	17%	19%

Sources: Eurostat (National accounts, inflations, Euribor, PPP, population, Labour Force Survey -incl. Secondary job), Insee (Capital Stock Accounts)
Data are averaged from 1995 to 2007 to exclude the crisis. Depending on availability, samples may start after 1995.
* in billion € in current prices
** annualised
*** aged from 15 to 64 in millions

Table 1: Actual data for France and the Euro Area and the corresponding values at steady state with our calibration

Structural parameters

	France	Eurozone	
Union-wide			
α	-	0.35	Consensus, ANA
δ	-	0.02	Consensus
S	-	6	(Smets and Wouters, 2002)
$\mathbb{N}$	-	135 922 100	ANA
g	-	0.003	ANA,(Coenen et al., 2012)
Monetary policy			
Π^*	-	1.005	Consensus, ECB
ρ	-	0.86	(Barthélemy et al., 2009)
r_π	-	1.6	-
r_y	-	0.16	-
National specific			
n^i	0.19	0.81	ANA
α^i	0.15	0.04	ANA
θ^i	6	6	Quest III
θ^i_w	4	4	(Smets and Wouters, 2002), GEM, QuestIII
ζ^i	0.1112	0.1119	ANA, GDP target
κ^i	2.77	3.30	ANA, Hours worked target
β^i	1.0002	1.0003	ANA, Debt to GDP target
β^i_g	0.998	0.997	-
σ^i_c	2	2	(Trabandt and Uhlig, 2011)
σ^i_l	1.19	1.19	(Smets and Wouters, 2002)
η^i	0.2	0.2	see *infra*.
h^i_c	0.56	0.56	(Smets and Wouters, 2002), NAWM, OECD Fiscal
h^i_l	0.5	0.5	-
h^i_g	0.56	0.56	-
μ^i	0.4	0.4	QuestIII, (Martin and Philippon, 2014)
ξ^i	0.66	0.66	(Smets and Wouters, 2002)
ξ^i_w	0.75	0.75	-
γ^i_p	0.43	0.43	-
γ^i_w	0.65	0.65	-
ψ_{slope}	0.0005	0.0005	Authors
ψ^g_{slope}	0.0005	0.0005	Authors
Fiscal policy			
$\bar{\nu}^{c,i}$	20.3%	19.5%	Eurostat
$\bar{\nu}^{w,i}$	39.1%	37.7%	Eurostat
$\bar{\nu}^{k,i}$	21.0%	17.0%	Eurostat
$\bar{\Phi}^i$	19.4%	17.4%	Eurostat

ANA stands for Annual National Accounting data. For France, data are from the Insee, whereas international comparison within the Eurozone is conducted based on Eurostat data.
Consensus indicates a value close to a large number of standard DSGE models.

Table 2: Structural parameters

4 Structural reforms in goods and labour markets

In this section, we focus on a first standard exercise in the DSGE literature, namely structural reforms in both goods and labour markets. The sign of production gains associated to structural reforms aimed at deregulating markets is unambiguously positive in the long run. However, the transition may be costly either in terms of output or utility. In addition the quantification of these gains is very sensitive to the specification of the households' utility and the share of *non Ricardian* agents, all parameters being crucial for the dynamics of the model and being weakly identified or estimated in empirical work.

As an introductory warning, it is important to keep in mind that our model does not integrate effects such as endogenous growth driven by innovations. As a result, it will always be optimum to decrease mark-ups to zero to reach perfect competition. In reality, and for instance in endogenous growth models such as (Romer, 1990), mark-ups and monopolistic powers may be necessary to allow and stimulate innovation and growth.

4.1 Assessing the impact of structural reforms

4.1.1 Qualitative insights on structural reforms

The existence of monopolistic labour and goods markets give rise to market powers (related to the degree of competition) and discrepancies (ie. mark-ups) between prices and the associated cost of production, as well as between wages and the underlying marginal desutility.

Both these mark-ups on the labour and good prices are distorsive and detrimental to the economy and in particular to the steady state level of output. In the light of five years of quasi economic stagnation, governments and international institutions plead for more flexibility and an increased competition. Intuitively, as the economy moves towards perfect competition, that is when goods and labours are more substitutable ($\theta^i \to \infty$ or $\theta^i_w \to \infty$), production increases as monopolistic inefficiencies disappear. However, structural reforms have differentiated effects whether they are implemented on the goods or labour market (Blanchard and Giavazzi, 2003). To understand the mechanisms at stake, we first simulate both types of reforms in a simplified version of our model presented in the Appendix A. This simplified version consists of a closed economy with purely *Ricardian* households, no government, no financial assets, no habit formation and no growth. Indeed, these different elements can crucially impact the gains from structural reforms (and in particular trade openness) but are not the fundamental source of production gains. Figure 1 and 2 present the transition of the economy following a permanent decrease of 10 p.p. of respectively the price and wage mark-ups. Deregulation leads in general to increases in consumption, investment, labour supply and therefore production.

Deregulation on the goods market - Figure 1 Increasing competition on the goods market ($\theta^i \uparrow$ or price markup $= \theta^i/(\theta^i - 1) \downarrow$) induces a change in the distribution of production factors remuneration (see Figure 3). As θ^i increases, the share of profits in production mechanically diminishes, and the shares paid to capital and labour increase, stirring up the production cost both in the short and long term (however sluggishly for real wages due to the Calvo process). The ensuing increase in the real marginal cost creates inflation through the price Phillips curve and the nominal interest rate reacts accordingly. Due to a no-arbitrage condition, this increase in the nominal interest rate also sustains the increase in the return on capital.

In turn, this increase in the return to capital modifies the consumption-leisure-investment arbitrage of households through a mix of substitution and wealth effects, consequence of the particular choice of the utility function as well as its calibration. In all, investment immediately increase upon reform to take advantage of this favourable return on capital, labour supply also increases in response to increased real wages. So does consumption today due to a wealth effect.

Eventually, the return on capital returns to steady state (unchanged by the reform) as the nominal interest rate returns to its initial steady state as well (no arbitrage condition). The long term increase in the real marginal cost therefore fully passes through to real wages. In all, production increases permanently due to both an increase in investment (that is capital) during the transition and to increased real wages and labour supply.

Deregulation on the labour market - Figure 2 Following an increase in competition on the labour market ($\theta^i_w \uparrow$ or wage markup $= \theta^i_w/(\theta^i_w - 1) \downarrow$), labour demand from firms increases as wages sluggishly adjust downwards. Through firms' arbitrage between production factors, upward pressure on the labour market passes on to the capital market: first the price (return on capital) adjusts upwards and, with delay, the capital quantity follows as capital is a stock variable.

In all the real marginal cost increases slightly (Equation A.4), generating inflation and a positive reaction of the nominal interest rate. This increase also persistently sustains the return on capital. As for reforms on the goods market, the increase in r^k modifies the consumption-leisure-capital trade-off and leads to an increase in labour supply, consumption, investment, and therefore production.

In the long run, and as in the previous reform case, the nominal interest rate returns to the initial steady state as inflation converges to the central banker's target. The return on capital follows (no arbitrage condition). Eventually the adjustment of prices offsets the drop of wages so that the real wage returns to the initial steady state as well (as there has been no change in the repartition of production between profits and production factors, Figure 3).

Note that the increase in consumption is stronger than the one for goods market reforms. This difference is attributed to the strong and permanent decline in dividends following a decrease in the price mark-up and mechanically in the firms' profits. Also, contrary to price mark-up reforms, the increase in labour supply leads to a temporary decrease in wages, as there is no compensation through a higher share of production paid to factors of production.

4.1.2 Quantitative simulations in the fully-fledged model *MELEZE*

Numerically in the fully specified model, we perform labour and goods markets reforms for a broad range of mark-ups, and compare these results to the reform scenarios proposed by (Everaert and Schule, 2006). They simulate deregulation reforms by considering an increase in competition in France up to the average level of the three best European performers, being Denmark, Sweden and the United Kingdom.

In their calibrations of the IMF's GEM model (Bayoumi et al., 2004), the French mark-up on wages (resp. on tradables) is initially at 35% (resp. 21%), against 33% (resp. 20%) in our model. The post-reform target corresponds to a 13% mark-up on labour and a 14% mark-up on tradables (see Table 3).

	Labour		Goods	
	MELEZE	*E. & S.*	*MELEZE*	*E. & S.*
Initial	33%	35%	20%	21%
Post-reform	13%		14%	

E. & S. stands for (Everaert and Schule, 2006) calibration.

Table 3: Pre- and post-reforms mark-ups on labour and good markets

Figures 14 and 15 highlight the transitional dynamics in the particular case of Everaert and Schule's reforms, whereas Figures 12 and 13 in the appendix present the long-term response of a few macroeconomic variables for France following these reforms. Indeed, as in the simplified model, deregulating markets leads to a permanent increases in investment and labour supply fostering production. Therefore additional channels such as the openness of the economy, the presence of habits, etc, do not modify the sign of gains, yet they influence their magnitudes.

Reforms in an open economy First, structural reforms, in addition to increasing production in both countries also induce an increase in the size of the domestic country relative to the foreign country. That is these reforms in France benefits to the rest of the Eurozone (see Figures 14 and 15) but to a relatively small extent.

Most importantly, trade openness allows for a temporary inflation differential. Inflation relatively to the rest of the Euro area allows for lasting appreciation in the terms of trade and a resulting gain

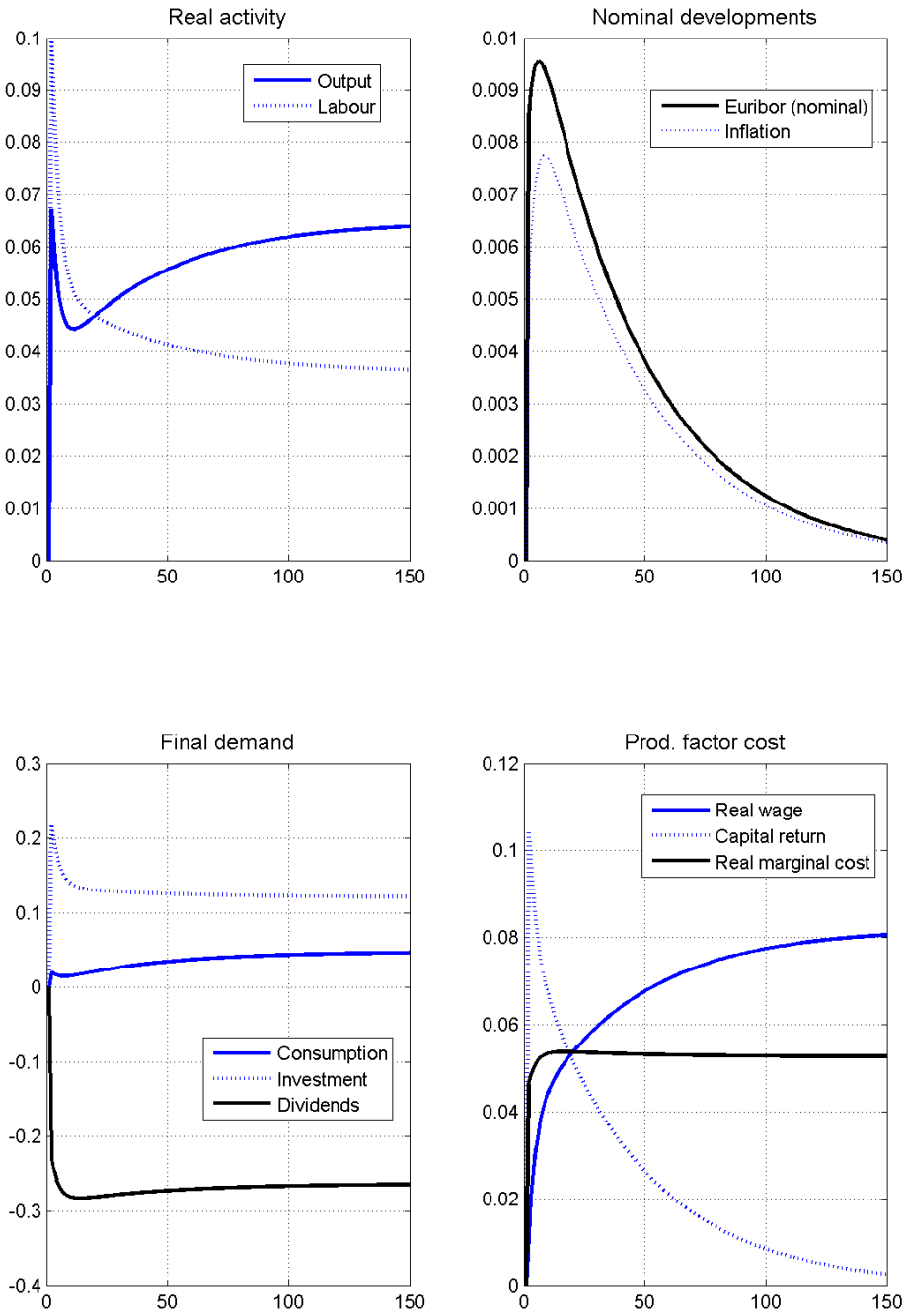


Figure 1: Transition following a 10 p.p. decrease in the price markup - stylized model

These transitions are simulated in stylized version of *MELEZE* to highlight the key mechanism at work for structural reforms. This corresponds to a closed economy version of the model, with no *non Ricardian* agents, no habit formation, no financial markets, no government and no growth. Concretely, with the previous notations $\alpha^i, h_c^i, h_l^i, \nu^{c,i}, \nu^{k,i}, \nu^{w,i}, \Phi^i, pa^i, fa^i, \mu^i, \eta^i, g, \Psi^i, \Psi^g$ are set to 0, and $n = 1$.

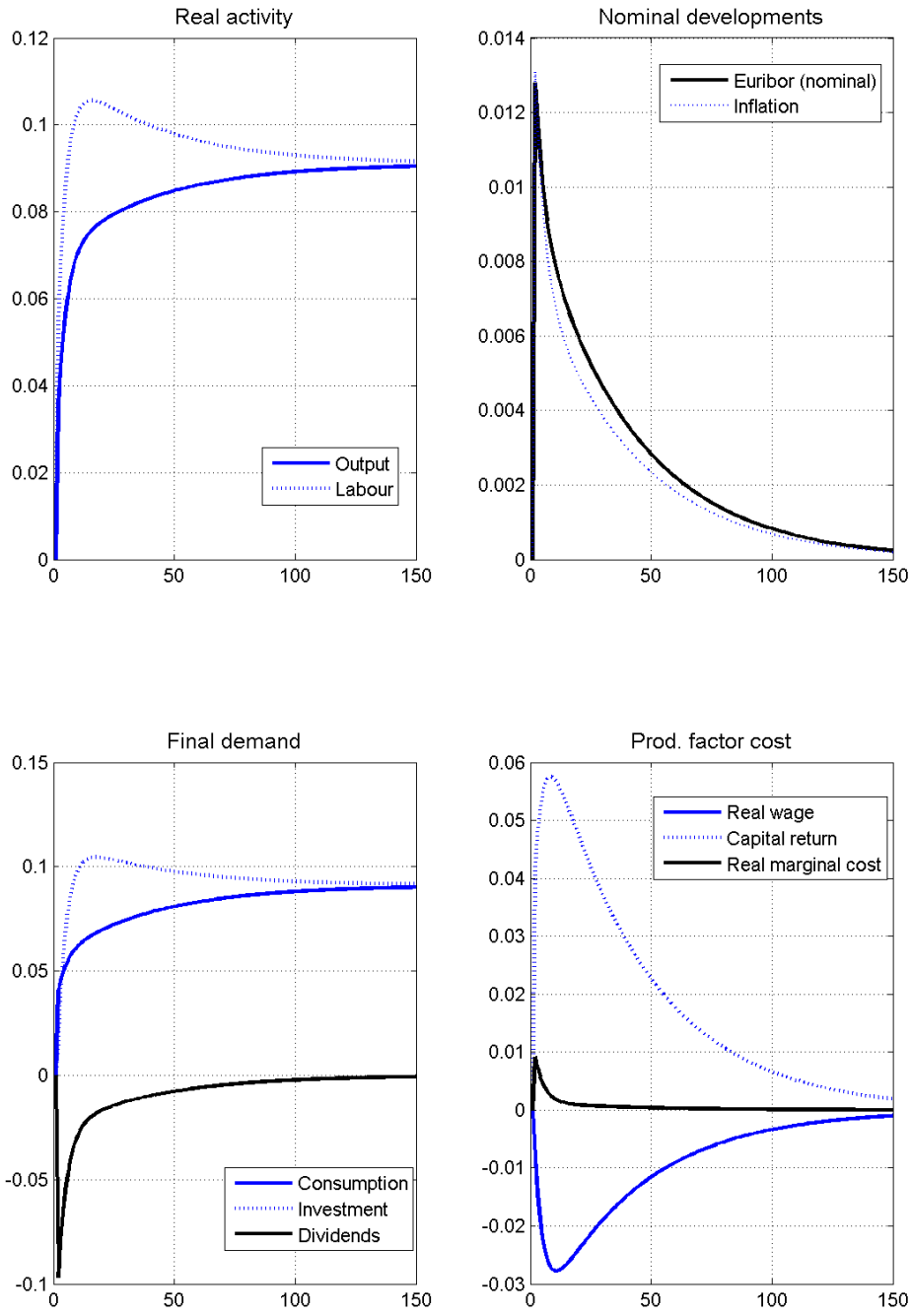


Figure 2: Transition following a permanent 10 p.p. decrease in the wage markup - stylized model

These transitions are simulated in stylized version of *MELEZE* to highlight the key mechanism at work for structural reforms. This corresponds to a closed economy version of the model, with no *non Ricardian* agents, no habit formation, no financial markets, no government and no growth. Concretely, with the previous notations $\alpha^i, h_c^i, h_l^i, \nu^{c,i}, \nu^{k,i}, \nu^{w,i}, \Phi^i, pa^i, fa^i, \mu^i, \eta^i, g, \Psi^i, \Psi^g$ are set to 0, and $n = 1$.

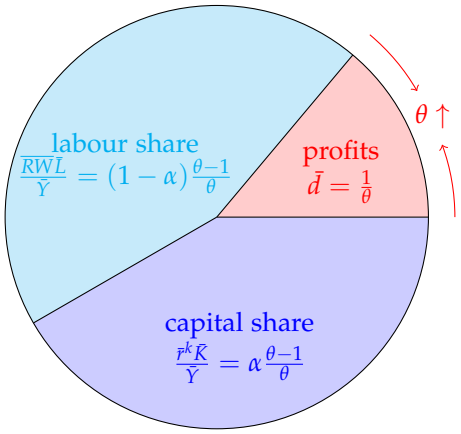


Figure 3: Decomposition of production

in competitiveness. Otherwise, the core mechanisms are the same as in the simplified closed economy model.

For a wage mark-up reform, the appreciation in the terms of trade implies a permanent decrease in real wages. Indeed, real wages are expressed relative to the price of consumption of households that is a compound of both domestic and foreign prices. As nominal wages decrease upon reform, the domestic cost of production decreases more than the price of consumption. As a result, the relative price of consumption increases and so do real wages. As in the closed economy case, the capital return as well as the real marginal cost (in real terms with respect to domestic production prices) goes back to their initial level.

Transitions support Blanchard and Giavazzi's prescription of a simultaneous conduct of goods and labour markets reforms to improve political and social implementability. Indeed, reforming the labour market induces a permanent fall in real wages whereas an increase in goods competition has the opposite effect.

Numerical results Numerically (see Table 4), decreasing the price (resp. wage) mark-up by 6 p.p. (resp 20 p.p.) as (Everaert and Schule, 2006) leads to gains in production of 11.3 p.p. (resp. 17.1 p.p.), as well as an increase in production shares in the monetary union. Figure 12 shows that these gains remain sizeable even for smaller decrease in the mark-ups. In comparison, Everaert and Schule obtain gains in production of 1.6 p.p (resp. 6.1 p.p) for goods (resp. labour) market reforms.

Therefore at first sight, we obtain results of the same sign but of larger magnitude. However, directly

Targeted market	Production	Consumption	Labour	Investment
MELEZE				
Labour	17.1	14.4	18.6	14.4
Goods	11.3	7.0	9.2	15.5
Everaert & Schule				
Labour	6.1	6.1	6.7	5.9
Goods	1.6	1.3	1.4	4.9

Markups are reduced following Everaert and Schule's reforms (see. Table 3).

Table 4: Long-run effects of increased competition on the labour and goods markets (in % deviation from the initial level)

comparing these results might be partially misleading. Actually, our model remains a synthetic DSGE model and additional rigidities are often incorporated in larger DSGE models, leading to a differentiated impact of a decrease in mark-ups. Moreover, as tradable goods account for the whole production in *MELEZE* (no service/non-tradables), for an identical decrease in mark-ups, the effects of a market deregulation will therefore be amplified in *MELEZE* and might explain part of the observed differences. Indeed, Everaert and Schule show that mark-up reforms induce stronger effects if implemented in the service sector.

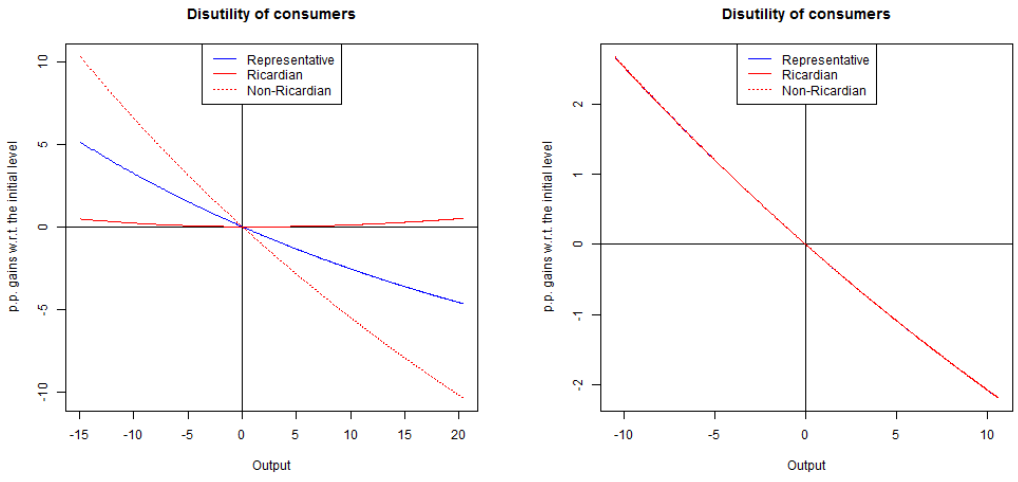
Section 4.2 gives a deeper exploration of these significant differences across models.

Utility and inequalities between households The introduction of heterogeneous households allows to study the effect of deregulation on inequalities. The right column of Figure 13 presents *Ricardian* to *non Ricardian* ratios for consumption, labour and real wages (respectively 2.00, 1.20. and 1.06 at steady state).

Deregulating the product market leads to a decrease in consumption: as firms' profit shrinks so does *Ricardian* households received dividends. As a result the increase in consumption for *Ricardian* households comes at a slower pace than for *non Ricardian* agents. Conversely, reforming the labour market leaves firms' profits untouched, consumption increases in the same fashion for both types of households and inequalities stagnate (up to the small trade openness effect). Deregulation on both markets also leads to a decrease in wages inequalities.

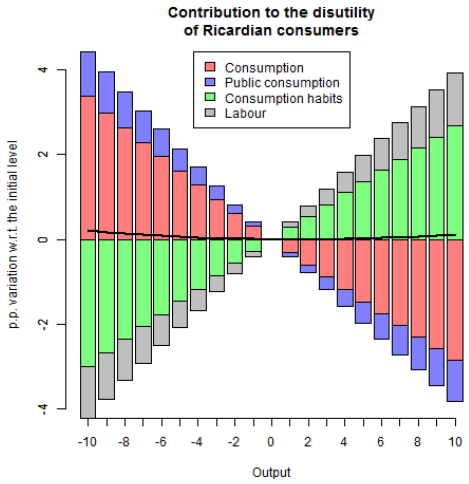
In addition, Figure 4 presents the variation in the steady state disutility of agents[6] following a markup reform (indexed by the induced variations in production), as well as the contribution of each variable to this disutility: namely personal consumption, consumption habits, government consumption,

[6]This choice is implied by the negativity of the steady state utility level due to the particular calibration of $\sigma_c^i > 1$. In this case, a negative growth rate of utility indicates a lesser negative utility level, that is an improvement in utility. As such, an interpretation in terms of disutility is more convenient and intuitive to interpret the graphs.

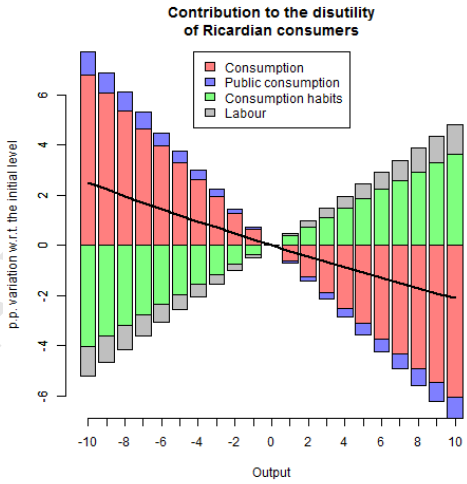


(a) Goods market reform

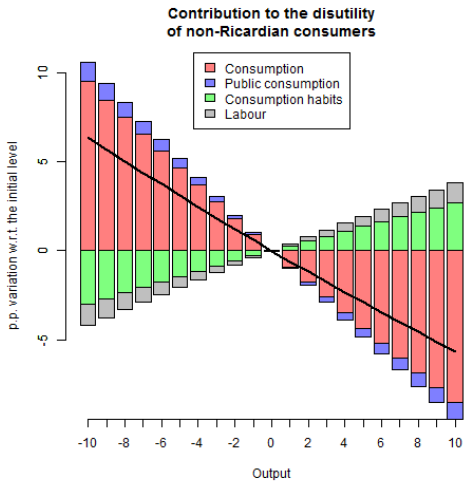
(b) Labour market reform



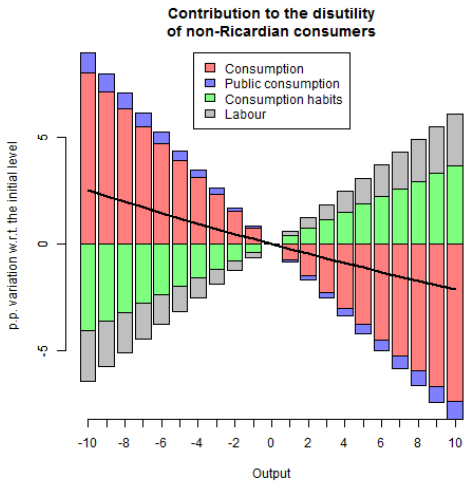
(c) Goods market reform



(d) Labour market reform



(e) Goods market reform



(f) Labour market reform

Structural reforms are implemented for a markup range from 10% to 30% (θ^i from 4.33 to 11) for goods market reforms and 20% to 50% (θ^i_w from 3 to 6) for labour market reforms. To ease the policy interpretation of utility, we index the graphs on the X-axis with the p.p. gains in production induced by the reform.
These graphs represent the disutility of households. Therefore a decrease in the disutility is beneficial to the household. Similarly, a negative contribution to disutility implies a positive contribution to utility.

Figure 4: Steady state disutility level of agents upon structural reforms in p.p. with respect to the standard calibration

and labour. Note that due to the non-separable (and non-linear) form of the utility function, as well as to ease representation, both labour and public consumption are treated as a whole with no distinction of habits.

A few features appear. First, the aggregate disutility level decreases (the utility therefore increases) with output gains for both type of reforms. Therefore, at least in the long term the economic desirability of an increased output goes along with an increased utility. Second, whereas this improved aggregate utility is undifferentiated across households in the case of labour market reforms (Figure 4b), it does hide a loss in utility for Ricardian households when goods market are deregulated (Figure 4a). This relates to the previous remark on dividends paid by non-financial firms to Ricardian households only.

Decomposing disutility allows to see that the main drivers of utility are private consumption and consumption habits, labour and public consumption playing a minor role. Moreover, the relative size of Ricardian households in the population allows to understand the dynamics of consumption habits (formed on the aggregate consumption level). In particular, the larger increase in the disutility of consumption habit for Ricardian households relative to non-Ricardian households is responsible for the observed decrease in utility for Ricadian agents following an important price markup reform.

Lastly, Figure 16 in the Appendix presents the response of the instantaneous utility for markup reforms as conducted in (Everaert and Schule, 2006), and allows to stress that even though they could be utility gains in the long-term, the transitional dynamics can be detrimental. This case only arise here for Ricardian households for wage markup reforms with a transitory increase in disutility. Therefore, and as highlighted in (Blanchard and Giavazzi, 2003), the political and social implementability of structural reforms also need to take a deep look at transitional dynamics.

More generally, these transitions bring us back to the concept of utility itself. Indeed, labour leads to disutility, and therefore, *ceteris paribus*, the less the households will work, the happier it will be. As such, real wages do not directly impact the utility level, they do only through their impact on labour supply. Hence, and for instance in the case of a labour market deregulation, (most) households will instantaneously enjoy an increase in utility as defined here. However, one should be particularly cautious about a real world policy translation of this result, as immediately decreasing real wages can push households to fight the reform.

4.2 A sensitivity analysis to structural reforms

Even though the impact of deregulation in *MELEZE* might not be directly comparable with results obtained by Everaert and Schule, the observed differences still call out for further investigations. Hence, we now turn to a detailed sensitivity analysis of the magnitude of these gains to trade openness, the

specification of the households' utility and the share of *non Ricardian* agents.

4.2.1 Trade openness

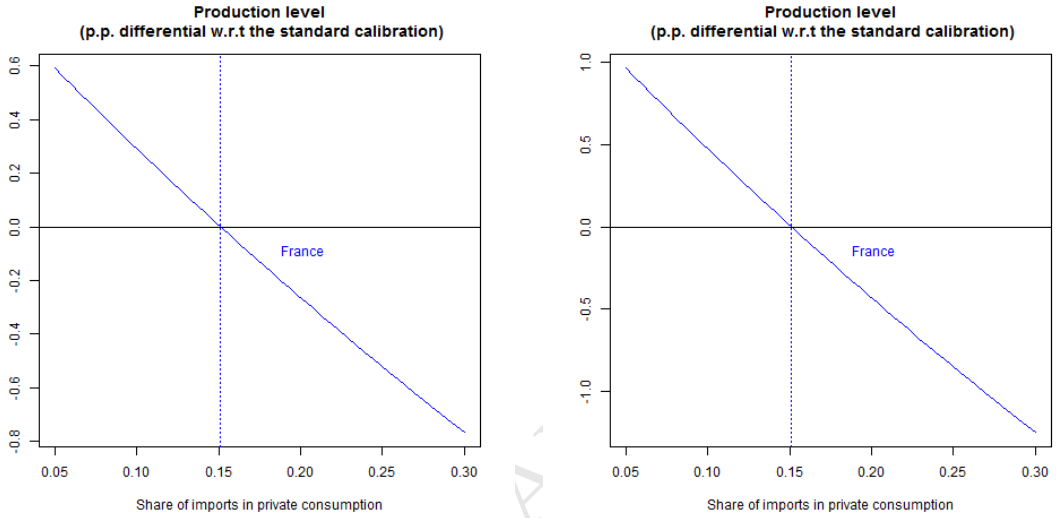
A first parameter likely to noticeably change the impact of structural reforms is trade openness. As shown above, even though the main mechanisms remain the same between a closed and open economy model, some variables are strongly affected by trade and and this was in particular the case for real wages. The key parameter governing trade openness in our model is the share of imports in private consumption and investment α^i.

In *MELEZE*, this share is calibrated to 12% for France taking only into account the within-eurozone trade, close to (Eggertsson et al., 2014) with a share of 15% under the same definition, or close to Bayesian estimated models for the Eurozone such as Quest III (Vogel, 2012). Enlarging to take into account all European Union trade gives a share of 20%, and 32% if adding world trade. Using more detailed OECD Input-Output data, (Bussiere et al., 2011) estimate this share to be 12%, or 23% when integrating the indirect import content of private consumption. In all, α^i can largely vary depending on the range of import considered or the methodology used.

As presented on Figure 5, the relationship between the differential impact of structural reforms with the share of imports in private consumption is relatively linear. In particular, for a 5 p.p. variation in the share of import can account for a differential impact of deregulation of up to 0.2 p.p. in the case of price deregulation and 0.5 p.p. for labour market reforms. In particular, the less opened the economy, the stronger the impact of structural reforms.

Indeed, as mentioned before, for a permanent decrease in the wage markup we observe a permanent long-term decrease in real wages as trade openness increases, stemming from a discrepancy between domestic production prices and consumption prices. This decrease affect households' revenues and therefore mitigates the gain in production through a relatively lower consumption.

Similarly, for goods market reforms, for a more opened economy, deregulation leads to a stronger improvement in the terms of trade, that is also an increase in the relative price of consumption. As real wages are inversely related to this relative price of consumption, a stronger terms of trade improvement leads to lower real wages. As such, the more opened the economy, the weaker the gains in real wages stemming from the change in the distribution of production (as explained above), and the weaker the gains in consumption and output.



(a) Goods market reform

(b) Labour market reform

Trade openness is defined here as the share of imports in private consumption (ie α^1 in our model).
Structural reforms implemented here are the ones of Everaert and Schule (see Table 3. As a result and for instance, a 0.5 p.p. impact differential for a goods market reform translates into a total gain in production of $0.5 + 11.3 = 11.8$ p.p. (see. Table 4 for the baseline case).

Figure 5: *MELEZE* - Impact differential of structural reforms in p.p. with respect to the standard calibration depending on trade openness

4.2.2 Specification of households' utility

A second crucial source of differences across models is the specification of households' utility. For instance, the IMF's model is based on the calibration $\sigma_c = 3$ for the inverse intertemporal elasticity of substitution of consumption and $\sigma_l = 3$ for the inverse Frisch elasticity, whereas our calibration is $\sigma_c = 2$ and $\sigma_l = 1.2$.

As highlighted in (Everaert and Schule, 2006), the estimation and identification of these two parameters, and in particular the (Frisch) elasticity of labour supply, is very sensitive to the methodology (micro or macro) and the sample considered. As a result, it is important to have a critical eye on the results with respect to these parameters.

(Trabandt and Uhlig, 2011) calibrate their model to an inverse Frisch elasticity of $\sigma_l = 1$ in line with (Kimball and Shapiro, 2008). They also consider an alternative based on (Cooley and Prescott, 1995) with $\sigma_l = 0.33$. These values are in line with the business cycle literature and close to values estimated by Bayesian methods, as for instance in (Smets and Wouters, 2002) with $\sigma_l = 1.2$. However, micro and macro evidences are not easily reconciled and lead to very different values of the Frisch elasticity. (Bayoumi et al., 2004) mention that micro studies give a range for σ_l from 3 to as large as 20. In alternative scenarios for the GEM model, (Bayoumi et al., 2004; Everaert and Schule, 2006) set $\sigma_l = 6$ or 7.

For the inverse of the intertemporal elasticity of consumption σ_c, the debate is less fierce and values range from 0.5 in (Bayoumi et al., 2004) to 2 as in (Trabandt and Uhlig, 2011).

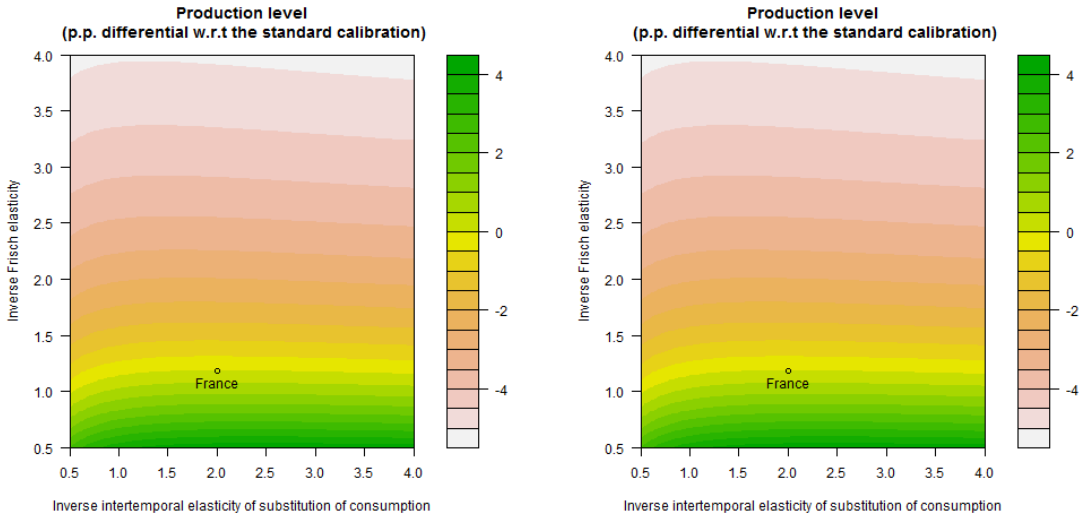
Intuitively, we can expect weaker effects of reforms following an increase in both the inverse of the intertemporal elasticity of consumption and the inverse of the Frisch elasticity, as they go in the same direction of more "rigid" households. Actually, as σ_c increases, the intertemporal risk aversion increases and agents should more strongly smooth their consumption across periods. Similarly, as σ_l increases, labour supply is more rigid and should respond more weakly to variations in real wages.

Table 5 and Figure 6[7] show that this modification of the behaviour of households can lead to a significant divide by two of the gains from deregulation. As pictured, this result is almost only driven by the Frisch elasticity, that is by a lowest reaction of labour supply to changes in real wages. Numerically, we observe that changes in the elasticity of consumption give weak and ambiguous results.

Even though, we do not test for it here, it is also important to note that these results are also highly dependent on the form of the utility function itself. In line with (King et al., 2002), we work with a non separable utility, consistent with long-term growth in our model. This particular form introduces

[7] Additional figures for consumption, labour and real wages are given in the Appendix. See Figure 18

additional dependencies between consumption and labour and might also be an important determinant of the efficiency of structural reforms.



(a) Goods market reform

(b) Labour market reform

The inverse intertemporal elasticity of substitution of consumption corresponds to σ_c^1, and the inverse Frisch elasticity to σ_l^1. Structural reforms implemented here are the ones of Everaert and Schule (see Table 3. As a result and for instance, a 0.5 p.p. impact differential for a goods market reform translates into a total gain in production of $0.5 + 11.3 = 11.8$ p.p. (see. Table 4 for the baseline case).

Figure 6: *MELEZE* - Impact differential of structural reforms in p.p. with respect to the standard calibration depending on the calibration of the utility

Targeted market	Calibration	Y	C	L	I
Goods					
Labour	$\sigma_c = 2$ et $\sigma_l = 1.2$	17.1	14.4	18.6	14.4
alternative	$\sigma_c = 3$ et $\sigma_l = 3$	8.5	4.3	5.7	14.0
Goods	$\sigma_c = 2$ et $\sigma_l = 1.2$	11.3	7.0	9.2	15.5
alternative	$\sigma_c = 3$ et $\sigma_l = 3$	7.2	3.7	4.8	11.8

Table 5: Long-run effects of increased competition on the labour and goods markets (in % deviation from the initial level) - Sensitivity to agents' utility specification

4.2.3 Share of *non Ricardian* agents

Lastly, the calibration of the share of *non Ricardian* households in the economy is a key determinant of the size of production gains.

This parameter is often estimated using Bayesian methods or simply calibrated with "expert" insights as in (Everaert and Schule, 2006). For instance, this share is estimated to be 35% in France and 45% in the Euro area in GEM, and 40% for both in QUEST III. However, micro-studies highlight that these estimated shares might be over-evaluated as only a few agents a strictly banned from financial markets. Moreover (Fève and Sahuc, 2013) show that once government spending is accounted for in the utility function the estimated share of *non Ricardian* agents in a model *à la* (Smets and Wouters, 2007) drops to 7% only. Indeed, a large number of agents, designated as *wealthy hand-to-mouth*, do possess a large illiquid wealth, such as housing, so that their short-term consumption is highly correlated to their current income. However, in the long-term, this conclusion might differ as assets can be traded. (Kaplan et al., 2014) compute values for the share of *wealthy hand-to-mouth* agents around 20% for France. Close to (Kaplan et al., 2014), (Martin and Philippon, 2014) focus on the fraction of households with liquid assets representing less than 2 months of total gross income and calibrate their model to a 46.6% share of *non Ricardian* agents in France.

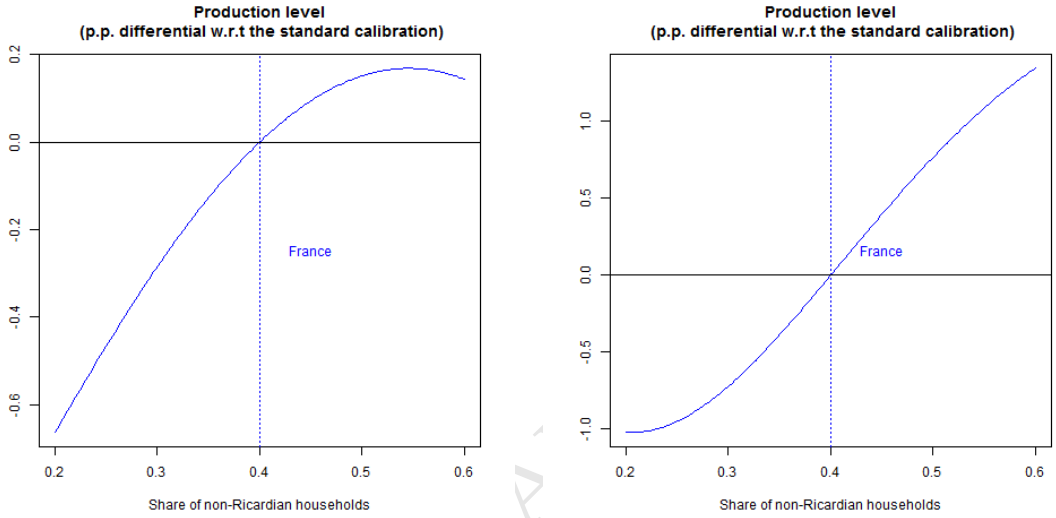
We choose to calibrate our model to estimated values in QUEST III, as lower values of the parameters as advocated by micro-studies are not sufficient to induce a positive response of aggregate consumption to a positive shock in public spendings (see (Galí et al., 2007)).

Performing deregulation on both labour and goods markets, with and without *non Ricardian* agents, as plotted on Figures 7a and 7b[8] lead to substantial differences. In the presence of liquidity-constrained agents, the effect of structural reforms (as performed in Everaert and Schule) is magnified with additional gains of 4.3 p.p. in production with respect to the initial steady state level for reforms on the labour market, and 1.9 p.p. for reforms on the goods market. Morevover, we observe that this increase is non-linear and stronger decreases in markups will lead to even larger gains in the presence of *non Ricardian* agents.

5 Fiscal multipliers

In the continuity of structural reforms, we perform a second standard policy exercise, namely the simulations of fiscal reforms focusing in particular on the size of fiscal multipliers. To better understand the mechanisms at work, we compare our model to other institutional DSGE models for Europe developed at the IMF, the OECD, the ECB and the European Commission. Based on these models (Coenen et al., 2012) implement and compare various fiscal stimulus packages and measure instantaneous fiscal multipliers for these models, concluding to strong similarities across models. However, and although our model is in line with these benchmarks, this Section aims at giving a deeper understanding of

[8] Additional figures for consumption, labour and real wages are given in the Appendix. See Figure 19



(a) Goods market reform

(b) Labour market reform

The share of *non Ricardian* households corresponds to μ^1.
Structural reforms implemented here are the ones of Everaert and Schule (see Table 3. As a result and for instance, a 0.5 p.p. impact differential for a goods market reform translates into a total gain in production of $0.5 + 11.3 = 11.8$ p.p. (see. Table 4 for the baseline case).

Figure 7: *MELEZE* - Impact differential of structural reforms in p.p. with respect to the standard calibration depending on the calibration of the utility

parameters, factors an implementations crucially influencing the size of fiscal multipliers.

5.1 Temporary fiscal shocks in DSGE models

5.1.1 Fiscal multipliers dependency to the model class

A first line of analysis is the structural class of the model. Indeed, as (Coenen et al., 2012) compare only DSGE model constructed along the same core models and structures, it might not be surprising to obtain similar results across models. However, DSGE models are often confronted (both historically and ideologically) to large-scale macroeconometric models such as Mésange developed at the Insee, Mascotte at the Banque de France or MFMod at the World Bank. This second class of model differ in their lack of full micro-foundations and rational expectations but in their highly detailed national accounting structure, their capacity to replicate observed data as well as their estimation flexibility. For the comparison, we will focus on the *Mésange* model (see (Klein and Simon, 2010)) of the French economy featuring around 500 equations of which 50 are behavioural. Note that even if *Mésange* is strictly speaking not an open economy model as it only features one country, exports and imports volumes as well as prices are explicitly modelled. In parallel, we will also compare our results to simulations from the European Commission's model Quest III in its endogenous growth version for France within the rest of the euro area (see (Roeger et al., 2008)).

We implement a two-years decrease in public spendings amounting to 1% of *ex-ante* value added, with no monetary accommodation. Classically, we define the instantaneous fiscal multiplier as the ratio of the change in output to the 1% increase *ex ante* and not to the change in government spendings *ex post*.

Following this stimulus, we find that the fiscal multiplier is lower than one both for our model and the R&D version of QuestIII and for all regions considered (Figure 8a). This result is in line with other DSGE models (Figure 8b) with multipliers ranging from 0.8 to 0.9 in all *European* models (namely OECD's Fiscal, EC's Quest, ECB's NAWM and IMF's GIMF).

With the macroeconometric model *Mésange* (Klein and Simon, 2010) however, the fiscal multiplier is clearly larger than one making this model most likely more *Keynesian* than the other considered *neo-Keynesian* models. This difference between DSGE and macroeconometric models indicates how fiscal multipliers are sensitive to the implementation of the stimulus and the reaction or commitment of policy makers to this shock. Among others, the smaller size of the fiscal multiplier in DSGE models compared to Mésange model comes from the central bank response, interest rates being exogenous in Mésange. An increase in final demand by the government represents a potentially inflationary pressure and the central bank's Taylor rule advocates an increase in the nominal interest rate that mitigates the favourable effects of the public spendings stimulus. As we show in the next section, in the presence

of monetary accommodation, that is when the nominal interest rate is kept constant, fiscal multipliers increase further in our model (and in other DSGE models) and compare to the size observed in the *Mésange* model.

More generally, the purely backward structure of macroeconometric models[9] does not allow the design of complex Taylor rules based on inflation expectations. However one can implement rules similar to the one in *MELEZE* based on contemporary inflation. In the case of Mésange and as France shares a common monetary policy with other Eurozone members, the absence of economic spillovers and feedbacks with other members limits the interest and the impact of a Taylor rule as France represent only a quarter of the Eurozone.

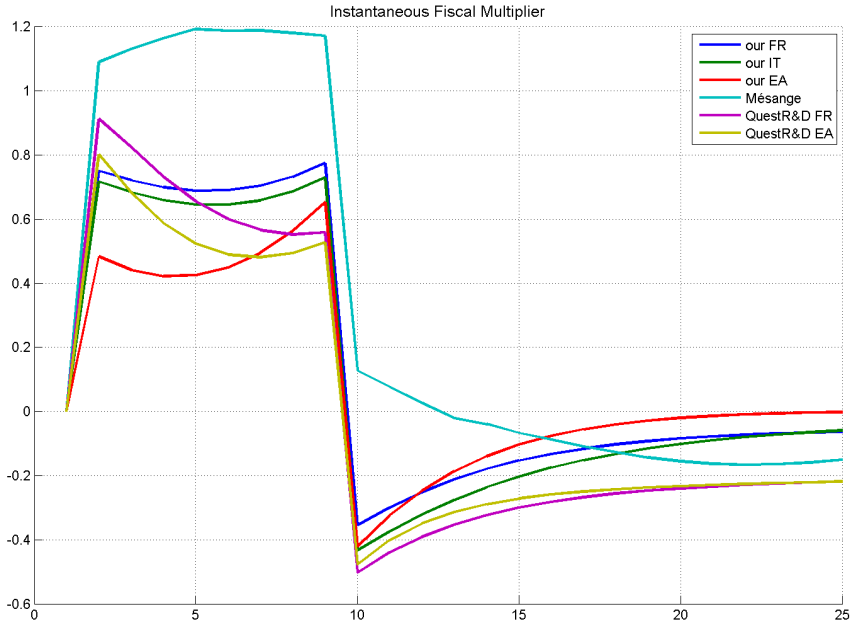
5.1.2 Policy implementation sensitivity of fiscal multipliers

We now turn to a sensitivity analysis of the size of fiscal multipliers with respect to the policy implementation of shock. In particular, we focus on the dependency to the timing of the shock, its duration, and the behaviour of both the government and the central bank to fiscal shocks.

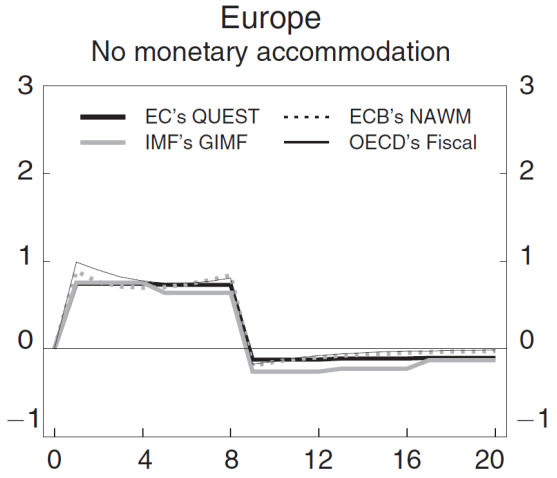
First, fiscal multipliers depend on the way both the fiscal and monetary authorities respond to the stimulus, that is the way they are modelled. We consider 5 different variants for a two year increase in public spendings *a priori* equal to 1% of pre-stimulus output: the benchmark case where the government and the central bank set their decisions *as usual* (no accommodation), the case where monetary policy accommodates the fiscal authority's decision by keeping its interest rate at the steady state level, the case where the government commits to its decision by not reacting to the temporary increase in public debt, and also the case of standard budget rules with and without monetary accommodation.

Monetary accommodation, by not raising the interest rate following an inflationary increase in final demand magnifies the fiscal multiplier (Figure 9a). Indeed, as the nominal interest rate remains unchanged, the increase in inflation expectations lowers the real interest rate therefore fostering private consumption today. Nevertheless, the fiscal multiplier remains lower than one with our forward looking government. When the government commits to the increase in public spendings and the central bank is accommodative, the fiscal multiplier is now larger than one with an order of magnitude comparable to the *Mésange* model. This relates to the previous mention of the exogeneity of the nominal interest rate in *Mésange*.

[9] With the exception of a few hybrid models such as the FRB-US at the FED including expectations.



(a) ... in *MELEZE*, QuestIII R&D, and *Mésange*



(b) ... in QuestIII, NAWM, GIMF and OECD's Fiscal

Government spendings increase for 2 years by 1 percent of *ex ante* output. In the upper figure, fiscal multipliers are plotted for France only in *MELEZE* and *Mésange*, and both France and the Euro Area for QUEST III R&D. The lower figure is taken from (Coenen et al., 2012). Note that for Quest III, responses are annualized.

Figure 8: Instantaneous fiscal multipliers for a two-year increase in government consumption

Moreover, when the government is modelled through a budget rule, the fiscal multiplier is temporarily larger than one, all the more so if the central bank is accommodative. The fiscal multiplier then compares in terms of profile with the Quest model (Figure 8a). The difference in profile of the fiscal multiplier is directly related to the government's reaction to its own decision: with a forward looking government and our calibration, the government compensates its own spending shock through the endogenous level of public spending more rapidly which mitigates instantly the fiscal multiplier below one.

Lastly, the duration of the shock mitigates the size of the fiscal multiplier (Figure 9b). With a one quarter (unexpected) decrease in public spendings, the fiscal multiplier is larger than one. The longer is the fiscal stimulus, the smaller is the multiplier and larger is the after effect when the reform is abrogated.

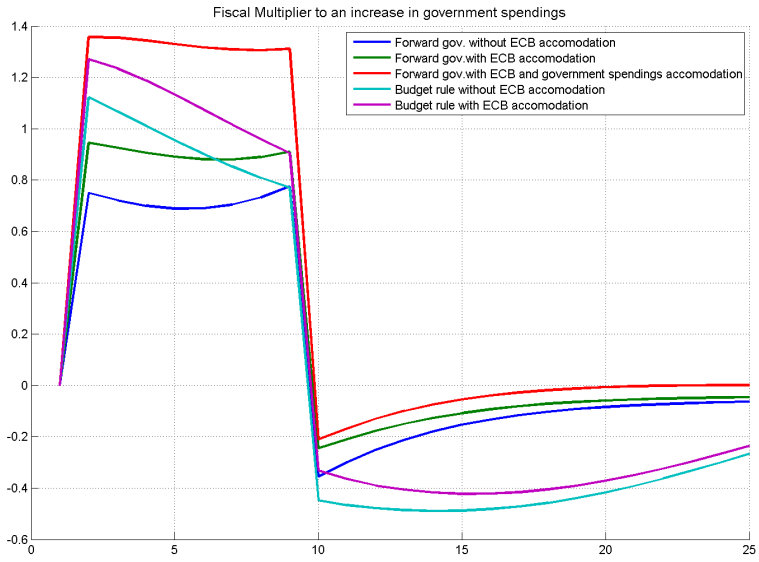
All in all, we stress that one should be particularly cautious to identify the underlying policy implementation when referring to fiscal multipliers. Indeed, the mere quantification of fiscal multipliers is hard to directly transpose into policy recommendations, timeliness and the political context being crucial determinants of their size.

5.1.3 Fiscal multipliers of other policy instruments

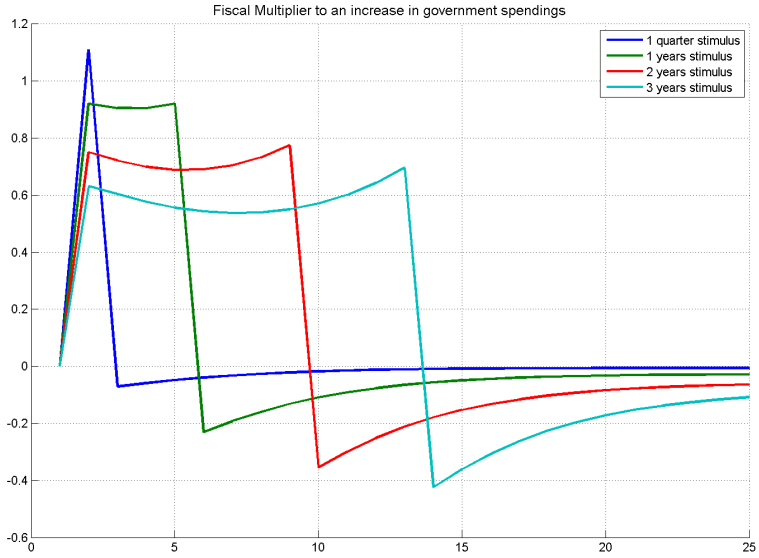
Lastly, we evaluate the fiscal multipliers of other fiscal stimulus with the same method as government spendings: we implement a fiscal stimulus (decrease in tax rate or increase in transfers) *a priori* equal to 1% of output for two years. Results are compared with equivalent simulations for European and US model presented in (Coenen et al., 2012). To further highlight the effect of the governments commitment to fiscal stimulus, we implement for France two scenarios, either the government and central bank keep their spendings and interest rate respectively at steady state or the government partially compensates through its spendings the increased indebtedness.[10] We also performed equivalent stimulus in the Euro Area as a whole by implementing the same shock in the two countries of our symmetric calibration. The comparison of the fiscal multipliers in this case and in the *France in the rest of the Euro Area* case measure the mitigating effect of fiscal spillovers in a monetary union.

When computed under accommodation, the fiscal multipliers compare with those of other models. However, the reaction of government spendings to an increase in transfers is quite large and can nullify the multiplier. In the case of taxes on corporate or labour income a sharp reaction can even make the multiplier negative the first year. On the other hand, when implemented in the Euro Area as a whole (modelled here as a closed economy) the fiscal multipliers are systematically larger which implies that

[10] To highlight this compensation effect we have run these simulations with a forward looking government whose reaction is the most sensitive.



(a) ... depending on monetary policy accommodation and government's behaviour



(b) ... lasting from one quarter to 3 years

We assume that government spendings are increased *a priori* by 1 percent of output. In the upper figure, we compare the fiscal multiplier in *MELEZE* for France, in the cases where the ECB maintain its interest rate constant or not and whether the government is forward looking or follows a budget rule. We also consider a temporary perfect commitment to public expenditures in which case the government does not react to its spending shock. In the lower figure, we compare the fiscal multiplier in our model for France for 1 quarter, 1,2 or 3 years stimulus.

Figure 9: Instantaneous fiscal multiplier to a temporary increase in government spending by 1% of initial output

	US	EU	our FR	our FR^{bis}	our EA
Government consumption: 2 years	1,55	1.52	1.35	0.92	1.54
1 years	1.20	0.90	1.23	1.02	1.34
Targeted Transfers (to *non Ricardians*)	1.30	1.12	1.02	0.35	1.32
Consumption taxes	0.61	0.66	0.51	0.23	0.78
General transfers	0.42	0.29	0.48	0.00	1.01
Corporate income taxes	0.24	0.15	0.28	-0.18	0.49
Labor income taxes	0.23	0.53	0.13	-0.05	0.06

Table 6: Average first-year instantaneous multiplier from different types of fiscal stimulus

We assume that fiscal stimulus of *a priori* by 1 percent of output are implemented for 2 years (unless specified otherwise). The first two columns correspond to (Coenen et al., 2012, Table 3) where fiscal multipliers from the different model tested are averaged out. Fiscal multipliers form these columns are computed with monetary accommodation (2 years). The first column *our FR* corresponds to fiscal multipliers with monetary accommodation and government commitment, the second *our FR^{bis}* without commitment.

fiscal spillover in a monetary union mitigate the opportunity to foster activity through fiscal instrument if not coordinated, especially in the case when transfers to both types of agents are distributed.

A result robust through the models is that only the fiscal multipliers to government spendings or transfers to *non Ricardian* households have a fiscal multiplier larger than one. For these stimuli the shock is directly translated to an increase in final demand, with full home bias in the case of government spendings, compensated in second round effect by crowding out with private consumption and sustained by higher hours worked hence labour income. For transfers to *non Ricardians* the multiplier is first smaller because part of their consumption is imported. It is also mitigated by these households' trade-off between consumption and leisure: lump-sum transfers generate an income effect which allows households to decrease their labour supply and not increase their consumption *ex-post* by as much as the transfer.

For other fiscal stimuli, the fiscal multiplier is smaller than one. The decrease in VAT rate has the largest effect as it is directly reflected in prices. However, this decrease symmetrically benefits to domestic and imported goods. In addition to the consumption leisure trade-off mentioned above, *Ricardians* also impacted by these measure have other possibilities to arbitrate (through savings in particular) which further dampens the fiscal multiplier.
General transfers implies an income effect distributed over the whole population. Aside from disparities in consumption per capita of *Ricardians* and *non Ricardians* an increase in general transfers is quite similar to a reduction in VAT under government's commitment. As for corporate income tax their decrease has an effect on both *Ricardian*s income and profitability of investment (an effect which is only short lived). Since *Ricardian*s arbitrate more than *non Ricardians* this stimulus has a smaller multiplier general transfers for instance. Finally, the first year multiplier of a decrease in income tax rate is only small. This decrease in the cost of labour will be only gradually reflected in prices (since these are sticky) and

temporarily reflected in higher profits.

5.2 Permanent increase in public spendings

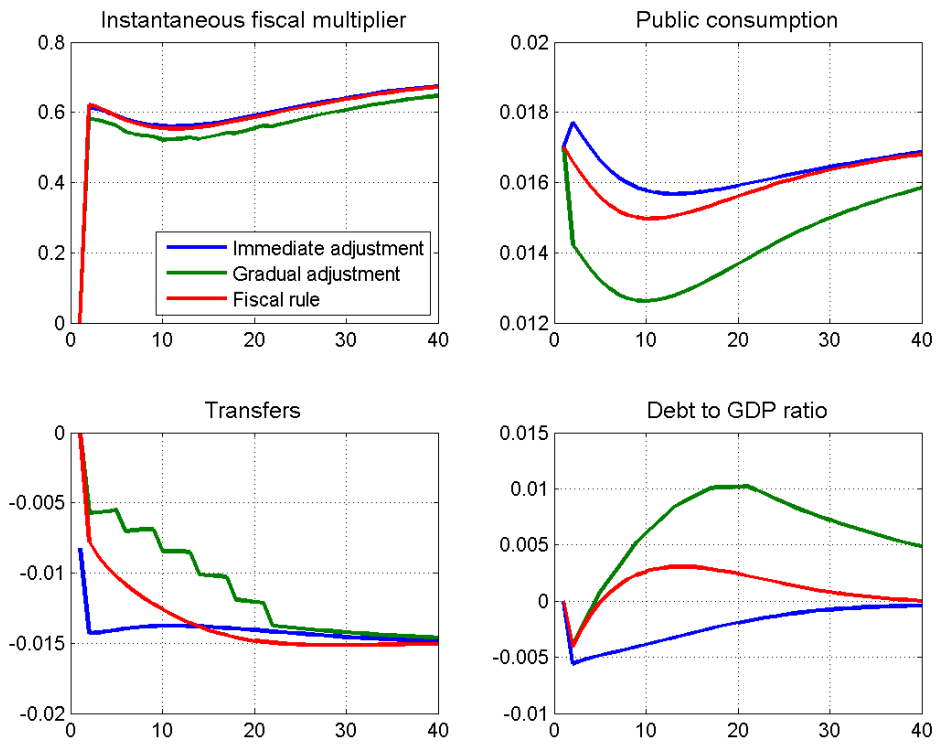


Figure 10: Fiscal multiplier to a permanent decrease in government spending financed through lump-sum transfers

We assume that government spendings are permanently increased by 1 p.p. of *ex ante* output. The increase in government expenditures is financed through a decrease in lump-sum transfers to households. This decrease is implemented in three different ways: an *immediate adjustment* in which transfers are directly adjusted to their new long term value, a *gradual adjustment* in which the transfers' decrease is spread over five years, and a *smoothed adjustment* in which transfers are adjusted through a fiscal rule allowing for the debt ratio to converge.

Similarly to previous section, we now study response of the economy to an equivalent *permanent* increase in government spendings by 1% of pre-reform output. Contrary to a temporary fiscal stimulus that will be temporarily financed by debt (but leaving the long term target unchanged), a permanent stimulus raises the question of long-term financing. This can be achieved either by raising taxes, increasing the long-term debt to GDP ratio or decreasing lump-sum transfers to households. Again, in order to compare our results to (Coenen et al., 2012), the long-term additional cost induced by higher public spendings is financed through lower lump-sum transfers. In our model, an increase in public

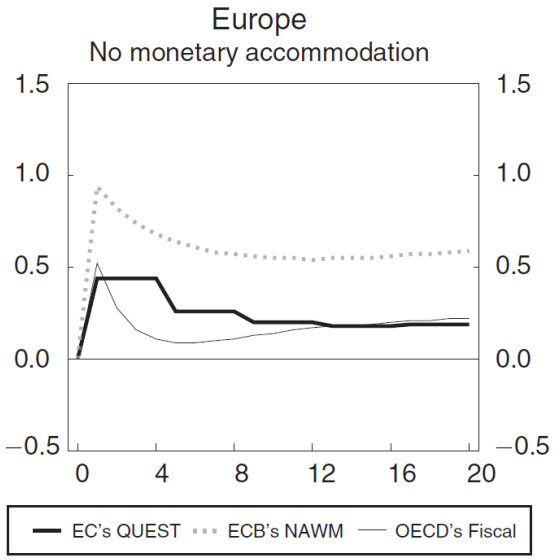


Figure 11: Fiscal multiplier to a permanent decrease in government spending financed through either lump-sum transfers or labour taxes

(Coenen et al., 2012) assume a permanent increase in government spendings by 1 p.p. of *ex ante* output. The increase in government expenditures is financed through either a decrease in lump-sum transfers to households or labour taxes depending on the adjusting fiscal tool in each model.

spendings by 1% of pre-reform output is financed by a decrease in the ratio of transfers to GDP from 18% to 17.7%[11].

Therefore, the permanent stimulus package decomposes as follows. Upon reform (that is at $t = 0$), the government immediately injects the targeted spendings level and therefore simultaneously changes its long-term target for gy^1, that is the share of its spendings in domestic GDP. As a perfectly rational agent, and using the full derivation of the steady state in levels, the government can accurately evaluate *ex ante* (and verify *ex post*), the new long-term target for gy^1 taking into account the increase in the steady state GDP level[12]. Concretely here, the change in gy^1 is therefore different from 1 p.p and corresponds to an increase from 22.6% to 22.8% in GDP.

Financing is achieved through three different implementations:

1. an *immediate adjustment* in transfers, where the government immediately switches the long-term

[11] This decrease in the ratio of transfers to GDP takes into account the evolution of the GDP level post-reform.

[12] In larger models such as GIMF or Quest III, the difficulty to compute the new steady state results in a *ex post* increase in public spendings different from the initial stimulus. Actually, the simulation of permanent shocks in such models uses an approximate approach: one can simulate a long-lasting transitory shock and observe the transitory convergence of the model to a new steady state (see the Model Solution Method appendix in (Roeger, 1999)). In our model, we fully derive *ex ante* the new steady state so that the government, as the policy maker, can fully commit to the chosen stimulus package. Simulations are simply achieved by the computation of the transition between two exact steady states.

level of transfers to its new target, and leaves it unchanged after.

2. a *gradual adjustment* in transfers, where the decrease is gradually implemented by fifth over five years.

3. an adjustment through a *fiscal rule*, where the current transfers respond to changes in the debt gap from its long-term target and changes in growth rate of deficit. This implementation replicates the endogenous adjustment method used in the Quest III (R&D). As such, we use their fiscal adjustment rule for lump-sum transfers given by:

$$\bar{\phi}^1(\hat{\phi}^1_t - \hat{\phi}^1_{t-1}) = \frac{0.01}{\bar{pa}^1}\hat{pa}^1_{t-1} + \frac{0.1}{\bar{pa}^1}(\hat{pa}^1_t - \hat{pa}^1_{t-1}) \tag{5.1}$$

Responses of the economy are presented in Figure 10, whereas fiscal multipliers computed in (Coenen et al., 2012) are given in Figure 11.

We obtain an instantaneous fiscal multiplier for a permanent stimulus of around 0.6 on impact (and 0.7 in the long-term), that is 0.15 lower than for a two-year stimulus. Indeed, due to an decrease in the present discounted value of transfers, households anticipate a lower future wealth and resulting in an immediate crowding out of private demand.

Moreover, (Coenen et al., 2012) show that models adjusting the government budget constraint through a fiscal rule based on an endogenous labour income tax, such as Quest III (non R&D) and the OECD's model, display even lower multipliers due to the distortionary aspect of this tax. Consequently, our fiscal multiplier appears in line with comparable models adjusting through transfers such as the New Area Wide Model at the ECB with a long term effect around 0.6 against 0.7 in our model (Figure 11). Indeed, labour tax-adjusting models exhibits lower long-term multipliers around 0.2.

Note that as in previous Section, the shape of the response with an absence of overshooting is a result of the forward looking behaviour of our government. As shown in Figure 8a, using a budget rule instead of a Euler equation gives results similar to the main compared models.

Despite quasi-identical instantaneous fiscal multipliers across the three financing implementations, we now turn to a more detailed analysis of the economic transition as those three *reforms* exhibits different transitional behaviours. The associated responses are given in Figure 10 and Table 7.

Following an increase in government spendings, production increases. Those higher indirect revenues for households transmits in an increase in consumption and investment. However, this increase remains small as the fall in transfers creates a negative wealth effect. Labour supply increases both due

to this negative wealth effect and an increase in labour demand coming from the higher production level. Also note that the simultaneous presence of rigid prices and of an active monetary policy suppress any inflationary pressure in the domestic economy.

The key differentiation across implementations lies in the timing of the transfers' decrease. A gradual adjustment over five years indeed induces a weaker negative wealth effect that may be desirable for households. However, the lack of revenues (or the excess costs) for the government implies both a higher temporary recourse to debt financing (with an identical long-term target) and in response lower public spendings. On the opposite side of the spectrum, an *immediate* full decrease in transfers allows the government to exhibit an improved deficit during the transition at the cost of a stronger wealth effects through transfers. In between, adjusting transfers through a fiscal rule displays a smoother transition.

In the end, a political trade-off exists. For quasi-identical impact on production, a gradual adjustment appears the most favourable implementation for households' consumption and therefore more easily implementable from a political point of view. However, the persistent higher transfers (compared to the other two scenarios) lead both to a lower negative wealth effect that results in a lower increase in labour, and to a persisting negative effect on the government debt to GDP ratio. A fiscal rule type of implementation therefore appears to be a potential "*compromise*" between an *immediate* and a *gradual* adjustment in transfers, if the government temporary allows itself to slightly increase its deficit.

For investment, real wages, and the capital cost, all three scenarios exhibits similar economic impacts.

Table 7: Macroeconomic impact of a permanent increase in government expenditures of 1% of pre-stimulus GDP (% deviations from initial steady state)

	Immediate adjustment					Gradual adjustment					Smoothed adjustment				
	1A	2A	5A	10A	LT	1A	2A	5A	10A	LT	1A	2A	5A	10A	LT
Production	0.6%	0.6%	0.6%	0.7%	0.7%	0.6%	0.5%	0.6%	0.6%	0.7%	0.6%	0.6%	0.6%	0.7%	0.7%
Consumption	0.2%	0.1%	0.1%	0.2%	0.3%	0.3%	0.2%	0.1%	0.2%	0.3%	0.2%	0.1%	0.1%	0.2%	0.3%
Labour	1.0%	0.9%	0.8%	0.8%	0.7%	0.9%	0.8%	0.7%	0.7%	0.7%	1.0%	0.9%	0.8%	0.8%	0.7%
Investment	0.6%	0.9%	1.0%	0.9%	0.7%	0.6%	1.0%	1.0%	0.9%	0.7%	0.6%	0.9%	1.0%	0.9%	0.7%
Imports	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%	0.3%	0.3%	0.4%	0.4%	0.3%	0.3%	0.3%	0.4%	0.4%
Exports	0.3%	0.2%	0.3%	0.4%	0.4%	0.3%	0.2%	0.3%	0.4%	0.4%	0.3%	0.2%	0.3%	0.4%	0.4%
Public consumption	1.7%	1.6%	1.6%	1.7%	1.7%	1.4%	1.3%	1.4%	1.6%	1.7%	1.6%	1.5%	1.6%	1.7%	1.7%
Transfers	-1.4%	-1.4%	-1.4%	-1.5%	-1.5%	-0.6%	-0.7%	-1.2%	-1.5%	-1.5%	-1.0%	-1.2%	-1.5%	-1.5%	-1.5%
Debt to GDP ratio	-0.5%	-0.4%	-0.2%	0.0%	0.0%	-0.1%	0.4%	1.0%	0.5%	0.0%	-0.1%	0.2%	0.2%	0.0%	0.0%
Real wages	-0.1%	-0.1%	-0.2%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%	-0.2%	-0.1%	0.0%
Capital cost	0.9%	0.7%	0.4%	0.2%	0.0%	0.9%	0.7%	0.3%	0.1%	0.0%	0.9%	0.7%	0.4%	0.2%	0.0%
Inflation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Terms of trade	-0.1%	-0.2%	-0.1%	0.0%	0.0%	-0.1%	-0.2%	-0.1%	0.0%	0.0%	-0.1%	-0.2%	-0.1%	0.0%	0.0%

The increase in government expenditures is financed through a decrease in lump-sum transfers to households. This decrease is implemented in three different ways: an *immediate adjustment* in which transfers are directly adjusted to their new long term value, a *gradual adjustment* in which the transfers' decrease is spread over five years, and a *smoothed adjustment* in which transfers are adjusted through a fiscal rule allowing for the debt ratio to converge.

6 Conclusion

In a two country neo-Keynesian model of a monetary union, we performed two standard exercises: structural and fiscal reforms. Our model includes the traditional *ingredients* of modern large-scale institutional DSGE models such as real and nominal rigidities, capital adjustment costs, *non Ricardian* agents, and a detailed public finance block. As a result, (i) our results for the simulation of long-term effects of deregulation on goods and labour markets are in line with stylized facts obtained in deregulation-oriented models such as (Blanchard and Giavazzi, 2003), and (ii) the size of fiscal multipliers for public spending or tax cuts is comparable to existing institutional DSGEs as summarized in (Coenen et al., 2012).

We proceeded to detailed sensitivity tests for those two exercises. Whereas qualitative results are robust to qualitative or quantitative changes in the specification of the model (positive gains from deregulations and positive fiscal multipliers for public spendings), quantitative results differ across specifications. The simple redefinition of households' utility can lead to additional gains or losses up to 10 p.p. in output following goods or labour markets deregulations. Similarly, a modification of the monetary environment and of the government's behaviour can lead to public spending multipliers ranging from below to above one (i.e. from 0.7 to 1.3), with therefore very different implications in terms of policy-making.

Hence, these results strongly argue in favour of a systematic conduct of sensitivity tests when performing quantitative economic analyses. Such tests should include changes in the calibration of households, the modelling of the government, and the monetary environment.

References

B. Annicchiarico, F. Di Dio, and F. Felici. Structural reforms and the potential effects on the Italian economy. *Journal of Policy Modeling*, 35(1):88–109, Jan. 2013. ISSN 01618938.

J. Barthélemy, M. Marx, and A. Poissonnier. Trends and cycles: an historical review of the euro area. 2009.

T. Bayoumi, D. Laxton, and P. Pesenti. Benefits and Spillovers of Greater Competition in Europe: A Macroeconomic Assessment. *Board of Governors of the Federal Reserve System, International Finance Discussion Papers*, 803(April), 2004.

P. Benigno. Optimal monetary policy in a currency area. *Journal of International Economics*, 63(2):293–320, July 2004. ISSN 00221996.

O. Blanchard and F. Giavazzi. Macroeconomic effects of regulation and deregulation in goods and labor markets. *The Quarterly Journal of Economics*, (August):879–907, 2003.

M. Bussiere, G. Callegari, and F. Ghironi. Estimating trade elasticities: Demand composition and the trade collapse of 2008-09. *NBER Working Paper Series*, 17712(December), 2011.

M. Cacciatore, R. Duval, and G. Fiori. Short-term gain or pain? A DSGE model-based analysis of the short-term effects of structural reforms in labour and product markets. *OECD Economics Department Working Papers*, 2012.

B. Campagne and A. Poissonnier. MELEZE a DSGE model for fiscal simulations in a monetary union. *Document de travail de la Dese-Insee*, (forthcoming), 2015.

J. Campbell and N. Mankiw. Consumption, income and interest rates: Reinterpreting the time series evidence. *NBER Macroeconomics Annual 1989, Volume ...*, 4(1989):185–216, 1989.

L. J. Christiano, M. Eichenbaum, and C. L. Evans. Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. *Journal of Political Economy*, 113(1):1–45, Feb. 2005. ISSN 0022-3808.

K. Clinton, M. Kumhof, D. Laxton, and S. Mursula. Deficit reduction: Short-term pain for long-term gain. *European Economic Review*, 55(1):118–139, Jan. 2011. ISSN 00142921.

G. Coenen, P. McAdam, and R. Straub. Tax reform and labour-market performance in the euro area: A simulation-based analysis using the New Area-Wide Model. *Journal of Economic Dynamics and Control*, 32(8):2543–2583, Aug. 2008. ISSN 01651889.

G. Coenen, C. J. Erceg, C. Freedman, D. Furceri, M. Kumhof, R. Lalonde, D. Laxton, J. Lindé, A. Mourougane, D. Muir, S. Mursula, C. de Resende, J. Roberts, W. Roeger, S. Snudden, M. Trabandt, and J. in't Veld. Effects of Fiscal Stimulus in Structural Models. *American Economic Journal: Macroeconomics*, 3(4):22–68, Jan. 2012. ISSN 1945-7707.

T. Cooley and E. Prescott. Economic growth and business cycles. In *Frontiers of business cycle research*, pages 1–38. 1995.

G. Corsetti, A. Meier, and G. Müller. Cross-border spillovers from fiscal stimulus. *International Journal of Central Banking*, 6(March):5–37, 2010.

F. D'Auria, A. Pagano, M. Ratto, and J. Varga. A comparison of structural reform scenarios across the EU member states-Simulation-based analysis using the QUEST model with endogenous growth. *European Commission Economic Papers*, 392(December), 2009.

G. Eggertsson, A. Ferrero, and A. Raffo. Can Structural Reforms Help Europe ? *Journal of Monetary Economics*, 61(January):2–22, 2014.

C. Erceg, D. Henderson, and A. Levin. Optimal monetary policy with staggered wage and price contracts. *Journal of monetary Economics*, 46, 2000.

L. Everaert and W. Schule. Structural Reforms in the Euro Area: Economic Impact and Role of Synchronization Across Markets and Countries. *IMF Working Papers*, 06(137):1, 2006. ISSN 1018-5941.

L. Everaert and W. Schule. Why It Pays to Synchronize Structural Reforms in the Euro Area Across Markets and Countries. *IMF Staff Papers*, 55(2):356–366, Apr. 2008. ISSN 1020-7635.

P. Fève and J.-G. Sahuc. On the Size of the Government Spending Multiplier in the Euro Area. *Toulouse School of Economics Working papers*, 396:1–31, 2013.

J. Galí and T. Monacelli. Optimal monetary and fiscal policy in a currency union. *Journal of International Economics*, 76(1):116–132, Sept. 2008. ISSN 00221996.

J. Galí, J. Vallés, and J. D. Lopez-Salido. Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, 5(1):227–270, 2007.

S. Gomes, P. Jacquinot, and M. Pisani. The EAGLE. A model for policy analysis of macroeconomic interdependence in the euro area. *Economic Modelling*, 2012.

J. Hø j, M. Jimenez, M. Maher, G. Nicoletti, and M. Wise. Product Market Competition in the OECD Countries. *OECD Economics Department Working Papers*, (575), 2007.

G. Kaplan, G. L. Violante, and J. Weidner. The Wealthy Hand-to-Mouth. *Brookings Papers on Economic Activity*, (Spring):77–153, 2014.

M. Kimball and M. Shapiro. Labor supply: Are the income and substitution effects both large or both small? *NBER Working Paper Series*, 14208(July), 2008.

R. King, C. Plosser, and S. Rebelo. Production, growth and business cycles: Technical appendix. *Computational Economics*, pages 87–116, 2002.

C. Klein and O. Simon. Le modèle MÉSANGE réestimé en base 2000. Tome 1-Version avec volumes à prix constants. *document de travail Insee*, 2010.

N. Mankiw. The savers-spenders theory of fiscal policy. *NBER Working Paper Series*, 2000.

P. Martin and T. Philippon. Inspecting the Mechanism: Leverage and the Great Recession in the Eurozone. *NBER Working Paper Series*, 20572(October), 2014.

M. Ratto, W. Roeger, and J. in't Veld. QUEST III : An estimated open-economy DSGE model of the euro area with fiscal and monetary policy. *Economic Modelling*, 26(1):222–233, 2009. ISSN 0264-9993.

W. Roeger. The Sensitivity of Solutions to Terminal Conditions: Simulating Permanent Shocks with Quest II. *Analyses in Macroeconomic Modelling*, 1999.

W. Roeger, J. Varga, and J. in't Veld. Structural Reforms in the EU: A simulation-based analysis using the QUEST model with endogenous growth. *European Economy âĂŞ Economic Paper*, 2008.

P. Romer. Endogenous technological change. *Journal of political Economy*, 98(5), 1990.

S. Schmitt-Grohé and M. Uribe. Closing small open economy models. *Journal of International Economics*, 61(1):163–185, Oct. 2003. ISSN 00221996.

F. Schorfheide. Estimation and Evaluation of DSGE Models : Progress and Challenges. *Federal Reserve Bank of Philadelphia, Working papers*, 11-7(January), 2011.

F. Smets and R. Wouters. AN ESTIMATED STOCHASTIC DYNAMIC GENERAL EQUILIBRIUM MODEL OF THE EURO AREA. *Working paper series, European Central Bank*, (171), 2002.

F. Smets and R. Wouters. An estimated dynamic stochastic general equilibrium model of the euro area. *Journal of the European Economic Association*, 1(5):1123–1175, 2003.

F. Smets and R. Wouters. Comparing shocks and frictions in US and euro area business cycles: a Bayesian DSGE approach. *Journal of Applied Econometrics*, (61), 2005.

F. Smets and R. Wouters. Shocks and frictions in US business cycles: A Bayesian DSGE approach. *CEPR Discussion Paper*, (6112), 2007.

J. B. Taylor. Discretion versus policy rules in practice. In *Carnegie-Rochester conference series on public policy*, volume 39, pages 195–214. Elsevier, 1993.

M. Trabandt and H. Uhlig. The Laffer curve revisited. *Journal of Monetary Economics*, 58(4):305–327, May 2011. ISSN 03043932.

L. Vogel. Structural reforms, fiscal consolidation and external rebalancing in monetary union: A model-based analysis. *Economic Modelling*, 29(4):1286–1298, July 2012. ISSN 02649993.

A Simplified model

In order to precisely identify the core mechanisms at stake when conducting structural reforms, Figure 1 and 2 refer to a simplified version of the model *MELEZE*. This simplified version corresponds to a closed economy model, with no *non Ricardian* agents, no habit formation, no financial markets, no government and no growth. Concretely, with the previous notations $\alpha^i, h_c^i, h_l^i, \nu^{c,i}, \nu^{k,i}, \nu^{w,i}, \Phi^i, pa^i, fa^i, mu^i, \eta^i, g, \Psi^i, \Psi^g$ are set to 0, and $n = 1$.

In all, the first order equations defining the model are:

$$1 = \beta \mathbb{E}_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma_c} \left(\frac{1 - \kappa(1-\sigma_c) L_{t+1}^{1+\sigma_l}}{1 - \kappa(1-\sigma_c) L_t^{1+\sigma_l}} \right)^{\sigma_c} \frac{R_t}{\Pi_{t+1}} \right\} \tag{A.1}$$

$$1 = \beta \mathbb{E}_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma_c} \left(\frac{1 - \kappa(1-\sigma_c) L_{t+1}^{1+\sigma_l}}{1 - \kappa(1-\sigma_c) L_t^{1+\sigma_l}} \right)^{\sigma_c} (1 - \delta + r_{t+1}^k) \right\} \tag{A.2}$$

$$K_t = (1-\delta) K_{t-1} + I_t \tag{A.3}$$

$$RMC_t = \frac{RW_t^{1-\alpha} r_t^{k\alpha}}{\alpha^\alpha (1-\alpha)^{1-\alpha}} \tag{A.4}$$

$$Y_t = L_t^{1-\alpha} K_{t-1}^\alpha \tag{A.5}$$

$$Y_t = C_t + I_t \tag{A.6}$$

$$d_t = \frac{Y_t}{\bar{Y}} (1 - RMC_t) \tag{A.7}$$

$$\frac{1-\alpha}{\alpha} = \frac{RW_t^i L_t^i}{r_t^{k,i} K_{t-1}^i} \tag{A.8}$$

$$0 = \sum_{T=t}^{\infty} (\beta^i \xi^i)^{T-t} \lambda_T^i Y_T^i \left(\frac{\tilde{P}_t^i(\varepsilon)}{P_T^i} \right)^{-\theta^i} \left(\frac{\tilde{P}_t^i(\varepsilon)}{P_T^i} - \frac{\theta^i}{\theta^i - 1} RMC_T^i \right) \tag{A.9}$$

$$\begin{aligned} 0 = E_t \sum_{T=t}^{\infty} (\xi_w^i \beta^i)^{T-t} \tilde{l}_{t,T}(\tau) \left(\frac{C_T^i(\tau)}{C_t^i(\tau)} \right)^{-\sigma_c} \left(\frac{1 - \kappa(1-\sigma_c) \tilde{l}^i{}_{t,T}(\tau)^{1+\sigma_l}}{1 - \kappa(1-\sigma_c) \tilde{l}^i{}_t(\tau)^{1+\sigma_l}} \right)^{\sigma_c} \\ \left[- C_T^i(\tau) \frac{\kappa \sigma_c (1+\sigma_l) \tilde{l}^i{}_{t,T}(\tau)^{\sigma_l}}{1 - \kappa(1-\sigma_c) \tilde{l}^i{}_{t,T}(\tau)^{1+\sigma_l}} + \frac{\theta_w^i - 1}{\theta_w^i} r \tilde{w}_t^i(\tau) \right] \end{aligned} \tag{A.10}$$

$$1 + r_t = \left(\frac{\Pi_t}{\bar{\Pi}} \right)^{r_\Pi} \left(\frac{Y_t}{\bar{Y}} \right)^{r_y} \tag{A.11}$$

Note that the household budget constraint does not need to appear explicitly as it is collinear to the previous system of equations. At steady state, the key relationships are :

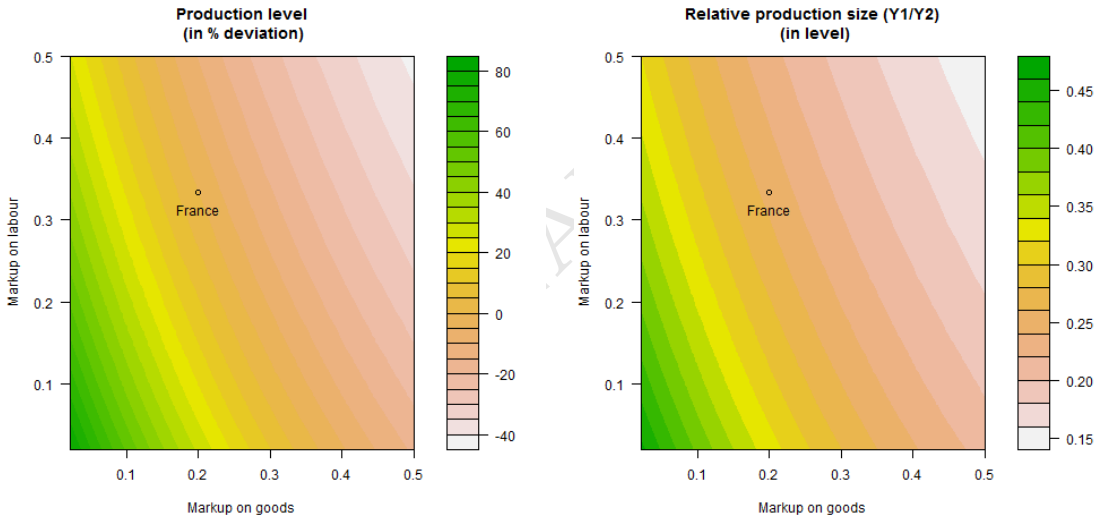
$$iy = \alpha \frac{\theta - 1}{\theta} \frac{\delta}{\bar{r}^k} \qquad cy = 1 - iy \tag{A.12, A.13}$$

$$\bar{r} = \frac{\bar{\Pi}}{\beta} - 1 \qquad \bar{r}^k = \frac{1}{\beta} - 1 + \delta = \frac{1 + \bar{r} - \bar{\Pi}}{\bar{\Pi}} + \delta \qquad \text{(A.14, A.15)}$$

$$\frac{\overline{RW}\bar{L}}{\bar{Y}} = (1-\alpha)\frac{\theta - 1}{\theta} \qquad \frac{\bar{r}^k \bar{K}}{\bar{Y}} = \alpha \frac{\theta - 1}{\theta} \qquad \text{(A.16, A.17)}$$

$$\overline{RMC} = \frac{\theta - 1}{\theta} = \frac{\overline{RW}^{1-\alpha} r^{k\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \qquad \text{(A.18)}$$

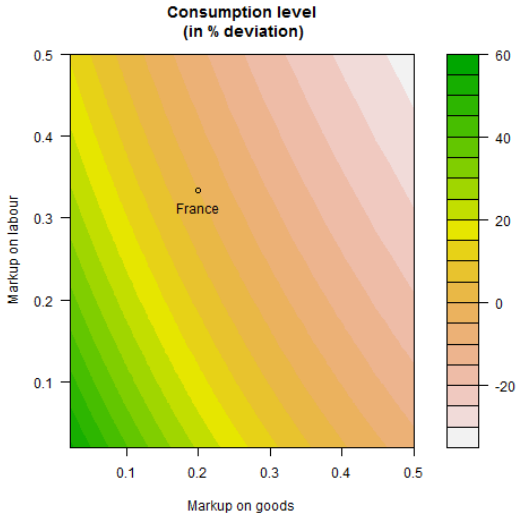
$$\frac{\overline{RW}\bar{L}}{\bar{C}} = \frac{\theta_w}{\theta_w - 1}\frac{(1+\sigma_l)\sigma_c}{1-\sigma_c}\frac{\kappa(1-\sigma_c)\bar{L}^{1+\sigma_l}}{1-\kappa(1-\sigma_c)\bar{L}^{1+\sigma_l}} = (1-\alpha)\frac{\theta - 1}{\theta cy} \qquad \text{(A.19)}$$



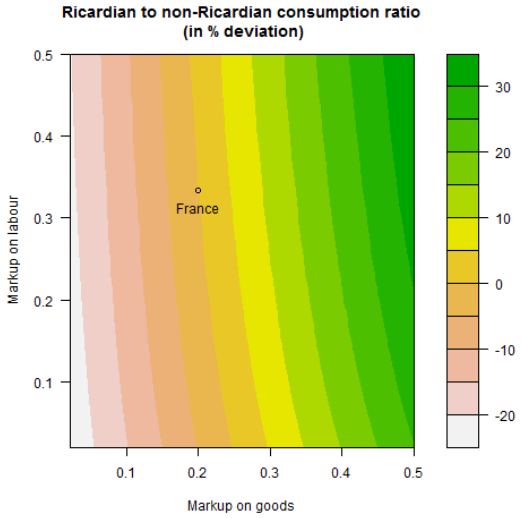
(a) Production level (b) Relative size θ

The x-axis represents the markup on goods whereas the y-axis represents the markup on labour. The initial calibration for France is symbolized by the black circle.

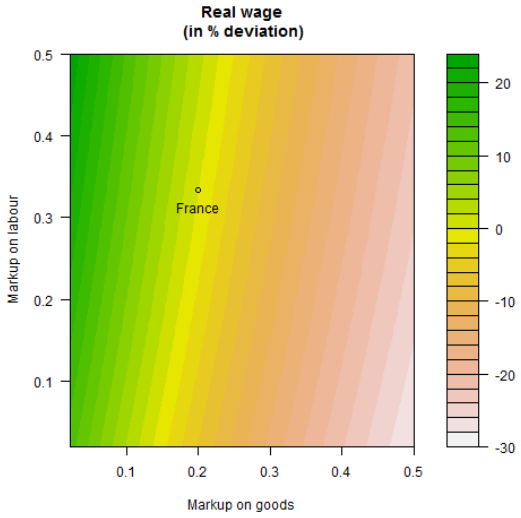
Figure 12: *MELEZE* - Long term effect of markup reforms in product and labour markets in France



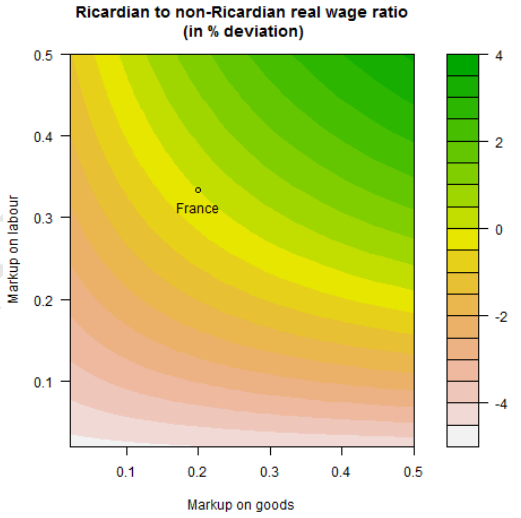
(a) Consumption level



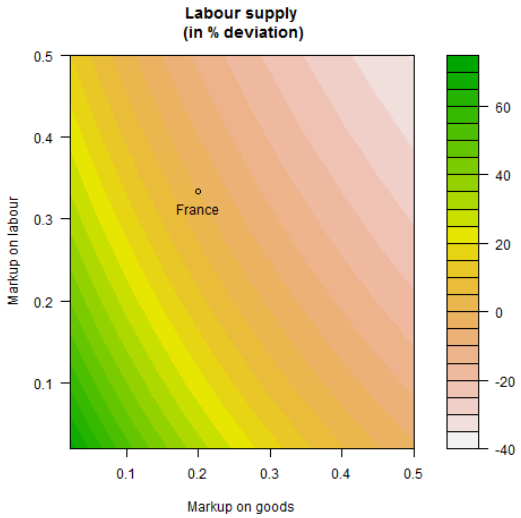
(b) *Ricardian* to *non Ricardian* consumption ratio



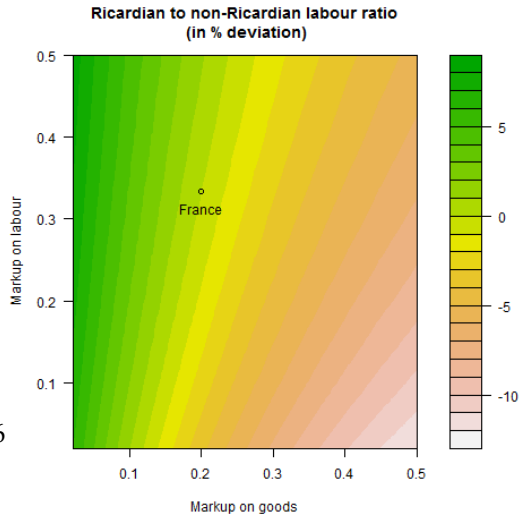
(c) Real wages



(d) *Ricardian* to *non Ricardian* real wages ratio



(e) Labour supply



(f) *Ricardian* to *non Ricardian* labour supply ratio

The x-axis represents the markup on goods whereas the y-axis represents the markup on labour. The initial calibration for France is symbolized by the black circle.

Figure 13: *MELEZE* - Long term effect of markup reforms in product and labour markets in France

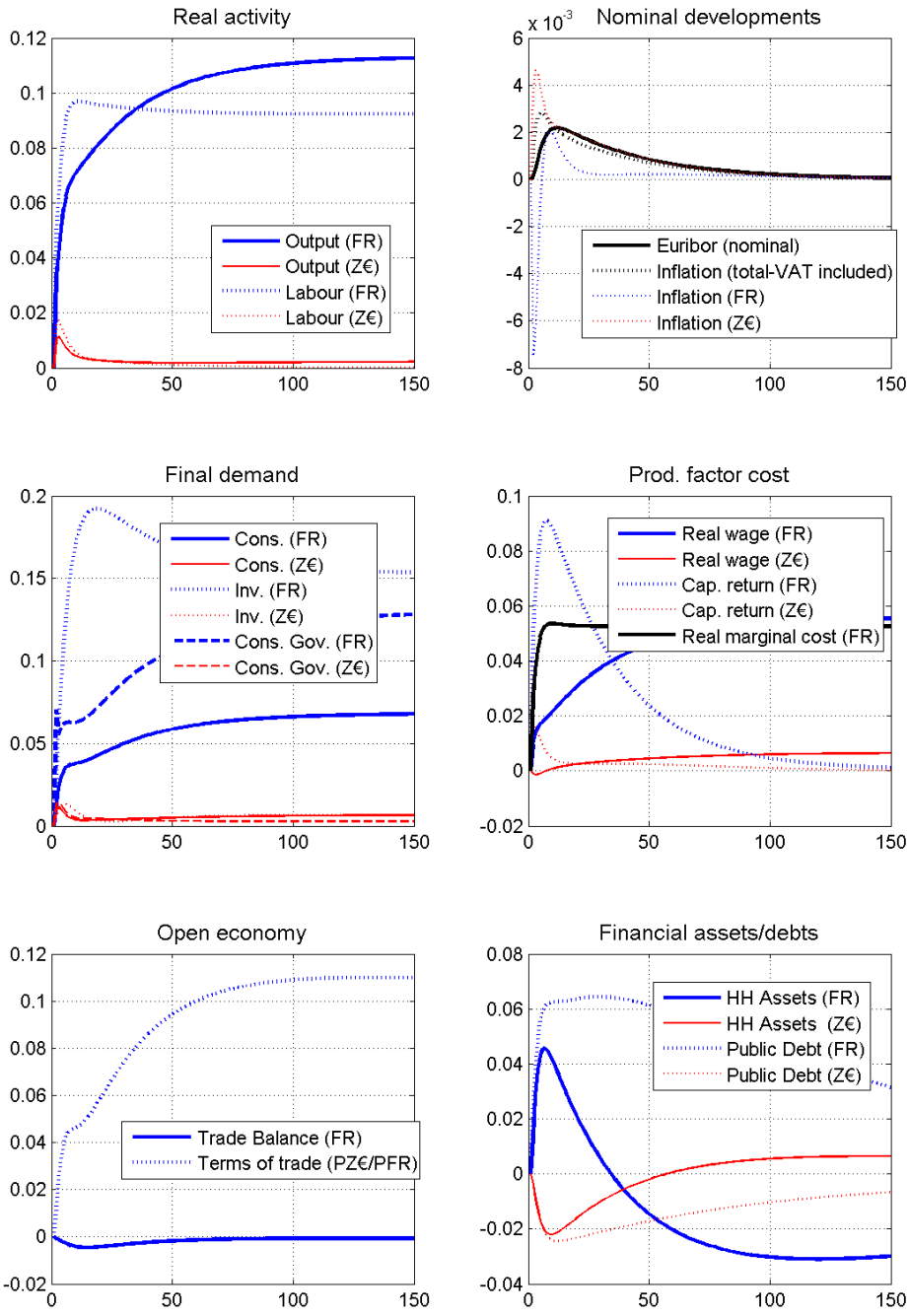


Figure 14: Transition following a decrease in the price markup following (Everaert and Schule, 2006)-*MELEZE*

These transitions are simulated in the fully specified model *MELEZE*. The price markup shock corresponds to a 6 p.p. decrease in the markup.

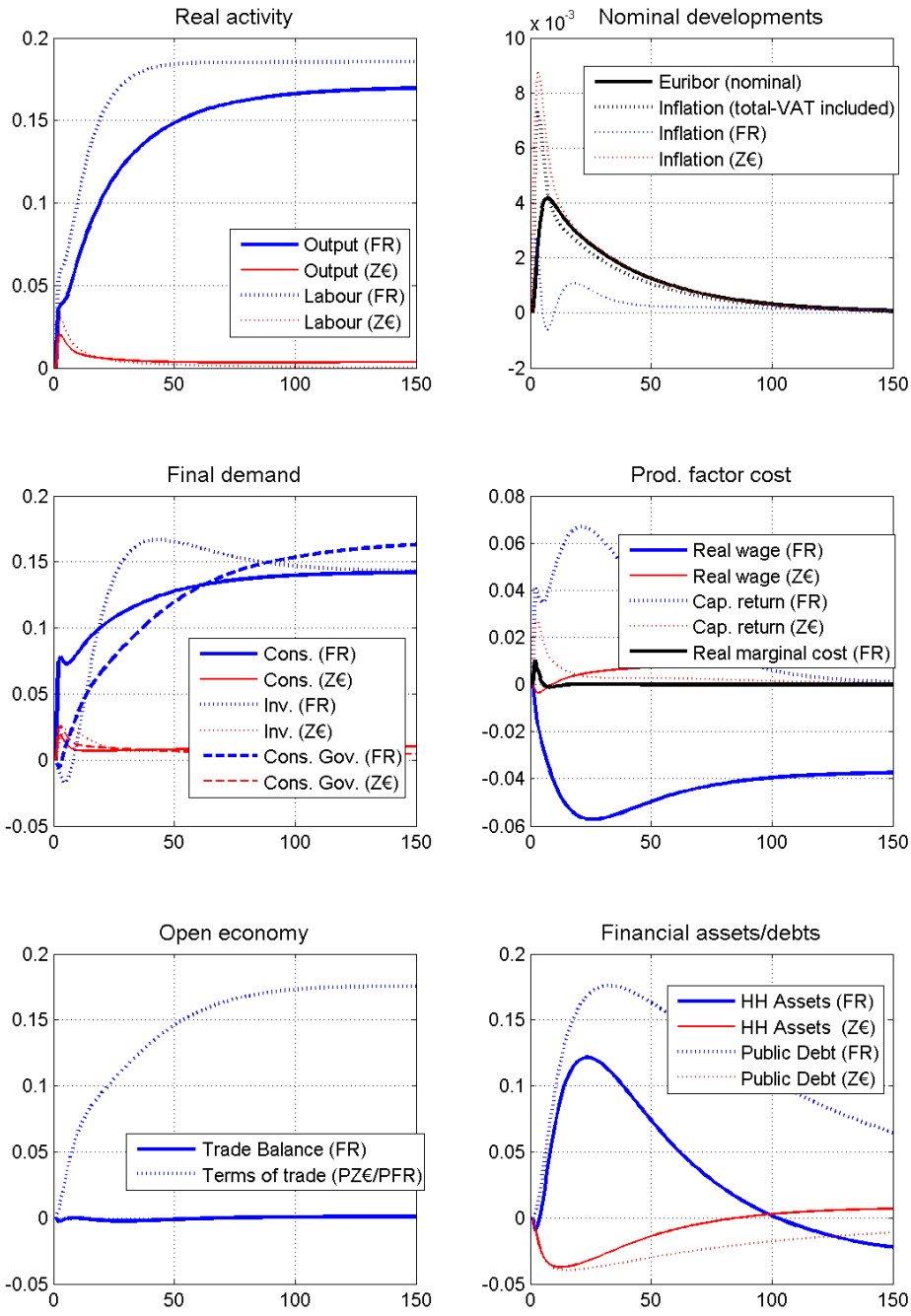
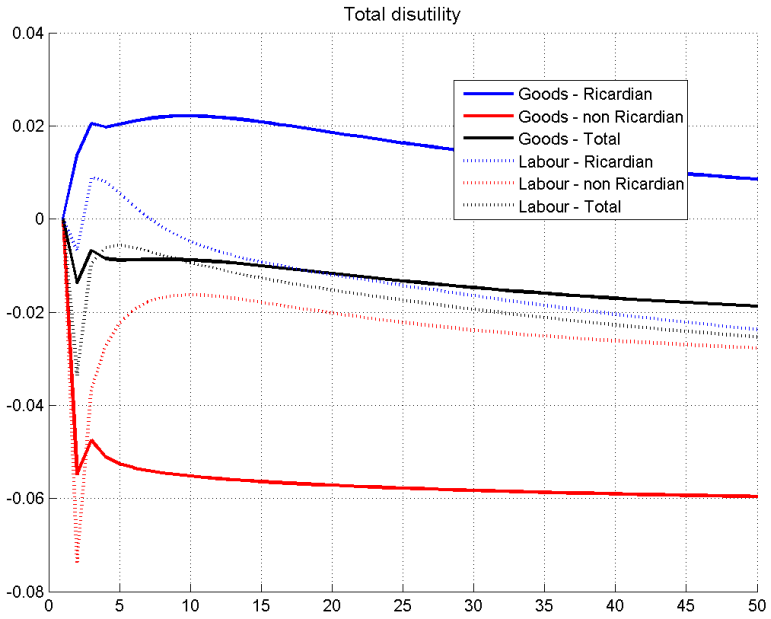


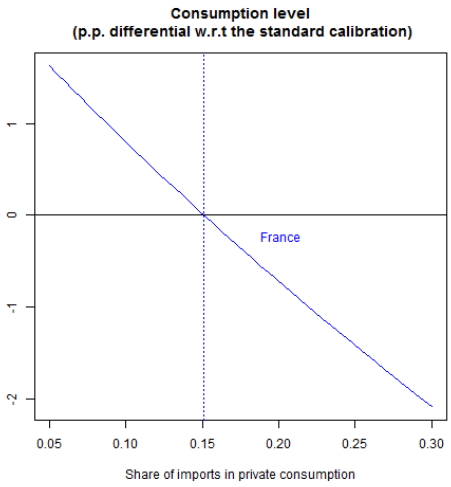
Figure 15: Transition following a decrease in the wage markup following (Everaert and Schule, 2006)-*MELEZE*

These transitions are simulated in the fully specified model *MELEZE*. The wage markup shock corresponds to a 20 p.p. decrease in the markup.

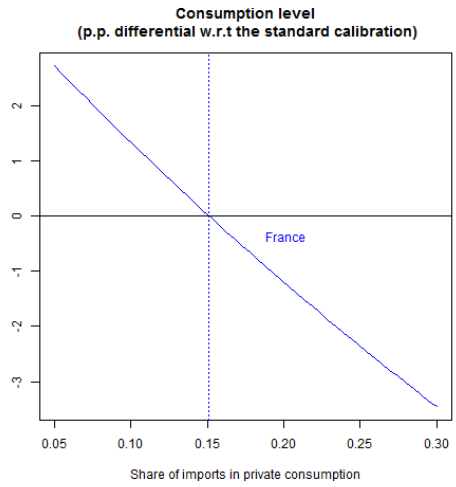


Structural reforms implemented here are the ones of Everaert and Schule (see Table 3. These graphs represent the disutility of households. Therefore a decrease in the disutility is beneficial to the household.

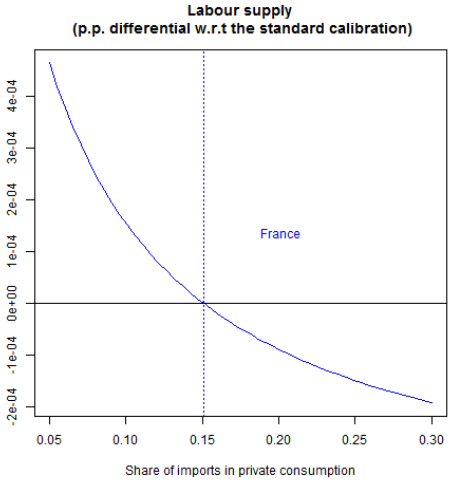
Figure 16: Instantaneous utility level following markup reforms



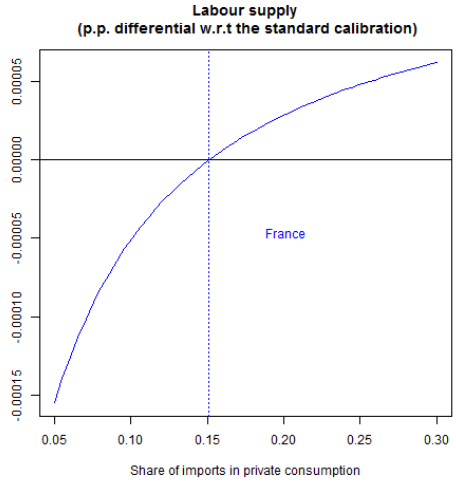
(a) Goods market - Consumption



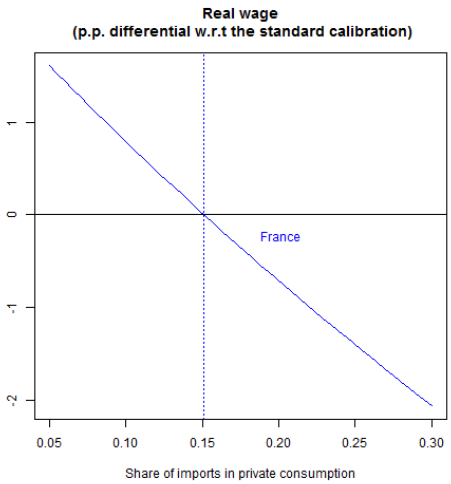
(b) Labour market - Consumption



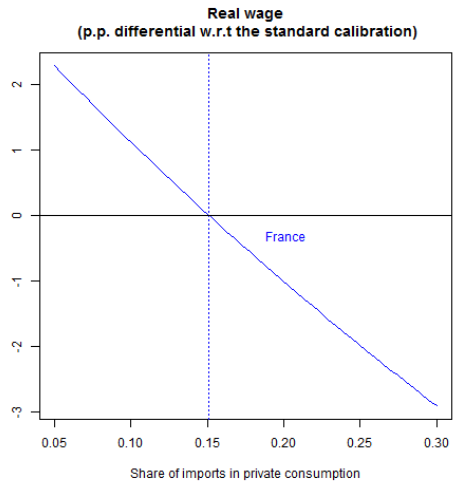
(c) Goods market - Labour



(d) Labour market - Labour



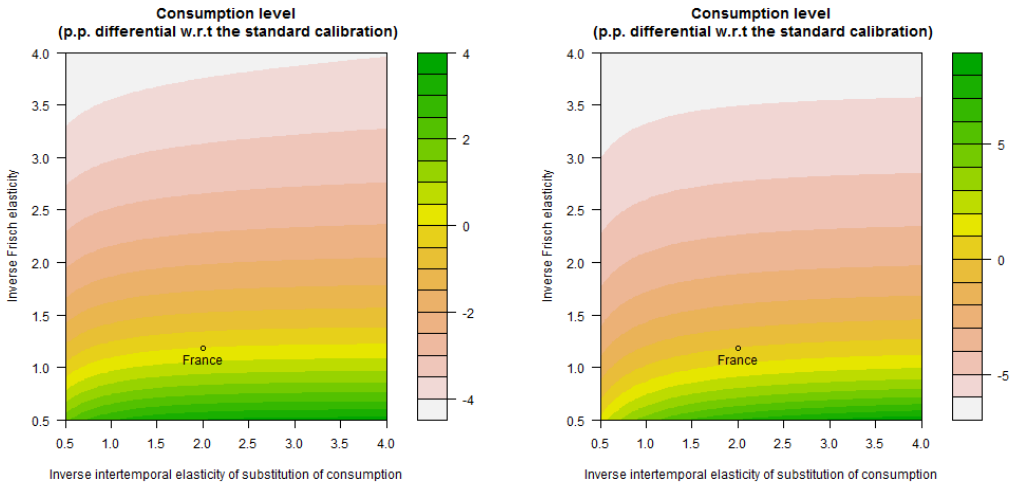
(e) Goods market - Real wages



(f) Labour market - Real wages

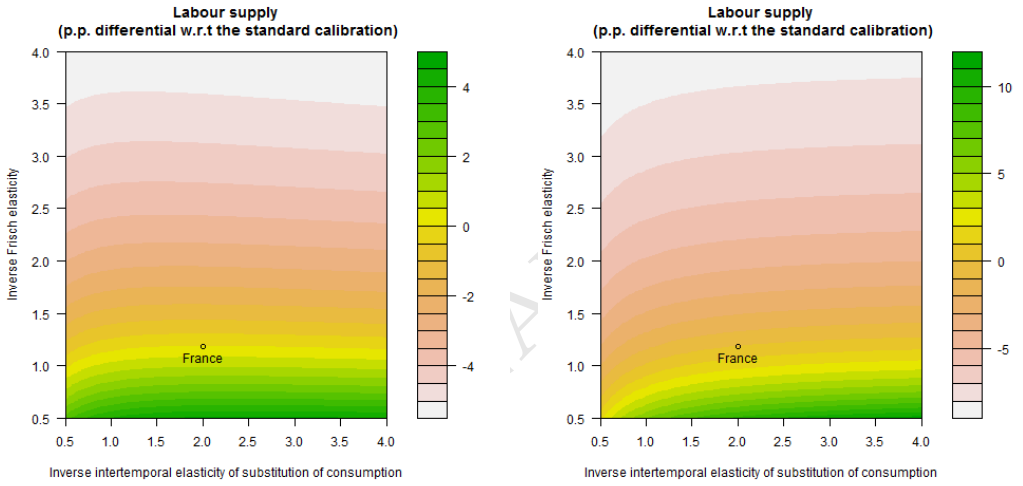
Trade openness is defined here as the share of imports in private consumption (ie α^1 in our model).
Structural reforms implemented here are the ones of Everaert and Schule (see Table 3. As a result and for instance, a 0.5 p.p. impact differential for a goods market reform translates into a total gain in production of $0.5 + 11.3 = 11.8$ p.p. (see. Table 4 for the baseline case).

Figure 17: *MELEZE* - Impact differential of structural reforms in p.p. with respect to the standard calibration depending on trade openness



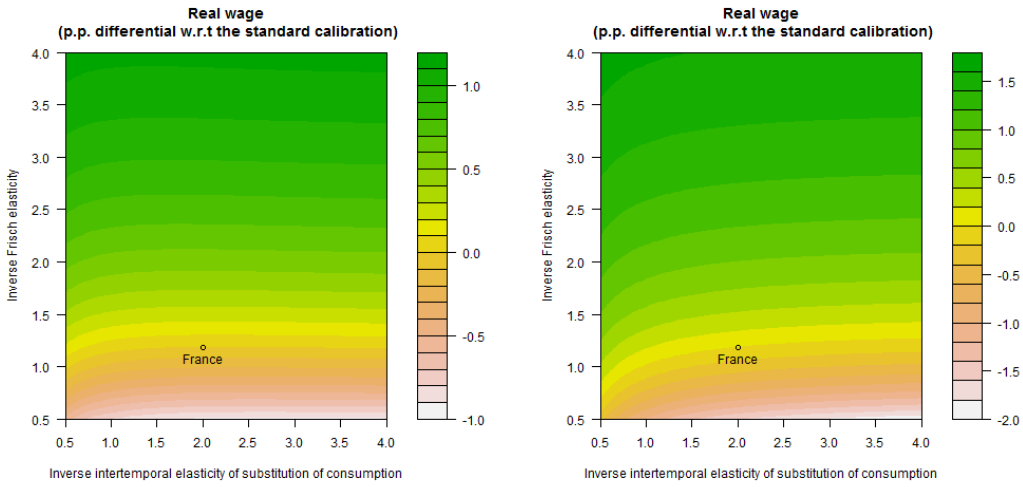
(a) Goods market - Consumption

(b) Labour market - Consumption



(c) Goods market - Labour

(d) Labour market - Labour

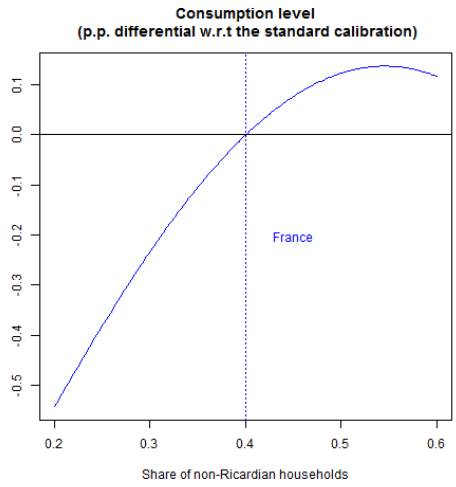


(e) Goods market - Real wages

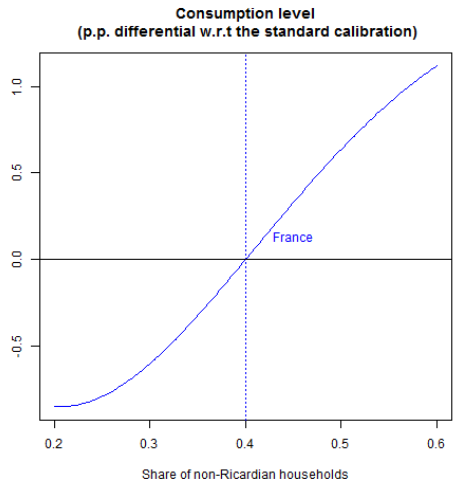
(f) Labour market - Real wages

The inverse intertemporal elasticity of substitution of consumption corresponds to σ_c^1, and the inverse Frisch elasticity to σ_l^1. Structural reforms implemented here are the ones of Everaert and Schule (see Table 3. As a result and for instance, a 0.5 p.p. impact differential for a goods market reform translates into a total gain in production of $0.5 + 11.3 = 11.8$ p.p. (see. Table 4 for the baseline case).

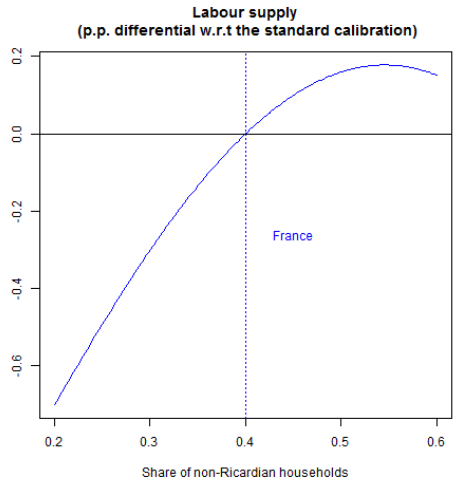
Figure 18: *MELEZE* - Impact differential of structural reforms in p.p. with respect to the standard calibration depending on the utility calibration



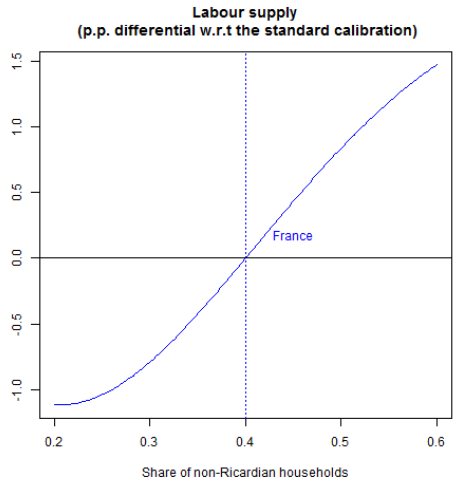
(a) Goods market - Consumption



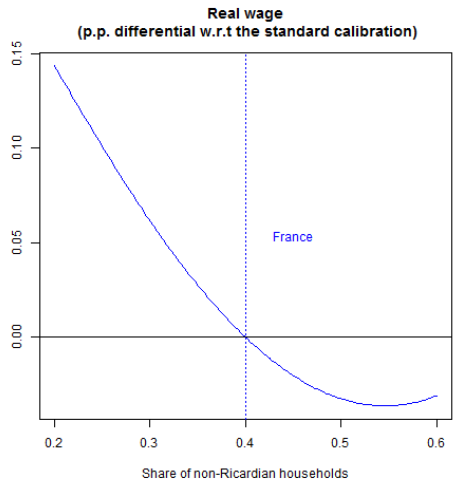
(b) Labour market - Consumption



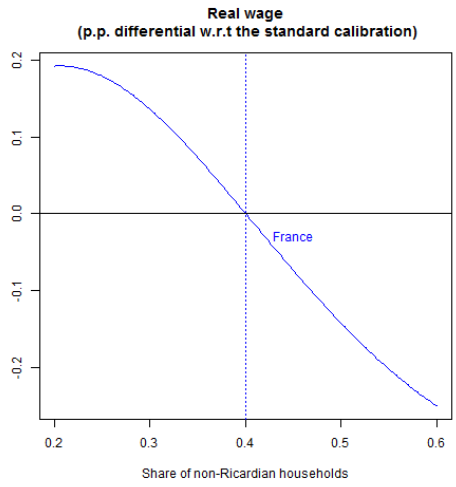
(c) Goods market - Labour



(d) Labour market - Labour



(e) Goods market - Real wages



(f) Labour market - Real wages

The share of *non Ricardian* households corresponds to μ^1.
Structural reforms implemented here are the ones of Everaert and Schule (see Table 3. As a result and for instance, a 0.5 p.p. impact differential for a goods market reform translates into a total gain in production of $0.5 + 11.3 = 11.8$ p.p. (see. Table 4 for the baseline case).

Figure 19: *MELEZE* - Impact differential of structural reforms in p.p. with respect to the standard calibration depending on the share of *non Ricardian* households

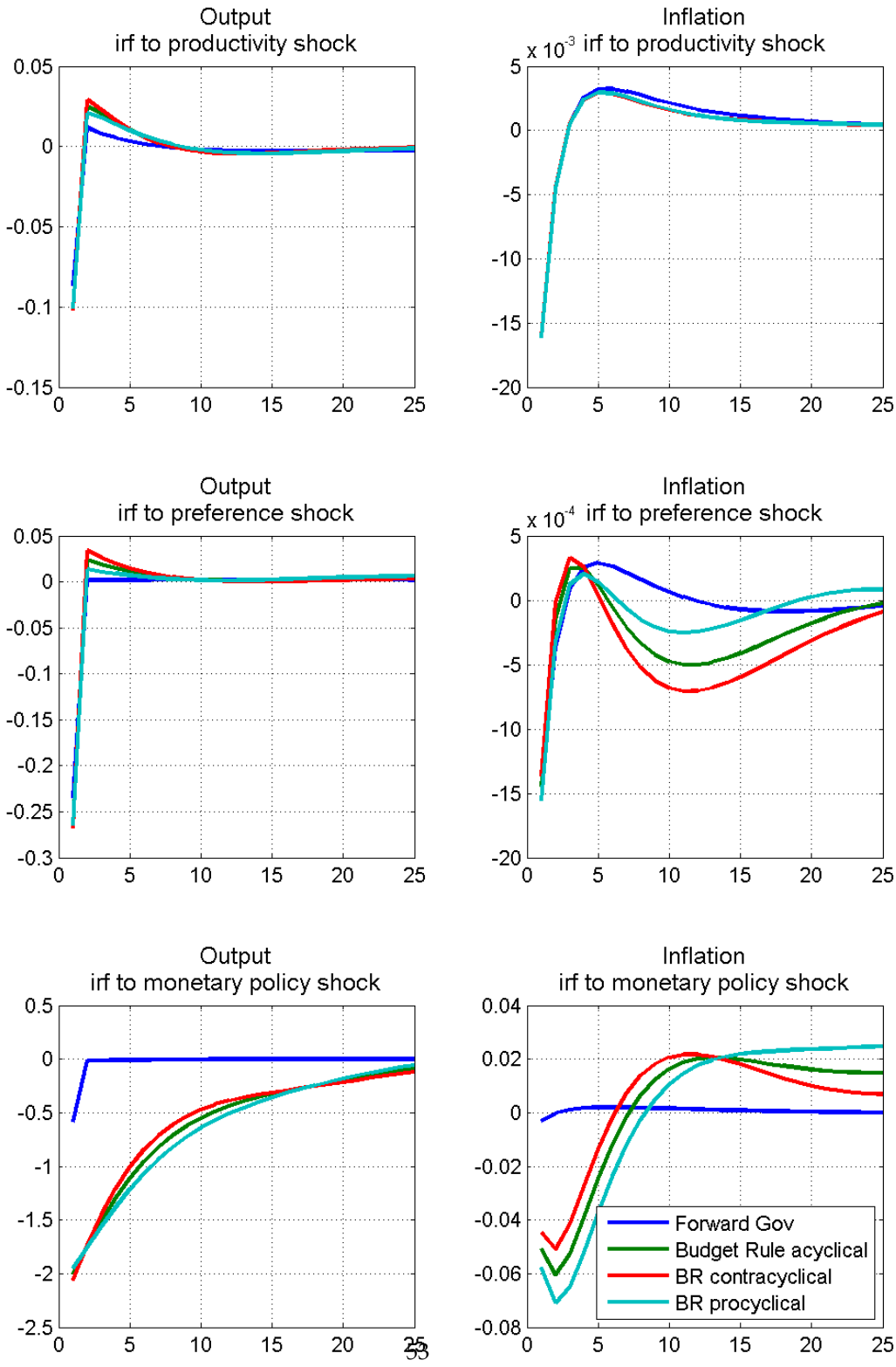


Figure 20: Compared IRF to standard shock in country 1

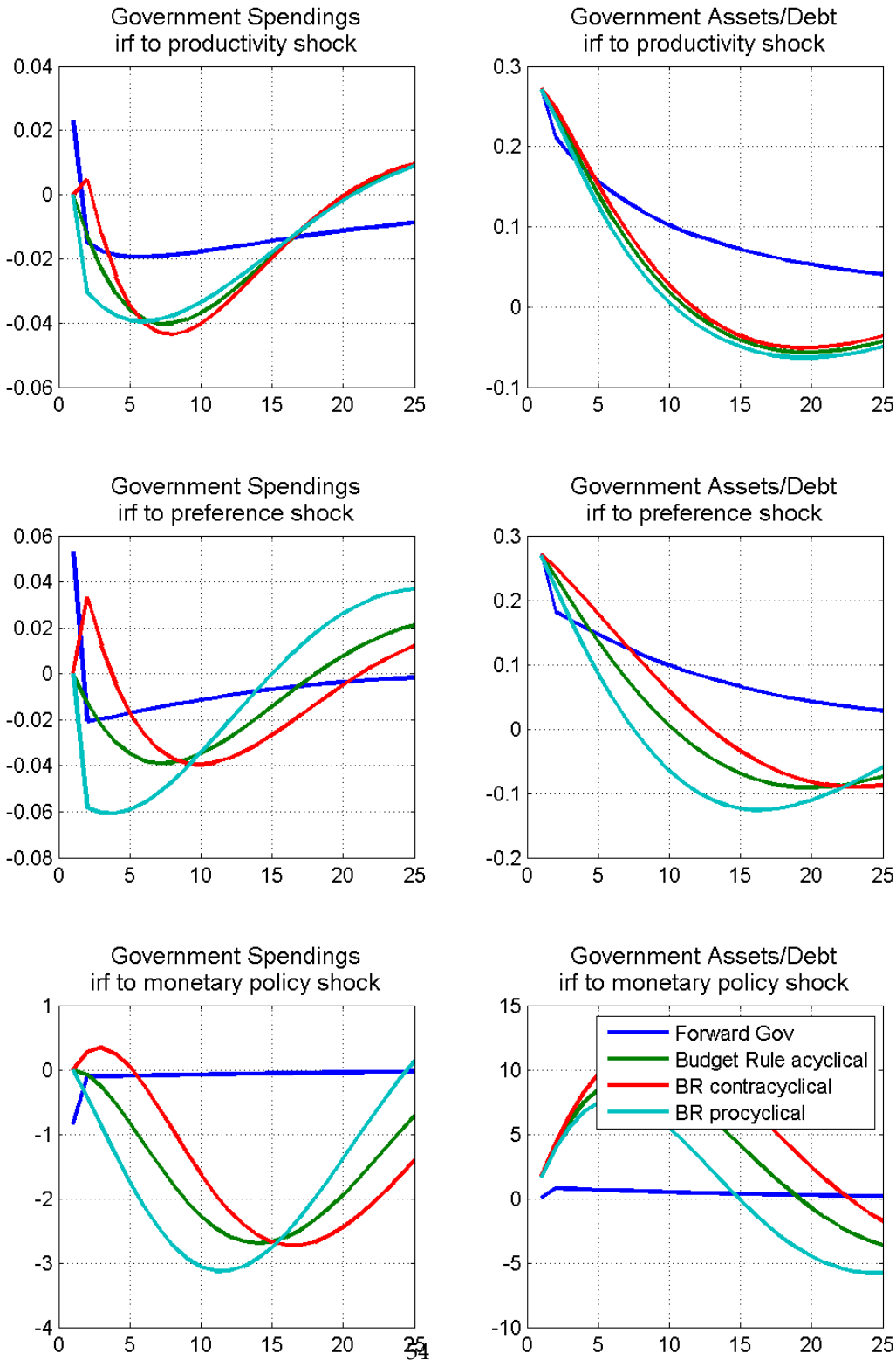


Figure 21: Compared IRF to standard shock in country 1

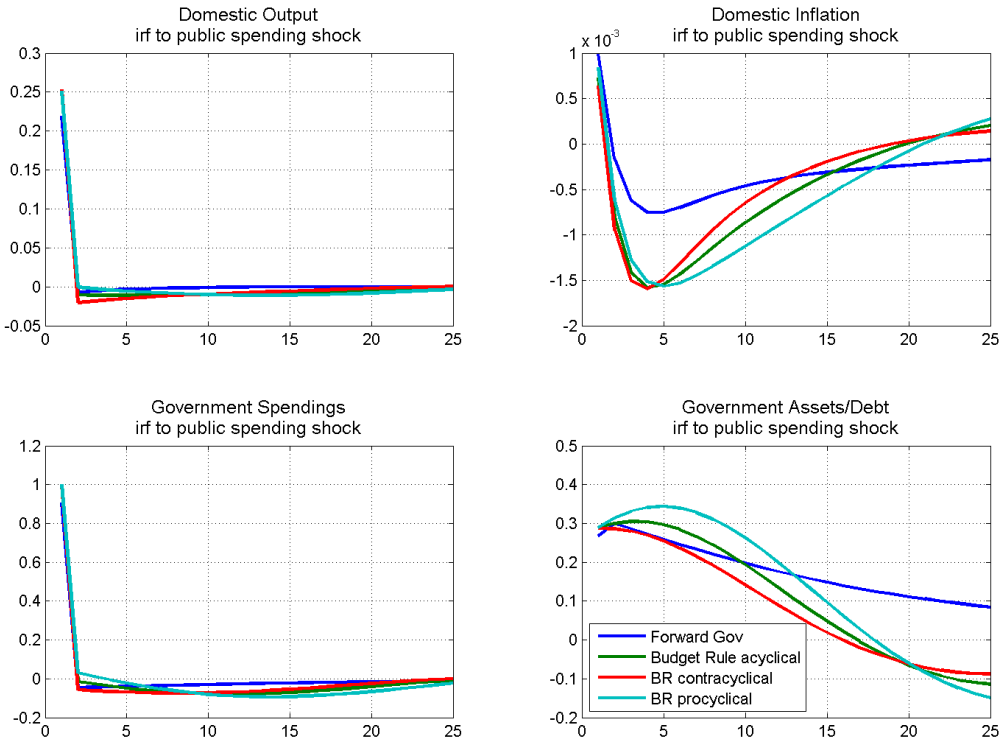


Figure 22: Compared IRF to a government spending shock in country 1

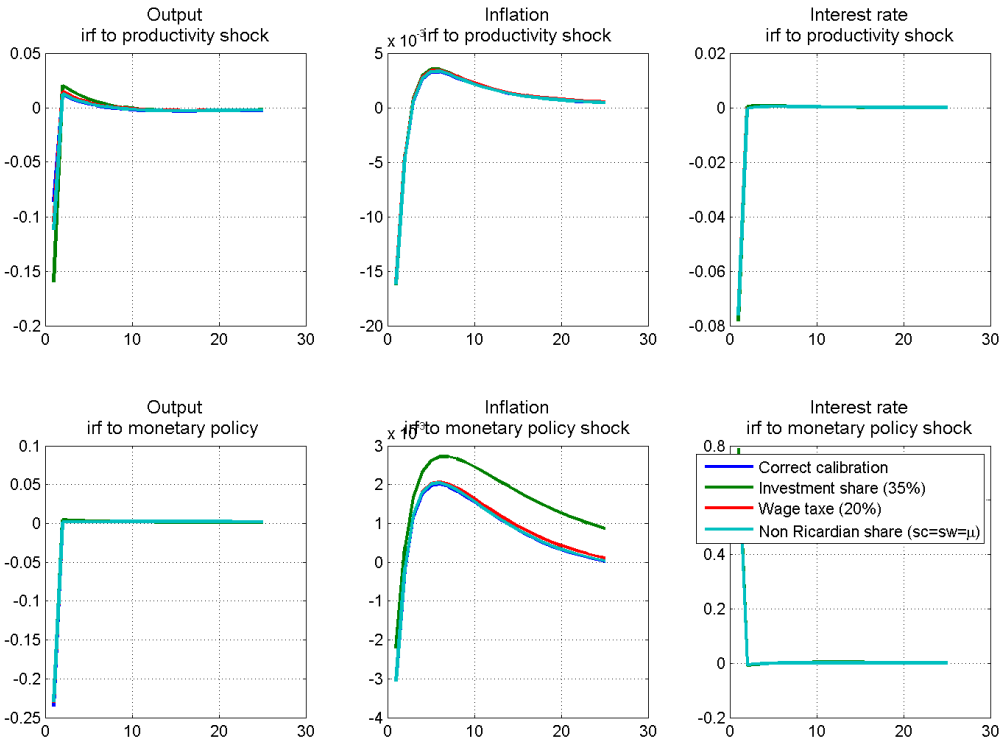


Figure 23: Reaction of consumption to a positive monetary policy shock

Y_t^i, $y^i(\varepsilon,t)$	Output in country i, resp. of firm ε
P_t^i, $P^i(\varepsilon,t)$	Production price in country i, resp. of firm ε
$\tilde{P}_t^i$, $\tilde{P}^i(\varepsilon,t)$, $\tilde{\Pi}_t^i$	Optimal price when reset in country i, resp. of firm ε and relative price $\tilde{\Pi}_t^i = \frac{\tilde{P}_t^i}{P_t^i}$
ζ_t^i	Productivity shock in country i
Δ_t^i	Dispersion index of firm size in country i
L_t^i, $l^i(\tau,t)$, $L_t^{NR,i}$, $L_t^{R,i}$	Labour supply in country i, of household τ, of *non Ricardian* or *Ricardian* households
W_t^i, $w^i(\tau,t)$, $W_t^{NR,i}$, $W_t^{R,i}$	Wages in country i, of household τ, of *non Ricardian* or *Ricardian* households
$\tilde{w}^i(\tau,t)$, $\tilde{W}_t^{R,i}$, $\tilde{W}_t^{NR,i}$	Optimal wage reset in country i by household τ, *Ricardian* or *non Ricardian* households
RW_t^i	Real wage in country i, i.e. purchasing power net of taxes incl. VAT
C_t^i, I_t^i	Consumption (Investment) in country i
$C_t^{R,i}$, $C_{j,t}^{R,i}$, $C_t^{NR,i}$, $C_{j,t}^{NR,i}$	Consumption of *Ricardian* (resp. *non Ricardian*) households in country i and of goods produced in country j
$C_{j,t}^i$, $I_{j,t}^i$	Consumption (Investment) in country i of goods produced in country j
$C_{i,t}$, $I_{i,t}$	Consumption (Investment) of goods produced in country j
λ_t^i, $\lambda_t^{R,i}$, $\lambda_t^{NR,i}$	Marginal utility of consumption
CPI_t^i	Consumption price in country i, before VAT
$RPC_t^i = \frac{CPI_t^i}{P_t^i}$	Relative price of consumption in country i
$T_t = \frac{P_t^2}{P_t^1}$	Terms of trade
Π_t^i, $\Pi_t^{c,i}$	Inflation of production and consumption prices in country i
FA_t^i, $FA^i(\tau,t)$	Financial assets in country i (resp. of household τ)
$fa_t^i = \frac{FA_t^i}{P_t^i \tilde{Y}^i}$, $\psi(fa_t^i)$	Real financial asset to GDP ratio and intermediation fees paid on these assets in country i
pa_t^i, $\psi^g(pa_t^i)$	Real public asset to GDP ratio and intermediation fees paid on these assets in country i
K_t^i, $K^i(\tau,t)$, $K^i(\varepsilon,t)$	Real capital stock in country i, of household τ or firm ε
D_t^i, $D^i(\tau,t)$	Dividends received in country i or by household τ
Φ_t^i, $\Phi^i(\tau,t)$, $\Phi_t^{R,i}$, $\Phi_t^{NR,i}$	Lump-sum public transfers in country i, to household τ, to *Ricardian* and *non Ricardian* households
ϕ_t^i, $\phi^i(\tau,t)$, $\phi_t^{R,i}$, $\phi_t^{NR,i}$	Real lump-sum public transfers to GDP ratio
FD_t^i, $FD^i(\tau,t)$	Financial dividends received in country i or by household τ
FY_t	Production of the financial sector
$\nu_t^{c,i}$, $\nu_t^{w,i}$, $\nu_t^{k,i}$	Tax rates on consumption, wages and capital returns
Γ_t^{T-1}, $\Gamma_{w,t}^{T-1}$	Indexation of prices and wages if not reset
$MC^i(\varepsilon,t)$, MC_t^i, RMC_t^i	Marginal cost of production of firm ε, in country i and in real terms
$r_t^{k,i}$	Returns on capital (in real terms)
G_t^i	Public expenditure in country i
PA_t^i	Public assets in country i
CN_t	Aggregate cash needs of the financial sector
$\tilde{Y}_t$, Π_t^{union}	Output and inflation targets of the Central Banker
$R_t = 1 + r_t$	Monetary policy rate
$GDP_t^{i,nom}$, $I_t^{GDP_r^i}$	Nominal GDP and growth index of real GDP in country i
X_t^i, M_t^i	Exports from and imports to country i
$\bar{\bullet}$, $\hat{\bullet}$	Steady state and deviation rate from steady state operators

Table 8: Definition of the endogenous and exogenous variables

p, $\mathbb{P}$, p^i	Relative, absolute and national varieties number
n, $\mathbb{N}$, n^i	Relative, absolute and national population size
θ^i, θ^i_w	Elasticity of substitution between goods/labour in country i
α^i	Import share of country i
β^i, β^i_g	Households and government discount factors
σ^i_c, σ^i_l	Inverse intertemporal elasticity of substitution and inverse Frisch elasticity in country i
σ^i_g	Inverse intertemporal elasticity of substitution on government consumption in country i
h^i_c, h^i_l	Habit parameters on consumption and labour in country i
h^i_g	Habit parameter on government consumption in country i
κ	Labour disutility weight
γ^i_p, γ^i_w	Prices and wages indexation level in country i
$1-\xi^i$, $1-\xi^i_w$	Calvo resetting probabilities on prices and wages in country i
μ^i	Share of *non Ricardian* households in country i
δ	Depreciation rate
α	Technology parameter
R^*, Π^*, ρ, r_π, r_y	Monetary policy parameters
θ^l, θ^{fa}, θ	Scale parameters in labour, financial assets and production
cy^i, gy^i, iy^i	Share of private/public consumption and investment in GDP in country i
s^i_c, s^i_{wl}	Share of *non Ricardian* households in consumption and payroll in country i

Table 9: Definition of the parameters