Structural reforms in DSGE models:
a plead for sensitivity analyses *

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Abstract

We use a standard DSGE model of the Euro Area to shed a new light on a popular exercise in these times of crisis: structural reforms evaluation. We provide with a detailed analysis of the underlying mechanisms and proceed to a sensitivity analysis. The simple redefinition of households' utility can lead to additional gains or losses of a few percentage points in output following goods or labour markets deregulations. In addition, welfare analyses show that policy recommendations for structural reforms are less clear-cut than those solely based on output gains. Introducing *non Ricardian* agents allows stylized yet informative inequality analyses showing that goods market reforms reduce inequalities while labour market reforms are neutral. In all, our results advocate for the extensive use of sensitivity analyses for policy purposes.

JEL-code: E10, E60, E20
Keywords: structural reforms, DSGE model, mark-ups, sensitivity, welfare

1 Introduction

The evaluation of structural reforms has become a standard 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. All call for such reforms as a solution to the structural imbalances and loss of competitiveness in Europe.

Indeed, there is a large consensus on the ability of such reforms to foster output. However, in these large scale models it is difficult to disentangle the core mechanisms through which deregulation affects the economy. Furthermore, despite this consensus numerical differences remains, calling for a thorough sensitivity analysis to identify sources of divergence, as well as their quantitative influence.

Therefore, we study the impact of mark-up reforms in the labour and goods markets both in the long run and in the transition in a medium scale neo-Keynesian model. In particular, we provide with a detailed analysis of the underlying mechanisms. First, simulations are globally in line with the specifically designed two period model from (Blanchard and Giavazzi, 2003).

Moreover, in line with the existing literature, we indeed find gains from pro competitive reforms. However, their effects are particularly sensitive to the modelling of households, their consumption-leisure substitution elasticity, the introduction of habits on consumption and labour, and the introduction of financially constrained households. For the same reform, output gains can differ by as much as a few percentage points of output.

Besides, such output augmenting reforms can have a negative welfare impact with standard calibrations. Also, when financially constrained households are considered, goods market reforms lead to a decrease in inequalities both in terms of consumption and utility, whereas inequalities stagnate following labour market reforms.

The underlying model builds on (Christiano et al., 2005) and (Smets and Wouters, 2003, 2005, 2007). Within this model, firms and consumers maximize their objective (utility or profit) by interacting on the goods, labour 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. This model is the core of many large scale institutional models.

The effects of structural reforms have been widely documented by D'Auria et al. (2009); Roeger et al. (2008); Varga et al. (2014) 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, the OECD or central banks have also conducted their own evaluations (Bayoumi et al., 2004; Everaert and Schule, 2006, 2008; Cacciatore et al., 2012; Forni et al., 2010). Their simulations concur to output gains of 5 to 10% following an average 15 points decrease in mark-ups. In a monetary union, (Everaert and Schule, 2006; Gomes et al., 2013) estimate positive spillovers from these reforms of approximately 1% output. In addition, these simulations also point to welfare gains. However, (Jonsson, 2007; Matheron and Maury, 2004) note that these long terms gains are partially offset by transitory losses.

The rest of the paper is organised as follows: in Section 2, we briefly recall the *Smets and Wouters* model. In Section 3, we give a short presentation of its calibration. In Section 4 we analyse the mechanisms at work in mark-up reforms in the labour and goods market both in the long run and in the transition. In Section 5 we explicate the dependency of these mechanisms to the behaviour of households (calibration of utility, liquidity constraint), as well as their impact in terms of welfare.

2 Model

This section gives a short presentation of the *Smets and Wouters'* model. Namely, it is a neo-Keynesian model in closed economy. Households operate on goods and labour markets to maximize their utility. Firms use capital and labour to produce partially substitutable goods. 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 through adjustment costs.

2.1 Households

The Euro Area is populated by a continuum of households of size $\mathbb{N}$.

Consumption and investment

Households arbitrage between consumption and savings, capital and financial assets, as well as between consumption and leisure today.

Each household τ maximises his intertemporal utility, non separable in private consumption and labour[1].

$$\max E_t \sum_{T=t}^{\infty} \beta^{T-t} \mathcal{U}_T(\tau) \mathcal{V}_T(\tau)$$

$$\text{with } \mathcal{U}_t(\tau) = \frac{1}{1-\sigma_c} \left[C(\tau,t) \left(\frac{C_{t-1}}{\mathbb{N}} \right)^{-h_c} \right]^{1-\sigma_c} \tag{2.1}$$

$$\mathcal{V}_t(\tau) = \left[1 - \kappa(1-\sigma_c) \left(l(\tau,t) \left(\frac{L_{t-1}}{\mathbb{N}} \right)^{-h_l} \right)^{1+\sigma_l} \right]^{\sigma_c}$$

subject to the budget constraint;:

$$
\begin{aligned}
FA_T(\tau) = & R_{T-1} FA_{T-1}(\tau) + w_T(\tau) l_T(\tau) \\
& - P_T C_T(\tau) + D_T(\tau) \\
& + \Phi_T(\tau) + P_T r_T^{K,i} K_{T-1}(\tau) - P_T I_T(\tau)
\end{aligned} \tag{2.2}
$$

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

where E_t, β are respectively the expectation at time t operator and the discount factor; σ_c is the inverse intertemporal elasticity of substitution; κ a weight assigned to labour in the utility function and σ_l the inverse of the Frisch elasticity. h_c, h_l are the external habit formation (on per capita level) parameters on consumption and labour. $C_t(\tau)$ and $l_t(\tau)$ are respectively the consumption and labour supply of agent τ; $w_t(\tau)$ correspond to the wage. $FA_t(\tau)$ is the financial asset holdings at the end of period t; R_t is the gross interest rate set by the monetary authority. D_t are the dividends paid by the firm to its owners. $\Phi(\tau,t)$ is a lump-sum tax to the government.

In the capital accumulation equation, $I_t(\tau)$ is the investment level with an adjustment cost[2] $\mathcal{S}\left(\frac{I_T(\tau)}{I_{T-1}(\tau)}\right)$ depending on previous period level of investment, and $K_t(\tau)$ is the capital stock of households depreciating at rate δ. As a result, households pay for the full investment allotment $I_T(\tau)$ and a share $\mathcal{S}\left(\frac{I_T(\tau)}{I_{T-1}(\tau)}\right)$ is

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[1]We follow the non separable utility form advocated by (King et al., 2002) in the presence of growth in the model. The choice of a specific non separable utility function follows (Trabandt and Uhlig, 2011), under this form, σ_l is the constant inverse Frisch elasticity.

[2]See (Christiano et al., 2005; Smets and Wouters, 2003, 2005, 2007). We follows these authors and assume $\mathcal{S} = 0$, $\mathcal{S}' = 0$ and $\mathcal{S}'' > 0$ at steady state.

lost in the installation process. $\epsilon_T^{i,I}$ represents an exogenous shock to this cost.

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

$$\beta E_t \left\{ \frac{\mathcal{U}'_{t+1}(\tau)\mathcal{V}_{t+1}(\tau)}{\mathcal{U}'_t(\tau)\mathcal{V}_t(\tau)} \frac{R_t}{\Pi_{t+1}} \right\} = 1 \tag{2.4}$$

$$1 = q_t(\tau)\epsilon_t^{i,I} \left(1 - \mathcal{S}\left(\frac{I_t(\tau)}{I_{t-1}(\tau)}\right) - \mathcal{S}'\left(\frac{I_t(\tau)}{I_{t-1}(\tau)}\right) \frac{I_t(\tau)}{I_{t-1}(\tau)} \right)$$

$$+ \beta E_t \left\{ \frac{\mathcal{U}'_{t+1}(\tau)\mathcal{V}_{t+1}(\tau)}{\mathcal{U}'_t(\tau)\mathcal{V}_t(\tau)} q_{t+1}(\tau)\epsilon_{t+1}^{i,I} \mathcal{S}'\left(\frac{I_{t+1}(\tau)}{I_t(\tau)}\right) \left(\frac{I_{t+1}(\tau)}{I_t(\tau)}\right)^2 \right\} \tag{2.5}$$

$$q_t(\tau) = \beta E_t \left\{ \frac{\mathcal{U}'_{t+1}(\tau)\mathcal{V}_{t+1}(\tau)}{\mathcal{U}'_t(\tau)\mathcal{V}_t(\tau)} \left(q_{t+1}(\tau)(1-\delta) + r_{t+1}^{k,i} \right) \right\} \tag{2.6}$$

with Π_{t+1} price inflation between t and $t+1$.

Labour supply and wage setting

Households provide labour on a monopolistically competitive market. An employment agency aggregates labour supplied and provides firms with an homogeneous labour bundle. The relationship between total demand for labour and each household supply is a function of the demanded wage over aggregate wage (Equation 2.7). In this context, households are paid with a mark-up over their marginal disutility of labour.

$$l_t(\tau) = \left(\frac{w_t(\tau)}{W_t} \right)^{-\theta_w} \frac{L_t}{\mathbb{N}} \tag{2.7}$$

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

Linearising the first order conditions around the steady state yields the following wage Phillips curve:

$$\widehat{RW}_t - \widehat{RW}_{t-1} + (\hat{\Pi}_t - \gamma_w \hat{\Pi}_{t-1}) =$$
$$\tilde{\beta}(1+g)\left(\widehat{RW}_{t+1} - \widehat{RW}_t + (\hat{\Pi}_{t+1} - \gamma_w \hat{\Pi}_t) \right)$$
$$+ \frac{(1 - \tilde{\beta}\xi_w(1+g))(1-\xi_w)}{\xi_w(1 + \theta_w((1+\sigma_l)(1+\mathcal{B}) - 1))} \left[-\widehat{RW}_t - \hat{L}_t + (1+\sigma_l)(1+\mathcal{B})(\hat{L}_t - h_l\hat{L}_{t-1}) + \hat{C}_t \right]. \tag{2.8}$$

with $\mathcal{B}$ a function of the parameters of the model, $\tilde{\beta}$ a function of β, g the exogenous growth rate of TFP,[3] θ_w the elasticity of labour demand to wages. RW_t corresponds to the real wage defined as W_t/P_t.

2.2 Firms

Demand for production factors

Firms produce partially substitutable goods from labour and capital. They hire domestic labour at cost W_t. In addition, firms rent capital $K_t^d(\varepsilon)$ from households at cost r^k.[4] We assume installation delays so that at market equilibrium and on aggregate $K_t^d = K_{t-1}$.

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[3]$\mathcal{B} = \frac{\theta_w - 1}{\theta_w} \frac{\theta-1}{\theta} \frac{(1-\alpha)(1-\sigma_c)(1-\eta)}{(1+\sigma_l)\sigma_c cy}$ and $\tilde{\beta} = \beta(1+g)^{(1-\sigma_c)(1-h_c)-1}$

[4]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 terms the rental cost of capital equals $r_t^k K_t^d(\varepsilon)P_t$.

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

$$y_t(\varepsilon) = (\zeta_t L_t(\varepsilon))^{1-\alpha} \left(K_t^d(\varepsilon) \right)^{\alpha} \tag{2.9}$$

with cost $W_t L_t(\varepsilon) + r_t^k P_t K_t^d(\varepsilon)$, $\tag{2.10}$

where ζ is the exogenous total factor productivity whose deterministic trend grows at rate g and α is the share of capital in value added. The arbitrage condition between labour and capital demand yields:

$$\frac{1-\alpha}{\alpha} = \frac{W_t L_t(\varepsilon)}{r_t^k K_t^d(\varepsilon) P_t} \quad \text{and on aggregate} \quad \frac{1-\alpha}{\alpha} = \frac{W_t L_t}{r_t^k K_{t-1} P_t} \tag{2.11}$$

and the real marginal cost of production:

$$RMC_t = \frac{MC_t}{P_t} = \frac{1}{\alpha^\alpha (1-\alpha)^{1-\alpha}} \left(\frac{RW_t}{\zeta_t} \right)^{1-\alpha} \left(r_t^k \right)^{\alpha} \tag{2.12}$$

Price setting

Partial substitutability allows firm to price a mark-up over their marginal cost. We assume a *Calvo* price setting. Firm ε reset its price $\tilde{P}_t(\varepsilon)$ with an exogenous probability $(1 - \xi)$ 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.[5]

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

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

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

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

2.3 Central bank and government

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 and the output gap.

$$R_t = R_{t-1}^\rho \left(R^* \left(\frac{\Pi_t}{\Pi^*} \right)^{r_\pi} \left(\frac{Y_t}{\bar{Y}} \right)^{r_y} \right)^{1-\rho} \tag{2.15}$$

Public consumption G_t is assumed exogenous, and financed by lump-sum taxes Φ.

3 Steady state and calibration

In the present model, growth is exogenous. In the long run, all real variables grow at the same rate as TFP. At steady state, we assume that inflation equals the central bank's target.

We calibrate the model based on (Smets and Wouters, 2005).[6] We marginally depart from this estimation by adjusting the mark-ups to better compare our simulations with other market reforms evaluations (in particular (Everaert and Schule, 2008)). Table 1 compares our model at steady state with actual data for the Euro Area (12). Table 2 presents our calibration of structural parameters.

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[5]This price indexation is necessary in a model with steady state inflation
[6]The calibration constraints are further detailed in (Campagne and Poissonnier, 2015).

	DATA	MODEL
	EA (12)	EA
Output in 2000 (GDP)*	6943	6943
Output per capita growth rate**	1.2%	1.2%
Working age population in 2000 ***	135.9	135.9
Hours worked per week and working age capita (since 2000)	34.3	34.3
Gross Op. Surplus to VA	46%	42%
Gross wages to VA	53%	58%
Nominal 3 month Euribor**	3.8%	4.0%
Inflation**	2.0%	2.0%
Private consumption to GDP ratio	56.3%	56.9%
Public consumption to GDP ratio	19.7%	19.7%
Investment to GDP ratio	21.9%	23.5%

Sources: Eurostat (National accounts, inflations, Euribor, population, Labour Force Survey -incl. Secondary job)
Data are averaged from 1995 to 2007 to exclude the crisis. Depending on availability, samples may start after 1995 and/or exclude some countries from the Euro Area (12).
* in billion € in current prices
** annualised
*** aged from 15 to 64 in millions

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

4 Understanding the mechanisms of structural reforms in goods and labour markets

4.1 What should we expect ?

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 should always be output enhancing to decrease mark-ups to zero to reach perfect competition. On the contrary, in endogenous growth models such as (Romer, 1990), mark-ups and monopolistic powers may be necessary to allow and stimulate innovation and growth. Such a mechanism is at play for the intermediate good sector in (Roeger et al., 2008).

(Blanchard and Giavazzi, 2003) construct a two period model to study the impact of structural reforms on the goods and labour market. The specificities of this model are an endogenous determination of the number of firms (linked to goods substitutability), both monopolistic competition and entry costs on the goods market and a reservation wage and Nash bargaining on the labour market.

In their framework, a decrease in the bargaining power of workers leads in the short run to both an increase in the firms' profits and a fall in real wages, but no change in unemployment. Larger profits then attract new firms, which in turn increase labour demand and real wages. Eventually, the price mark-up decreases as new firms stir up competition. In the end, unemployment is lowered by the reform and real wages are back to the initial steady state. In all, labour market reforms come with a trade-off: *lower real wages in the short run in exchange for lower unemployment in the long run (Blanchard and Giavazzi, 2003).*

As for goods market reforms, they consider two possibilities: a change in the elasticity of substitution which in the short run increases real wages and employment but is eventually neutralized by new firms entry; a decrease in entry costs which is neutral in the short run but increases goods substitutability in the long run as well as real wages and employment. In the *Smets and Wouters* model the two types of reforms can not be distinguished, their combination is implemented by a permanent increase in goods substitutability.

Technology			
Technology parameter	α	0.3	(Smets and Wouters, 2005)
Depreciation rate	δ	0.025	*idem*
Capital rigidity	S	6.17	*idem*
TFP growth rate	g	0.003	Eurostat
Population size	$\mathbb{N}$	135 922 100	Eurostat
Monetary policy			
Inflation	Π^*	1.005	Consensus, ECB
Smoothing parameter	ρ	0.85	(Smets and Wouters, 2005)
Weight on inflation	r_π	1.4	*idem*
Weight on output gap	r_y	0.11	*idem*
Prices and Wages			
Substitutability between goods	θ	6	QUEST III, GEM, NAWM, EAGLE [♯]
Substitutability between workers	θ_w	4	*idem*
Price rigidity	ξ	0.90	(Smets and Wouters, 2005)
Wage rigidity	ξ_w	0.92	*idem*
Price indexation	γ_p	0.29	*idem*
Wage indexation	γ_w	0.90	*idem*
Preferences			
Households discount factor	β	0.9983	SS constraint
Risk aversion	σ_c	1.13	(Smets and Wouters, 2005)
Inverse Frisch elasticity	σ_l	2	*idem*
Consumption habits	h_c	0.61	*idem*
Labour habits	h_l	0	*idem*
Weight on labour disutility	κ	5812.38	SS constraint on hours worked

[♯](Roeger et al., 2008; Bayoumi et al., 2004; Everaert and Schule, 2008; Coenen et al., 2008; Gomes et al., 2013)

Table 2: Structural parameters

(Cacciatore et al., 2012) incorporate some ideas from (Blanchard and Giavazzi, 2003) in a DSGE model: endogenous firms entry and Nash bargaining between workers and firms. The dynamic on the labour market is modelled by a search and matching mechanism. This feature differs from the *Smets and Wouters* model and implies in particular that following a labour market reform, there can be a short term increase in unemployment. The (Blanchard and Giavazzi, 2003) trade-off may be even more problematic.

4.2 Long term effect in the *Smets and Wouters* model

In the *Smets and Wouters* model, as in most other DSGE models, long term growth is exogenous. However, long term GDP and other real variables in level depend on structural parameters in a way we can compute.

The long term equilibrium is the result of supply for production factors by households and demand for these factor by firms.
Firms' profit maximization implies the following demands

$$\text{for capital} \quad \frac{\theta-1}{\theta}\alpha\zeta^{1-\alpha}\left(\frac{\bar{K}}{\bar{L}}\right)^{\alpha-1} = \bar{r}^k \tag{4.1}$$

$$\text{for labour} \quad \frac{\theta-1}{\theta}(1-\alpha)\zeta^{1-\alpha}\left(\frac{\bar{K}}{\bar{L}}\right)^{\alpha} = \overline{RW} \tag{4.2}$$

On households' side, the supply for capital is perfectly elastic because households can substitute financial savings for investment. They provide capital as long as its remuneration is equivalent to that of financial savings $\bar{r}^k = \overline{rr} + \delta$. As for labour, their supply is given by their individual consumption-leisure arbitrage:

$$\overline{RW} = \frac{\theta_w}{\theta_w-1}(1+\sigma_l)\bar{c}\frac{\sigma_c}{1-\sigma_c}\frac{\kappa(1-\sigma_c)\bar{l}^{(1+\sigma_l)(1-h_l)-1}}{1-\kappa(1-\sigma_c)\bar{l}^{(1+\sigma_l)(1-h_l)}} = \frac{\theta_w}{\theta_w-1}(1+\sigma_l)\bar{c}f(\bar{l}) \tag{4.3}$$

with $\bar{c}, \bar{l}$ individual consumption and labour supply respectively and f an increasing function of labour supply for hours work below *24/7*.

Reform on the goods market   A decrease in firms' market power on the goods market ($\theta \uparrow$) fosters output in the long run through three channels. First, as the distortion from the perfectly competitive equilibrium is reduced, firms capture less dividends in the production process and distribute more to factor remuneration at given output, hence higher costs (Figure 3). Firms then try to compensate this drop in the intensive margin by an increase in production (extensive margin): the demand for production factors is then scaled-up (direct effect of θ in Equations (4.1) and (4.2), the demand curves on Figure 1 shift from D1 to D').

In a second round effect, the demand for both factor increases (from D' to D2) as the productivity of each factor is fostered by the other (effect of L in Equation (4.1) and K in Equation (4.2)).

Finally, the supply curve for capital is unchanged (investment crowds out financial savings to meet firms increased demand for capital), but the supply curve for labour is shifted downwards by the increase in consumption consecutive to higher income (from S1 to S2 on Figure 1b), Equation (4.3)).[7]

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[7]These results are in particular compatible with (Blanchard and Giavazzi, 2003). A permanent increase in the elasticity of substitution across goods eventually leads to higher real wages and labour.

a) Capital market   b) Labour market
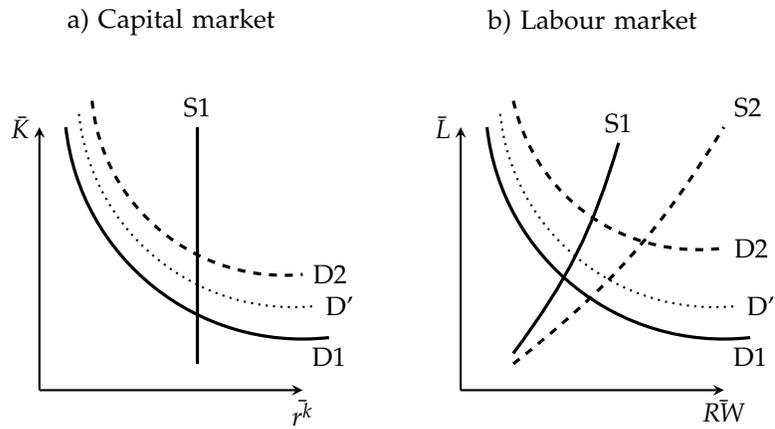
Figure 1: Effect of lower firms' market power $\theta \uparrow$ on the capital and labour market

a) Capital market   b) Labour market
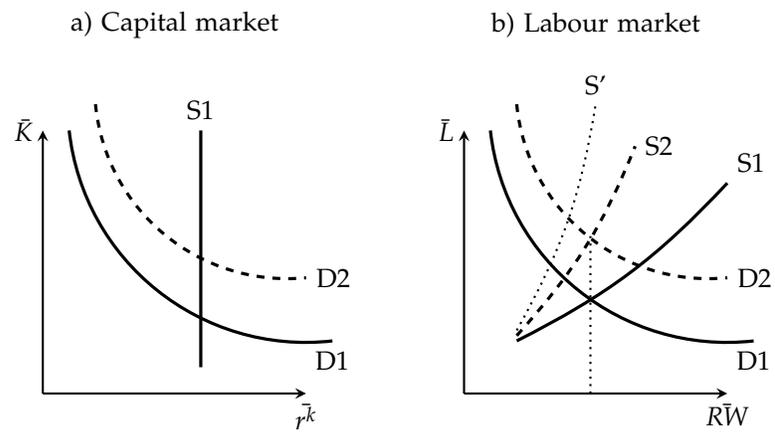
Figure 2: Effect of lower workers' market power $\theta_w \uparrow$ on the goods and labour market

labour share
$$\frac{\overline{RW}\bar{L}}{\bar{Y}} = (1-\alpha)\frac{\theta-1}{\theta}$$

profits
$$\bar{d} = \frac{1}{\theta}$$

$\theta \uparrow$

capital share
$$\frac{\bar{r}^k\bar{K}}{\bar{Y}} = \alpha\frac{\theta-1}{\theta}$$
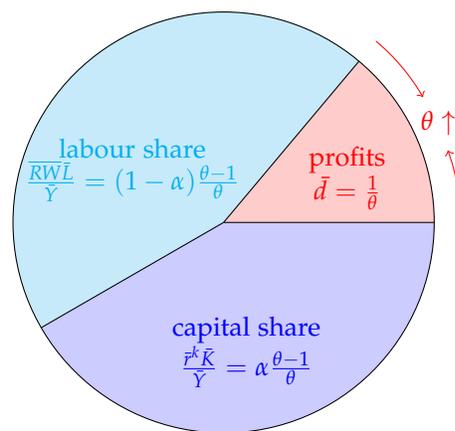
Figure 3: Decomposition of production

Reform on the labour market   A decrease of households' market power on the labour market directly affects the labour supply curve (Equation (4.3)). As they lost market power, households can not withhold their supply as much for a given wage rate (S1 shifts to S' on Figure 2b).

As labour supply increases, so does capital productivity and in turn firms' demand for this production factor. Symmetrically this increased capital demand fosters labour productivity and firms demand for this second production factor. In all, demand curves shift upwards from D1 to D2 on Figure 2.

Following a reform on the labour market, the relative use of capital and labour is fixed as the return on capital is anchored by the monetary policy rate (Equation (4.1)). Consequently the real wage is also unchanged by the reform (Equation (4.2)).[8] As a consequence, households adjust their consumption leisure arbitrage by substituting labour for consumption (labour supply shifts from S' to S2 on Figure 2b).

In all, capital and labour increase in the same proportion as output. As a consequence, so does investment and because of market clearing so does consumption. Labour market reforms thus result in an homothetic transformation of real quantities.

Long term elasticities   Having clarified the underlying key mechanisms leading to an increase in output, we compute the long term elasticity of output to structural reforms on the goods market to better understand the determinants of the scale of gains. In (Campagne and Poissonnier, 2015), we solve for the steady state equilibrium in an extended version of the model. These equations can be simplified according to the *Smets and Wouters* set-up.

From the production function we have :

$$\bar{Y} = \bar{\zeta}\left(\alpha\frac{\theta-1}{\theta}(\frac{1}{\tilde{\beta}}-1+\delta)^{-1}\right)^{\frac{\alpha}{1-\alpha}}\bar{L} \tag{4.4}$$

From households consumption-leisure arbitrage:

$$\bar{L} = \left(\frac{1}{\tilde{\kappa}}\frac{\mathcal{B}}{\mathcal{B}+1}\right)^{\frac{1}{(1+\sigma_l)(1-h_l)}} \tag{4.5}$$

where $\tilde{\beta} = \beta(1+g)^{(1-\sigma_c)(1-h_c)-1}$, $\mathcal{B} = \frac{\theta_w-1}{\theta_w}\frac{\theta-1}{\theta}\frac{(1-\alpha)(1-\sigma_c)}{(1+\sigma_l)\sigma_c cy}$, $cy = \bar{C}/\bar{Y}$ and $\tilde{\kappa} = \kappa(1-\sigma_c)\left(\mathbb{N}\right)^{-(1-h_l)(1+\sigma_l)}$.

Also, from the market clearing the shares of final demands in total output verify:

$$1 = cy + iy + gy \tag{4.6}$$

with the ratio of government expenditure to output *gy* being exogenous and the ratio of investment to output *iy* given by the equilibrium on the capital market:

$$\alpha\frac{\theta-1}{\theta} = \frac{\overline{rr}+\delta}{g+\delta}iy \tag{4.7}$$

Finally, in equilibrium the real wage verifies:

$$\overline{RW} = \bar{\zeta}\left(\alpha\frac{\theta-1}{\theta}(\frac{1}{\tilde{\beta}}-1+\delta)^{-1}\right)^{\frac{\alpha}{1-\alpha}}(1-\alpha)\frac{\theta-1}{\theta} \tag{4.8}$$

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[8]These results are also in line with (Blanchard and Giavazzi, 2003). A decrease in workers market power eventually leads to higher labour but has no effect on real wages.

Differentiating these equilibrium equations with respect to θ or θ_w we get the following elasticity of output to goods market reforms:

$$\frac{d\bar{Y}}{\bar{Y}} = \left(\frac{\alpha}{1-\alpha} + \frac{1}{(1+\sigma_l)(1-h_l)(1+\mathcal{B})}\left(1+\frac{iy}{cy}\right)\right)\frac{\frac{d\theta}{\theta}}{\theta-1} \tag{4.9}$$

and to labour market reforms:

$$\frac{d\bar{Y}}{\bar{Y}} = \frac{1}{(1+\sigma_l)(1-h_l)(1+\mathcal{B})}\frac{\frac{d\theta_w}{\theta_w}}{\theta_w-1} \tag{4.10}$$

We also compute the long term elasticity of households' utility to structural reforms on the goods market:

$$\frac{d\bar{U}}{\bar{U}} = (1-\sigma_c)(1-h_c)\left[\left(\frac{\alpha}{1-\alpha}-\frac{iy}{cy}\right) + \frac{1-\frac{\theta_w-1}{\theta_w}\frac{\theta-1}{\theta}\frac{(1-\alpha)(1-h_l)}{(1-h_c)cy}}{(1+\sigma_l)(1-h_l)(1+\mathcal{B})}\left(1+\frac{iy}{cy}\right)\right]\frac{\frac{d\theta}{\theta}}{\theta-1} \tag{4.11}$$

and on the labour market:

$$\frac{d\bar{U}}{\bar{U}} = (1-\sigma_c)(1-h_c)\frac{1-\frac{\theta_w-1}{\theta_w}\frac{\theta-1}{\theta}\frac{(1-\alpha)(1-h_l)}{(1-h_c)cy}}{(1+\sigma_l)(1-h_l)(1+\mathcal{B})}\frac{\frac{d\theta_w}{\theta_w}}{\theta_w-1} \tag{4.12}$$

In all four cases, the elasticity crucially depends on households utility parametrisation (σ_l, σ_c, $\mathcal{B}$),[9] which calls for a detailled sensitivity analysis (Section 5).

The effect of both types of reforms on output and other real variables is positive (Figure 4). Decreasing product and labour mark-ups to the level of Europe's best performers would imply roughly 10% increases in such variables.

The sign of the elasticity of utility is however ambiguous. This ambiguity does not stem from the term $1-\sigma_c$ whose sign is the same as the steady state utility $\bar{U}$ but in a more complicated way from the other terms.

With our calibration, the effect on utility of an output augmenting structural reform is negative (disutility increases, Figure 5).[10] Following either reform, both consumption and labour supply increase, contributing in opposite ways to households utility. In addition, habits (as in Abel (1990); Fuhrer (2000)) add a negative externality to welfare: the general increase in consumption mitigates the gains from each households' higher consumption (Figure 5b and 5c).

4.3 Transition dynamics

We simulate labour and goods markets reforms comparable to the scenarios proposed by (Everaert and Schule, 2006). They consider an increase in competition up to the average level of the three best European performers, being Denmark, Sweden and the United Kingdom. The reform corresponds to a shift from 33 to 13% mark-up on labour and 20 to 14% mark-up on goods. Figure 6 and 7 present the transition of the economy to the new steady state after such reforms. Quantitative aspects are commented in the next section on sensitivity analysis.

---

[9]Note that the sign of $\mathcal{B}$ is the sign of $1-\sigma_c$ and equation 4.5 implies that $1+\mathcal{B} > 0$ for the labour level to be well-defined, as $\mathcal{B}/\bar{k} > 0$. Moreover, $\bar{U}$ is also of the sign of $1-\sigma_c$

[10]We choose to refer to the disutility has the steady state level of utility is negative. As such, a negative p.p. differential of utility indicates a lesser negative utility level, that is an improvement in utility. An interpretation in terms of disutility is more convenient and intuitive as a negative p.p. differential of disutility is indeed a decrease in the disutility.
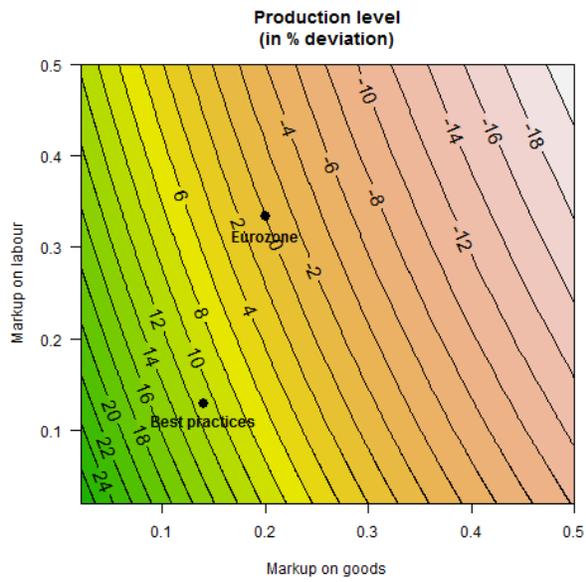
(a) Production
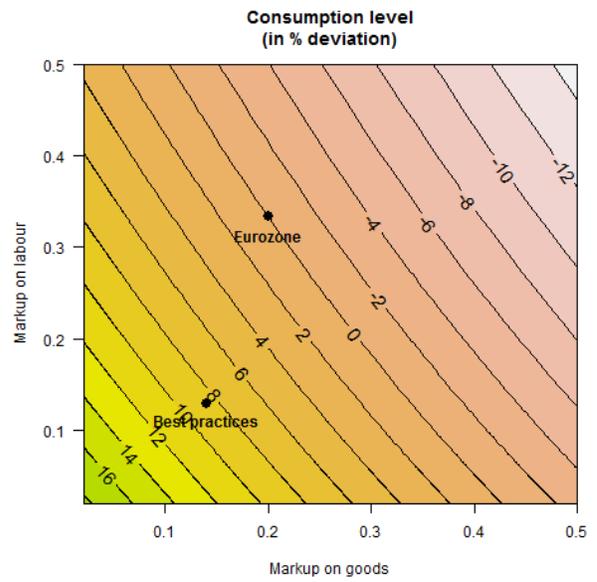
(b) Consumption
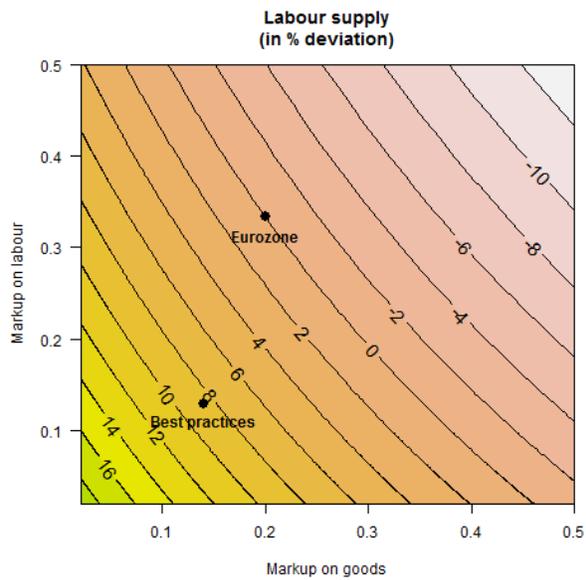
(c) Labour
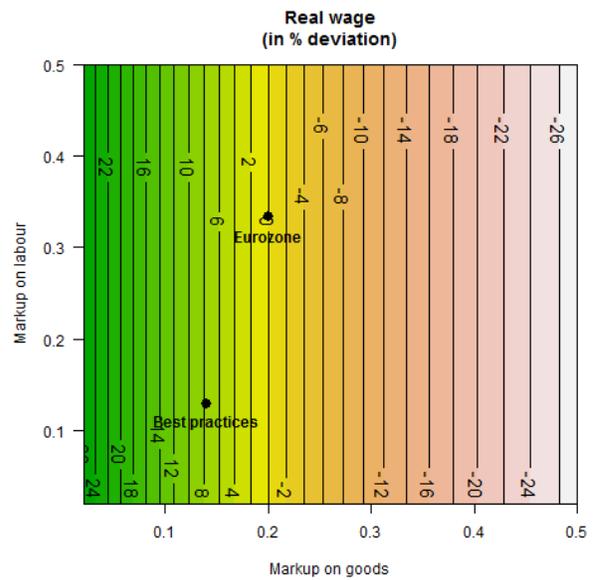
(d) Real wage

The x-axis represents the level of mark-up on goods (i.e. $1/\theta - 1$) whereas the y-axis represents the mark-up on wages (i.e. $1/\theta_w - 1$). The point named *Eurozone* corresponds to the standard calibration of our model and the point *Best practices* to the level of mark-ups in the three best European practices, namely Denmark, Sweden and the United Kingdom, as defined in (Everaert and Schule, 2006).

Figure 4: Steady state variations upon reforms in p.p. with respect to the initial calibration
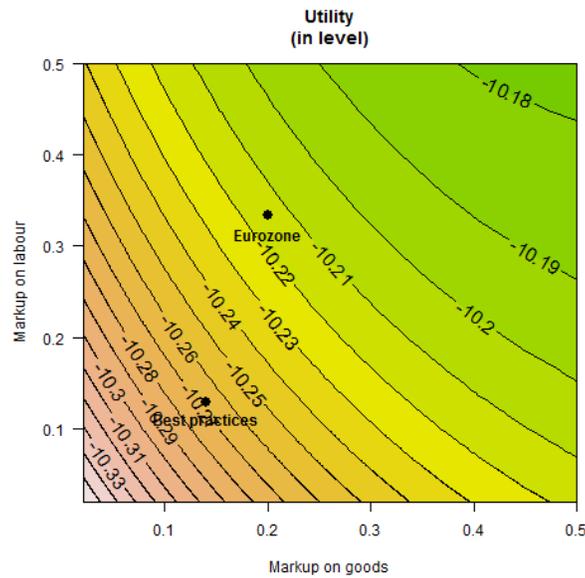
(a) Total utility
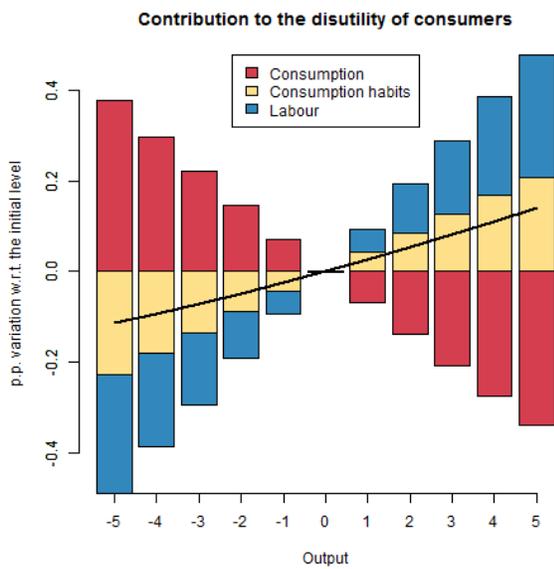
(b) Goods market deregulation
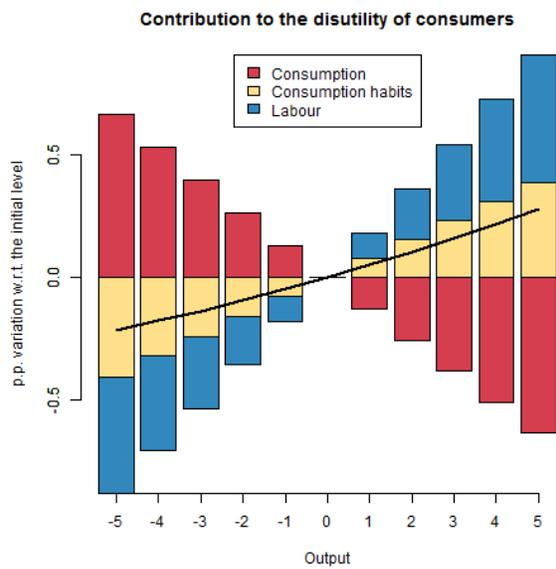
(c) Labour market deregulation

Upper figures: The x-axis represents the level of mark-up on goods (i.e. $1/\theta - 1$) whereas the y-axis represents the mark-up on wages (i.e. $1/\theta_w - 1$). The point named *Eurozone* corresponds to the standard calibration of our model and the point *Best practices* to the level of mark-ups in the three best European practices, namely Denmark, Sweden and the United Kingdom, as defined in (Everaert and Schule, 2006).

Lower figures: Decomposition of changes in disutility following deregulation reforms against the output increase induced by the reform. We represent the disutility of households. A increase in the disutility is therefore detrimental to the households.

The x-axis indexes structural reforms (θ or θ_w) by their impact on output.

Figure 5: Steady state utility levels and decomposition upon reforms

Deregulation on the goods market - Figure 6   Increasing competition on the goods market ($\theta^i \uparrow$ or price markup $= \theta^i/(\theta^i - 1) \downarrow$) induces an immediate change in the distribution of production factors remuneration as explicated in the previous section. 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 in the short term. On the capital market, adjustment through quantities being sluggish, the return on capital temporarily increases. On the labour market, the real wages only gradually increase, the labour demand overshoots in the short run.[11]

In nominal terms, the reform will eventually imply a decrease in prices. This expected deflation prevails in the Phillips curve compared to the increase in the real marginal cost. As inflation temporarily decreases, so does the nominal interest rate.

On households' side, the consumption-leisure-investment arbitrage is modified 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 increases upon reform to take advantage of the favourable return on capital, this investment is financed through increased labour supply and crowding out of financial savings. Consumption rapidly increases (without overshooting) in line with the increase in the permanent income (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 (Section 4.2).

In terms of utility (Figure 7), as labour supply overshoots in the transition to finance an early increase in investment and consumption, the disutility of labour outweighs the gains from higher consumption: there is a transition cost to the reform (Jonsson, 2007; Matheron, 2002; Matheron and Maury, 2004). In the long run, goods market reforms can be detrimental to welfare as well. We show how this result depends on the specification of utility in a sensitivity analysis (Section 5).

Deregulation on the labour market - Figure 6   Following an increase in competition on the labour market ($\theta_w^i \uparrow$ or wage markup $= \theta_w^i/(\theta_w^i - 1) \downarrow$), output, labour, consumption will eventually increase in the same proportion.

As for the goods market reform but in a lesser extend, in the transition, labour supply overshoots to finance the increase in consumption and investment, in line with higher capital demand and higher permanent income.

The labour supply overshoot increases capital returns, which in turns causes investment to overshoot. It also generates a small transitory decrease in real wages.[12] In all, the real marginal cost temporarily increases which puts upward pressure on prices. The monetary policy rate also adjusts upward.

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.

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[11]This increase of both real wages and labour in the transition is in line with the short term effect of a goods market reform in (Blanchard and Giavazzi, 2003).

[12]As mentioned by (Blanchard and Giavazzi, 2003) there is a trade-off between lower real wages in the short run against higher employment in the long run. However, as wages are sticky in our model, rapid and large gains in labour supply outweigh the small decrease in real wages in terms of income.

In terms of utility (Figure 7), there is also a cost to the reform in the transition and in the long run. We analyse this result more specifically in Section 5.

For both types of reforms, within a year most of the output gains are achieved, and convergence is obtained within 15 years.

5   A sensitivity analysis

In order to ease comparison, transitions presented on Figure 6 correspond, as mentioned above, to the implementation of structural reforms as described in (Everaert and Schule, 2006). In our baseline, product (resp. labour) market reforms lead to an permanent increase in production of 4.8 p.p (resp. 5.5 p.p.), whereas this increase is of a mere 1.6 p.p (resp. 6.1 p.p.) in the GEM model.

At first sight, structural reforms are output-enhancing in both models. Whereas magnitudes are close for labour market reforms, still with a long term difference of 0.6 p.p in production, this gap widens to more than 3 p.p. of production in the case of product market reforms.

Indeed, our model remains a synthetic DSGE model along the lines of *Smets and Wouters*, without the additional rigidities often incorporated in larger institutional DSGE models, and without a distinction between tradable and non tradable goods: results should obviously differ. However, and even though directly comparing results might be partially misleading, one should be cautious to carefully understand the size of production gains. In particular, we showed in Equations 4.9 and 4.10 that the impact of reforms crucially depends on the behaviour of households through their utility function.

Therefore, in this section, we focus on the impact of the specification of households' utility on the strength of structural reforms. In addition, we will take a deeper look at the implications in terms of welfare, and to the changes occurring when introducing hand-to-mouth households as it is common in institutional DSGE models.

5.1   Calibration of households' utility

Range of values   As highlighted in (Everaert and Schule, 2006), the estimation and identification of the utility function 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 the different versions of Smets and Wouters' model with $\sigma_l = 2.4$ (Smets and Wouters, 2003), $\sigma_l = 2.0$ (Smets and Wouters, 2005) and $\sigma_l = 1.9$ (Smets and Wouters, 2007). 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). The different versions of Smets and Wouters give $\sigma_c = 1.3$ in (Smets and Wouters, 2003), $\sigma_c = 1.1$ in (Smets and Wouters, 2005) and $\sigma_c = 1.4$ in (Smets and Wouters, 2007).
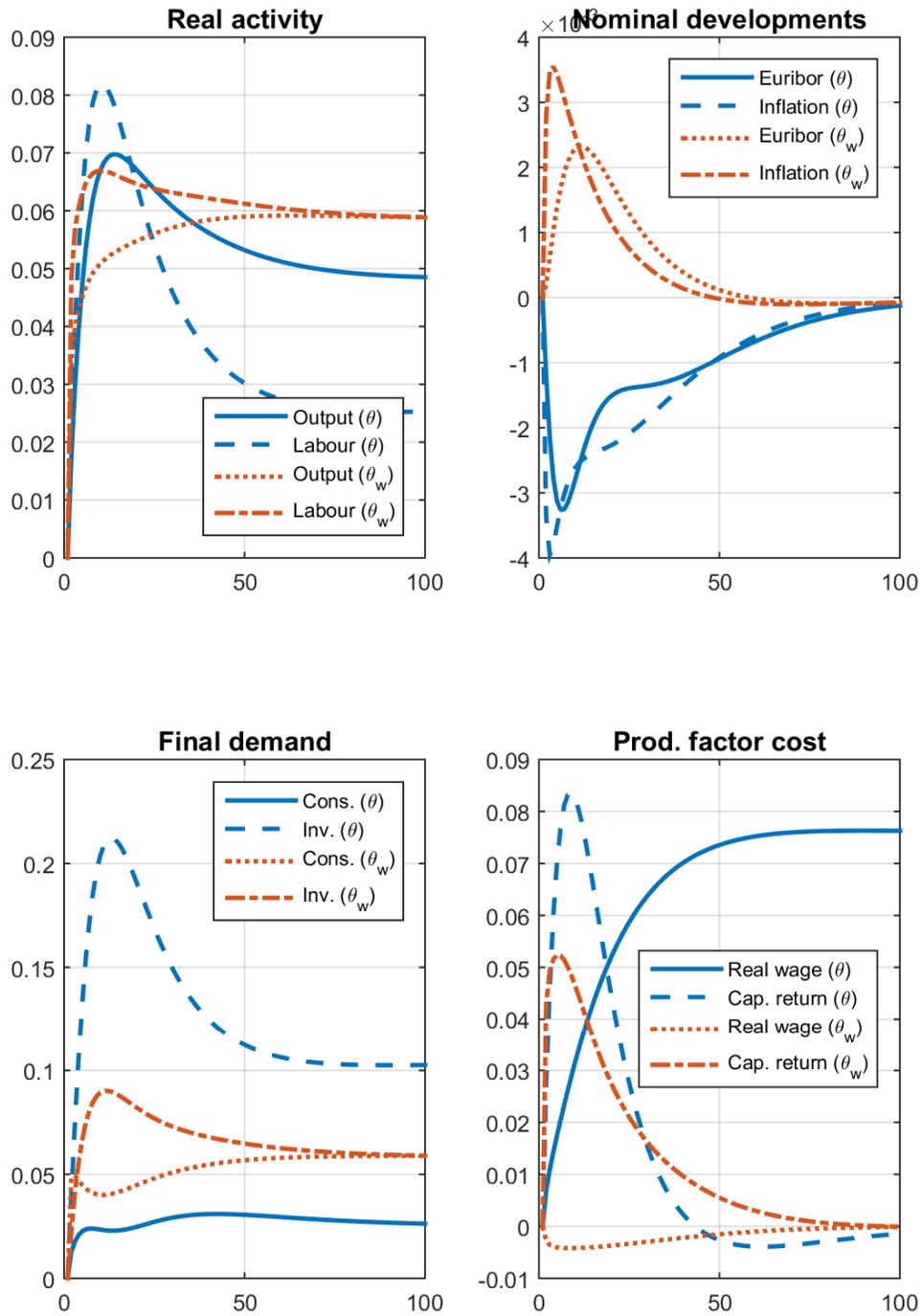
Structural reforms implemented here are the ones of (Everaert and Schule, 2006), that is of an alignment of markups on the level of the three best European performers.

Figure 6: Transition following a decrease in the price or wage markup
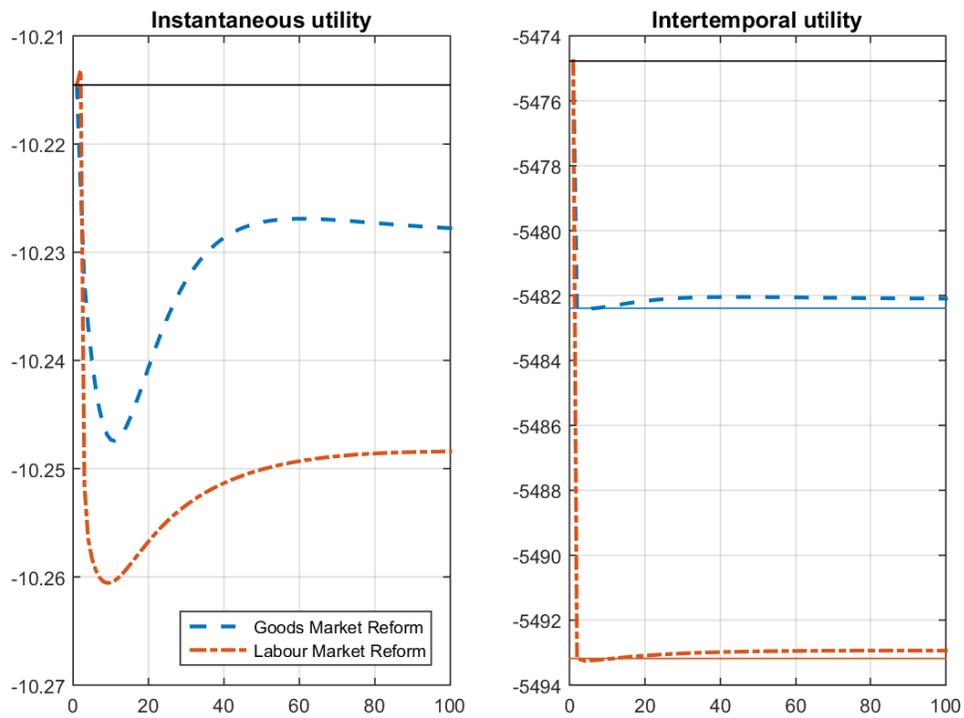
Structural reforms implemented here are the ones of (Everaert and Schule, 2006), that is of an alignment of mark-ups on the level of the three best European performers. Solid black lines correspond to utilities without reforms, i.e. initial steady state. Coloured solid lines represent the intertemporal utility once the reform is implemented. The difference between this line and the final steady state is the transition cost to the reform.

Figure 7: Utility in the transition following a decrease in the price or wage markup

Mechanism   Recalling long term elasticities (Equations (4.9) and (4.10)), we can anticipate that both σ_c and σ_l will play a role in the impact size of deregulation reforms. In particular, the inverse of Frisch elasticity of labour supply σ_l will be a crucial determinant.

Intuitively, we can expect weaker effects of reforms following an increase in both the inverse intertemporal elasticity of consumption and the inverse Frisch elasticity, as they go in the same direction of more *rigid* households.

In more specific details, an increase in σ_l directly translates into flatter labour supply curves on Figures 1 and 2. Recall that the consumption-leisure arbitrage is as follows:

$$\frac{\theta_w - 1}{\theta_w}\overline{RW} = f(\bar{L}) \tag{5.1}$$

When conducting a deregulation reform on the labour market (Figure 2), the left-hand side terms increases at any given $(\overline{RW}, \bar{L})$ through the increase in $\theta_w - 1/\theta_w$. As a result, we showed that the supply curve was shifting upwards, the amplitude of this shift being, by definition of the elasticity, negatively related to σ_l. As a result, the combination of both a flatter supply curve and of a lower shift as σ_l is higher implies a lower increase in labour and therefore in output.

In the case, of a product market reform (Figure 1), the increase in output mainly stems for a movement along the labour supply curve S1 when the labour demand curve shifts upwards. In the case of a flatter supply curve, the induced increase in labour (and therefore) output will be lower.

Numerical application   Conducting identical reforms as in the previous section for different calibrations of the utility function, Figure 8 shows that this modification of the behaviour of households can lead to a significant change of a few points of percentage of the gains from deregulation (for extreme values of σ_l closer to 1). Changes in the elasticity of consumption give weak and ambiguous results on these gains.

With respect to the effect on the transition dynamics, Figure 13 to 15 in the Appendix show that even though these parameters indeed appear in the households' first order conditions (Euler equation, wage Phillips curve, Tobins' Q and investment decision equations), their influence is very minor. They mainly scale the effects up or down in line with the impact on the steady state, but do not modify the "shape" of the dynamics.

Similarly for $h_c = 0$, Figures 16 and 20 in the Appendix, show that the role of habits on the transition is non-existent, and negligible in the long-run for consumption habits. For labour habits ($h_l = 0.5$) (Figures 17 and 20), the effect is also a scale effect, the existence of habits boosting the *without habits equivalent* inverse Frisch elasticity down[13]. In the long-run, the introduction of labour habits can boost up the impact of reforms of up to 2 p.p. (resp. 5 p.p.) of production for product (resp. labour) market reforms, in comparison to Figure 8.

5.2   Welfare costs - welfare gains

The output gains to structural reforms are positive. This result, we found unchallenged in the literature, is the consequence of diminishing market power and reducing the shortage organized by monopolistic competitors. The negative effect on welfare is rather unusual in the literature: (Jonsson, 2007; Matheron, 2002; Matheron and Maury, 2004) quantify the welfare cost of imperfect competition and (Everaert and Schule, 2006; Gomes et al., 2013; Forni et al., 2010) show based on institutional model simulations that structural reforms are welfare enhancing.

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[13]Indeed, terms in $(1 + \sigma_l)$ in the equations are now replaced by $(1 + \sigma_l') = (1 + \sigma_l)(1 - h_l)$, so for a given σ_l, the equivalent σ_l' is higher.
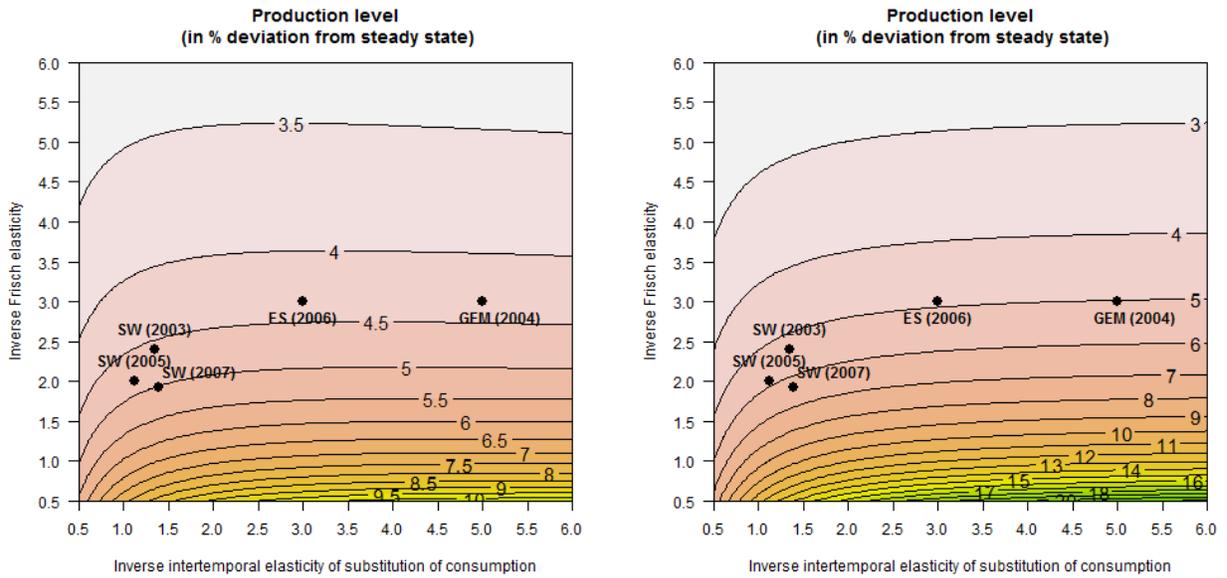
(a) Goods market reforms - standard   (b) Labour market reforms - standard

The inverse intertemporal elasticity of substitution of consumption corresponds to σ_c, and the inverse Frisch elasticity to σ_l. Structural reforms implemented here are the ones of (Everaert and Schule, 2006), that is of an alignment of markups on the level of the three best European performers.

SW (YYYY) indicates the calibration of the model following Smets and Wouters (YYYY) for the Euro area, expect for 2005 focusing on the US. Our standard calibration relies on (Smets and Wouters, 2005). *GEM (2004)* corresponds to (Bayoumi et al., 2004) and *ES (2006)* to (Everaert and Schule, 2006).

Figure 8: Impact of structural reforms in p.p. depending on the calibration of the utility function

Mechanism Long term elasticities (Equations (4.11) and (4.12)) nevertheless show that the effect on welfare of a structural reforms can be negative depending on the parametrisation of the model.

For goods market reforms (Equation (4.11)), the first term of indeterminate sign is $\frac{\alpha}{1-\alpha} - \frac{iy}{cy}$. It is positive only if capital income are high enough to finance investment (in comparison with how labour income finances private consumption). If not, income gains from the reform will finance investment instead of consumption in too great a proportion to be beneficial to households' utility. This term is positive if and only if $iy < \alpha(1 - gy)$ which is verified by our calibration.

The second term of ambiguous sign is common to Equation (4.11) and (4.12). If $\frac{\theta_w-1}{\theta_w}\frac{\theta-1}{\theta}\frac{(1-\alpha)}{cy}\frac{1-h_l}{1-h_c}$ is larger than one, structural reforms can imply welfare losses. The sign of $1 - \frac{\theta_w-1}{\theta_w}\frac{\theta-1}{\theta}\frac{(1-\alpha)(1-h_l)}{(1-h_c)cy}$ obviously crucially depends on the habit parameters.[14] Nevertheless, without habit there can be welfare losses from structural reforms. This can be the case if households who work more and receive higher income thanks to the increase in activity can not consume these gains in a large enough proportion.[15] With our calibration, structural reforms improve welfare if there is no habit formation, however, the opposite may occur with a larger share of government expenditure and/or a higher degree of competition on both the goods and labour market.

We focus on the negative impact on welfare through habit formation ($1 - h_l/1 - h_c$). The crucial term being consumption habits as $1/1 - h_c$ can be large when habits are strong. We introduce external habit formation in a multiplicative manner (a choice also made by Abel (1990); Gali (1994); Carroll et al. (2000); Fuhrer (2000)). We only consider external habits (i.e. Catching up with the Joneses), internal habits would require further sensitivity tests. (Carroll, 2000) actually shows that for the business cycle (i.e. in the linearised equations), multiplicative and additive habits can not be distinguished. Also, with non separable utility (a necessity with long term growth (King et al., 2002)), consumption habits do not alter the consumption leisure arbitrage, both in the business cycle and at steady state (U_c/U_l is independent from habits). The only modification is on the utility function itself. External habits are an externality. Consecutive to a structural reform, the general increase in consumption mitigates the welfare gains from each household's increase in consumption. With multiplicative habits this externality can be as large as implying welfare losses from the reform, while additive habits would be neutral on the long term elasticity of utility to a reform.

Numerical application Considering a recalibration of the model without consumption habits ($h_c = 0$), the transition to the post reform steady state is almost identical (Figure 16 in the Appendix). However, without this negative externality the effect on welfare from the reforms is now indeed positive (disutility decreases, Figure 9a and 9b). When there is a long term welfare gain from the reform, the transition is costly (Figure 19) . This cost (the difference between the final value of intertemporal utility and its value once the reform is effective) is however small relative to the long term gains (the difference between the final value of intertemporal utility and its value before the reform is effective).

We also consider the introduction of habits on labour (Bayoumi et al., 2004; Ratto et al., 2009). They work in a similar fashion as consumption habits as a *social norm* to which households compare. Following a general increase in labour supply, each household incurs a lesser disutility from working longer hours. While consumption habits are detrimental to welfare, labour habits are welfare enhancing. Considering such habits ($h_l = 0.5$) yields very similar transitions (Figure 17 in the Appendix) but greatly impacts long term effect of the reforms. In terms of utility, the positive externality from labour habits offsets the otherwise overall negative effect on welfare from the reforms (Figure 9c and 9d).

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[14]It is important to note here that habit are modelled in a multiplicative way. Otherwise it would not affect the elasticity of utility.

[15]Excluding habits, this term will always be smaller than 1, even for highly competitive markets, when $\alpha \overline{rr} - g/\overline{rr} + \delta > gy$ which is not verified by our calibration.
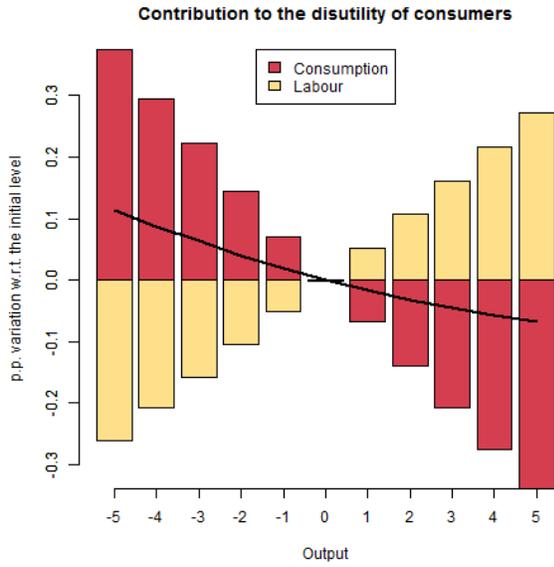
(a) Goods market - $h_c = 0$
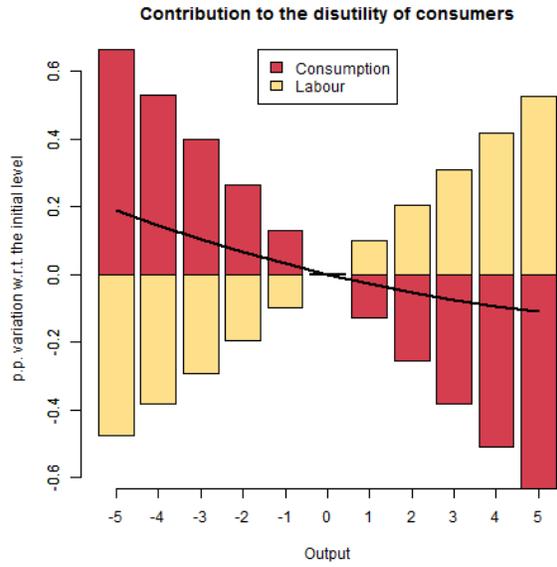
(b) Labour market - $h_c = 0$
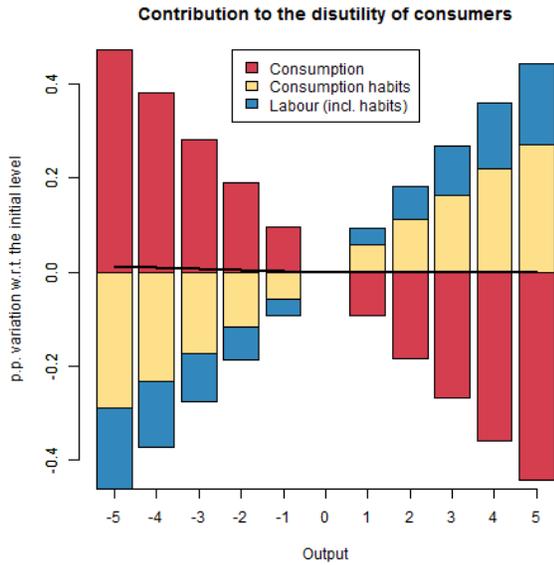
(c) Goods market - $h_l = 0.5$
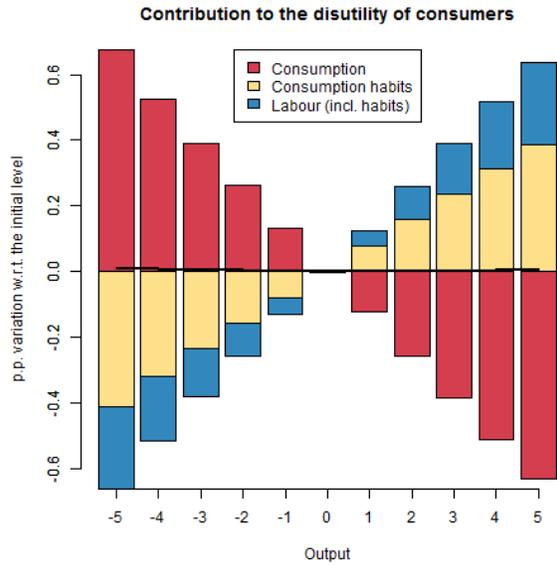
(d) Labour market - $h_l = 0.5$

Decomposition of changes in disutility following deregulation reforms against the output increase induced by the reform. We represent the disutility of households. A increase in the disutility is therefore detrimental to the households.
The x-axis indexes structural reforms (θ or θ_w) by their impact on output.

Figure 9: Steady state utility levels and decomposition upon reforms

5.3 Adding *non Ricardian* agents

As an additional standard mechanism, we introduce a fraction of hand-to-mouth consumers (Campbell and Mankiw, 1990). This element is often included in institutional neo-Keynesian models and has a sizeable impact on the size of production gains.

Range of values   The estimation or calibration of the share of non-Ricardian agents in the economy μ is subject to debate. Actually, 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. 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.

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.

In our current extension of Smets and Wouters' model with constrained households, we calibrate the share to estimated values in QUEST III, that is $\mu = 40\%$.

Utility and inequalities between households   The introduction of heterogeneous households allows to study the effect of deregulation on inequalities. Figure 10 presents the long-term responses of *Ricardian* and *non Ricardian* consumption, labour supply and real wages to both types of deregulation reforms. Level ratios between both types of households are presented on Figure 21 in the Appendix.

Deregulating the product market leads to a decrease in consumption and welfare disparities. Indeed both types of households are affected by a wealth effect, positive for *non Ricardians* as the real wage goes up; negative for *Ricardians* as dividends shrink. Therefore, *non Ricardian* consumption markedly increases while *Ricardian* consumption decreases slightly. *Ricardian* agents supply more labour as opposed to constrained households who decrease their supply. In addition, *Ricardians* are the only suppliers for the increased demand in capital which further crowds out their consumption.

Conversely, reforming the labour market leaves firms' profits untouched. The reform affects both types of households labour supply curve in a similar fashion: both work more. The increase in capital income finances investment, so much so that both types' consumption increases alike. All in all consumption, labour and utility inequalities stagnate.

Deregulation on both markets also leads to a decrease in wages inequalities.

In addition, Figure 11 presents the steady state variation in the disutility of agents following a mark-up reform (indexed by the corresponding variations in production), as well as the contribution of each variable to this disutility: namely individual consumption, external consumption habits, and labour.

In the case of a product market deregulation (left column), disutility of the representative consumer decreases (the utility therefore increases) with increasing output gains. Therefore, in the long term, the economic desirability of an increased output goes along with an increased utility. However, implications
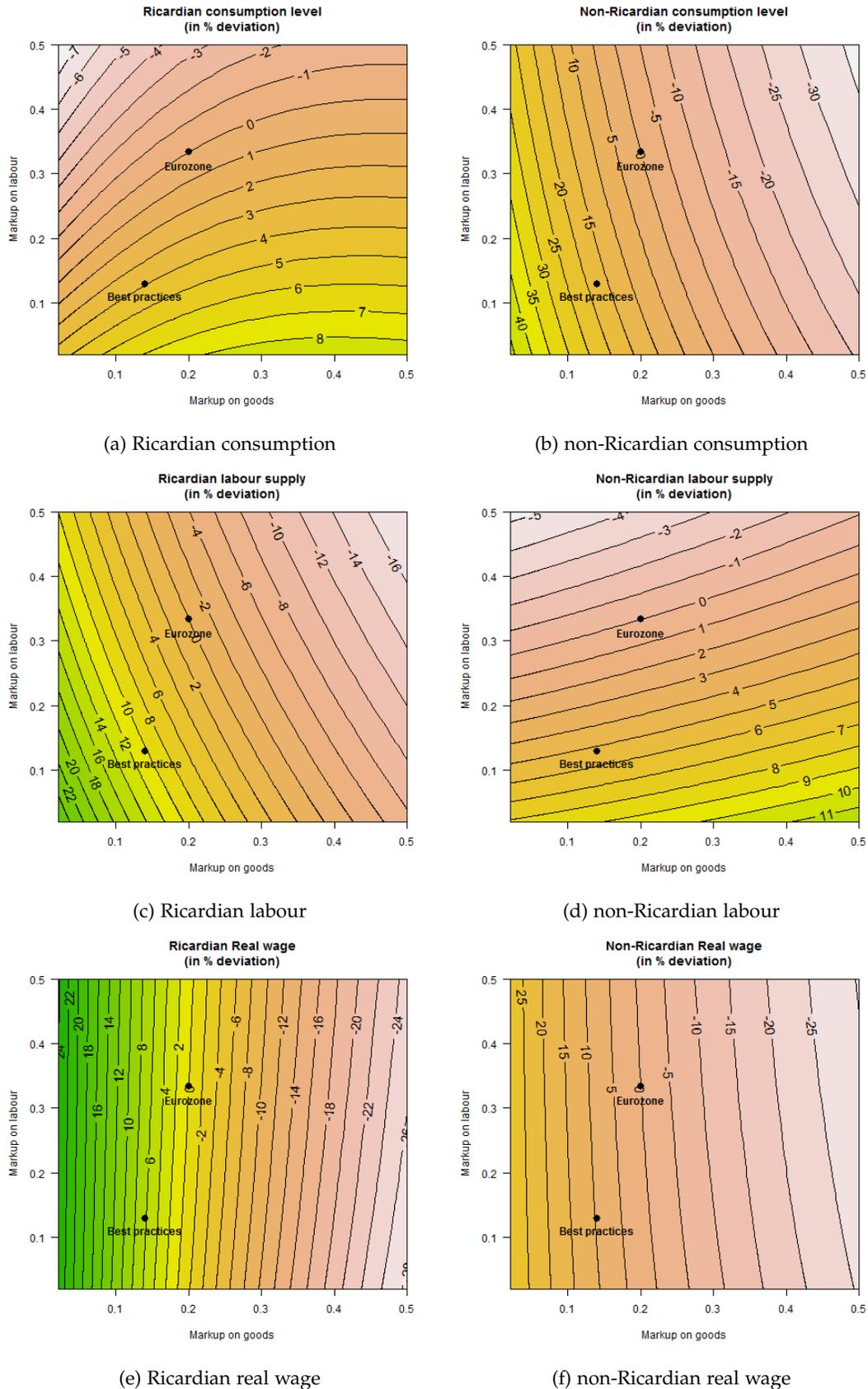
(a) Ricardian consumption

(b) non-Ricardian consumption

(c) Ricardian labour

(d) non-Ricardian labour

(e) Ricardian real wage

(f) non-Ricardian real wage

Decomposition of changes in disutility following deregulation reforms against the output increase induced by the reform. We represent the disutility of households. A increase in the disutility is therefore detrimental to the households.
The x-axis indexes structural reforms (θ or θ_w) by their impact on output.

Figure 10: Steady state variations upon reforms in p.p. with respect to the initial calibration the presence of non-Ricardian households
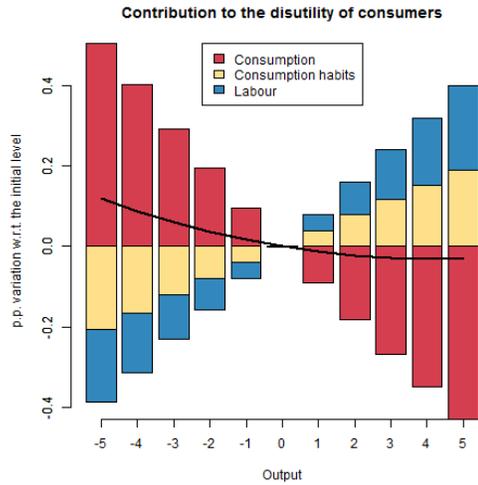
(a) Goods market reform - Representative
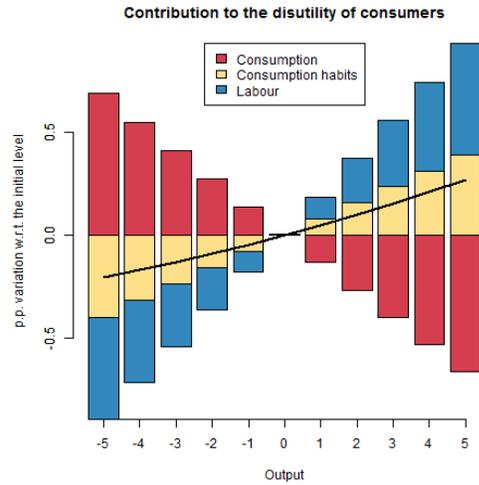
(b) Labour market reform - Representative
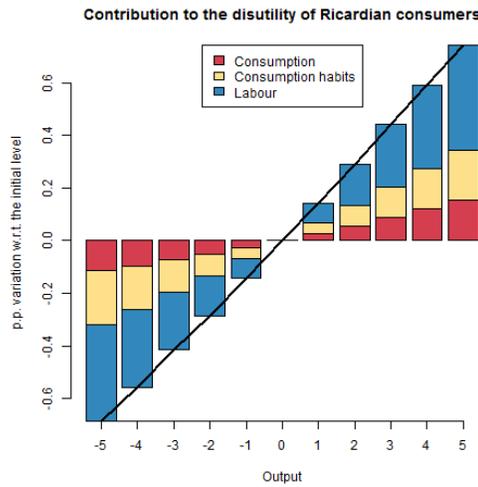
(c) Goods market reform - Ricardian
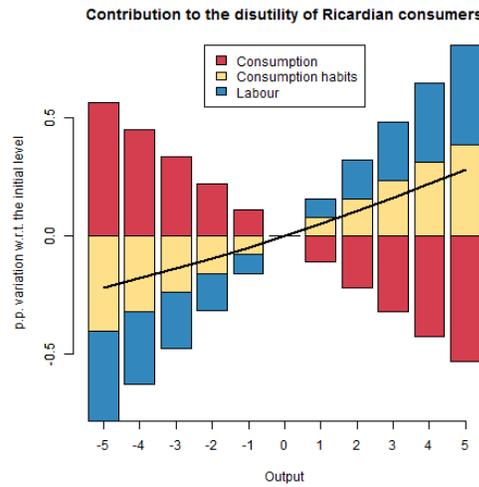
(d) Labour market reform - Ricardian
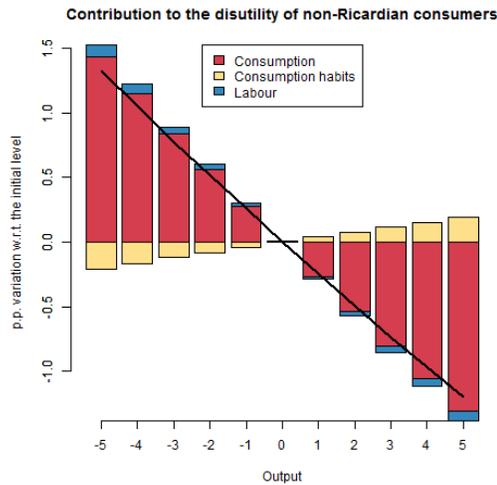
(e) Goods market reform - non-Ricardian
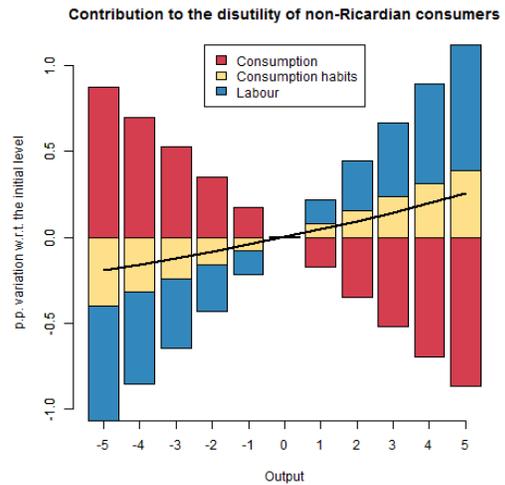
(f) Labour market reform - non-Ricardian

The x-axis represents the level of mark-up on goods (i.e. $1/\theta - 1$) whereas the y-axis represents the mark-up on wages (i.e. $1/\theta_w - 1$). The point named *Eurozone* corresponds to the standard calibration of our model and the point *Best practices* to the level of mark-ups in the three best European practices, namely Denmark, Sweden and the United Kingdom, as defined in (Everaert and Schule, 2006).

Figure 11: Steady state utility levels and decomposition upon reforms in the presence of constrained households

are very different across households. Indeed, we observe that *Ricardian* households are adversely affected by the reform as labour, individual consumption and consumption habits work in the same way of an increased disutility as labour supply increases and consumption decreases.

On the contrary, *non Ricardian* households strongly benefit from the reform as their consumption increases faster than aggregate consumption does (as *Ricardian* consumption decreases upon reform, and as *non Ricardian* households represent only 40% of the population with a lower steady state level of consumption). All in all, the net effect of consumption (individual consumption minus consumption habits) is strongly welfare improving. The decrease in labour supply also contributes mildly to the decrease in disutility.

For labour market reforms, aggregate disutility is increasing with output gains. Individual consumption increases and contributes positively to the utility. Even though, the total effect of consumption net of habits is still welfare enhancing, the increase in labour supply results in a long-term decrease in the utility level. This decomposition is undifferentiated across households.

Numerical implications for reforms' impact   Performing deregulation on both labour and goods markets, in the presence of constrained households (Figure 12) leads to additional differences in terms of long-term production gains. In the presence of liquidity-constrained agents, the effects of product market reforms can be mitigated by more than 0.5 p.p., whereas there are left almost unchanged for labour market reforms. However, we observe the introduction of *non Ricardian* agents goes for both types of reforms towards weaker gains.
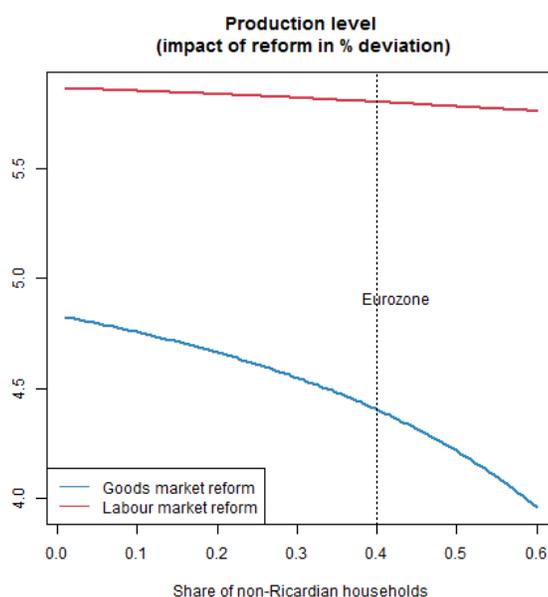
The share of *non Ricardian* households corresponds to μ.
Structural reforms implemented here are the ones of (Everaert and Schule, 2006), that is of an alignment of markups on the level of the three best European performers.

Figure 12: Impact of reforms in p.p. with respect to the initial production level depending on the share of non-Ricardian households

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6   Conclusion

In a standard neo-Keynesian model, we evaluated structural reforms. Despite different economic mechanisms, this model provides results in line with stylized facts obtained in deregulation-oriented models such as (Blanchard and Giavazzi, 2003).

We proceeded to a detailed sensitivity analysis. Whereas qualitative results are robust to changes in the specification of the model (positive gains from deregulations), quantitative results differ across specifications. The simple redefinition of households' utility can lead to additional gains or losses of a few percentage points in output following goods or labour markets deregulations.

In addition, welfare analyses show that policy recommendations for structural and fiscal reforms are less clear-cut than those solely based on output gains. Introducing *non Ricardian* agents allows stylized yet informative inequality analyses showing that goods market reforms reduce inequalities while labour market reforms are neutral.

In all, these results strongly argue in favour of a systematic conduct of sensitivity tests when performing quantitative economic analyses.

Beyond the mere quantitative evaluation of structural reforms, we explicated the core mechanisms through which output increases in this class of models, stressing in particular the importance of the leisure-consumption arbitrage. Considering the fact that DSGE models have been primarily developed and are best suited to describe business cycles, our sensitivity analysis raises a first question: are elasticities (Frisch and intertemporal substitution) equal in the long run and over the business cycle? More fundamentally, are the mechanisms introduced in a standard institutional DSGE model adequate for structural reforms evaluation, especially on the labour market, cornerstone of our simulations?

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(a) Goods market reform

(b) Labour market reform
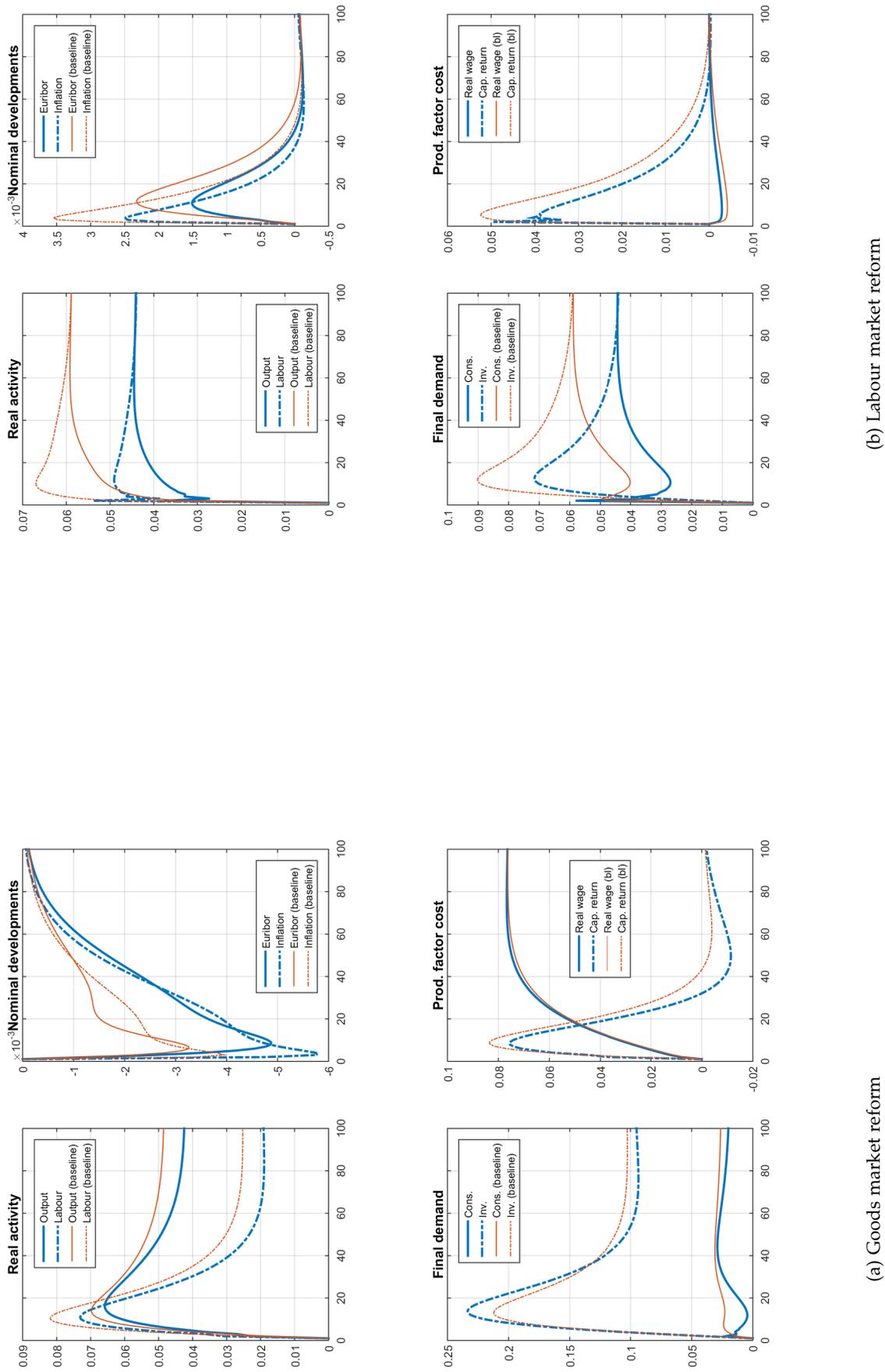
Figure 13: Sensitivity of the transition following mark-up reforms to the calibration ($\sigma_c = 0.5$ compared to baseline)

(a) Goods market reform

(b) Labour market reform
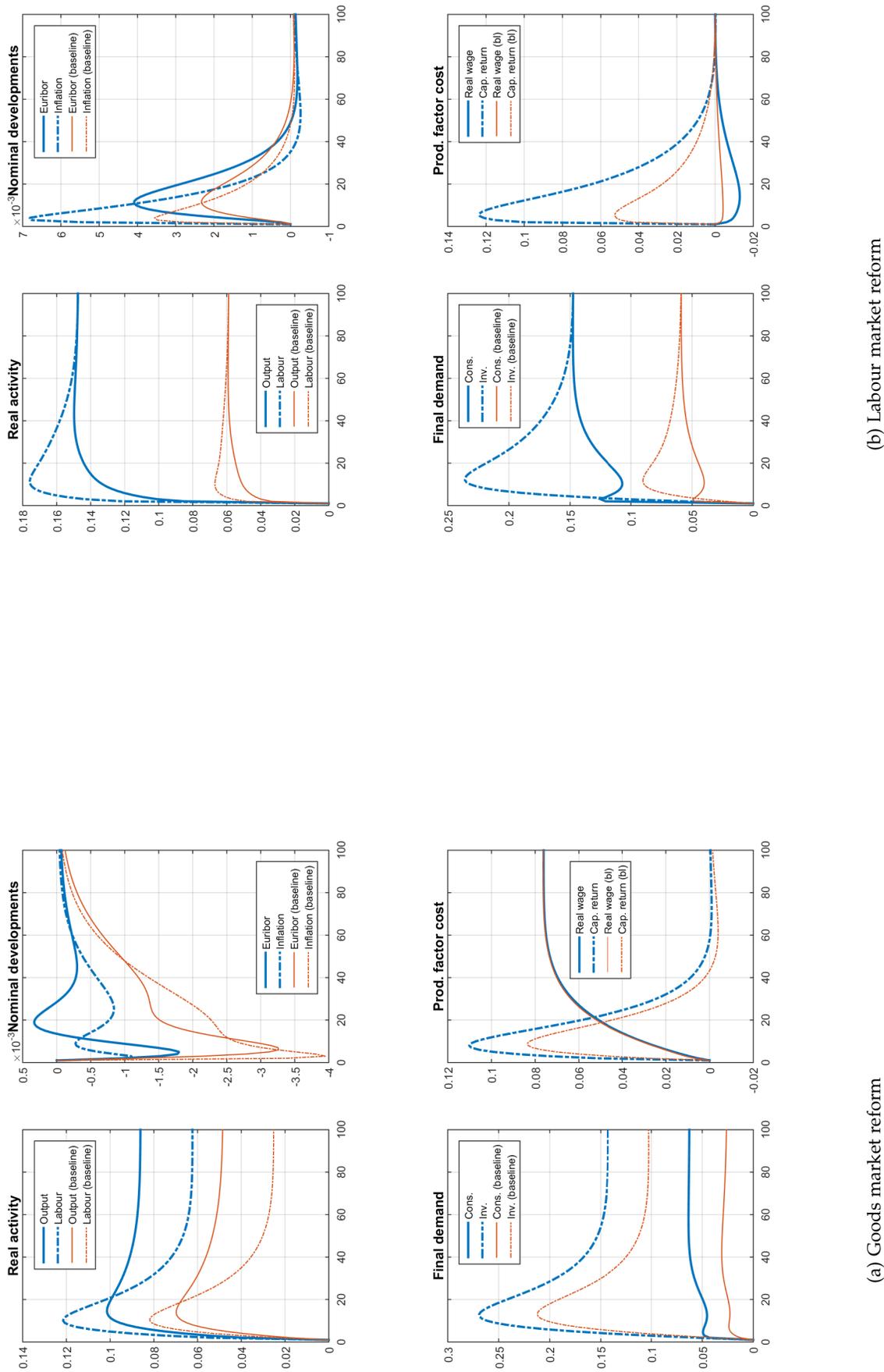
Figure 14: Sensitivity of the transition following mark-up reforms to the calibration ($\sigma_l = 0.3$ compared to baseline)
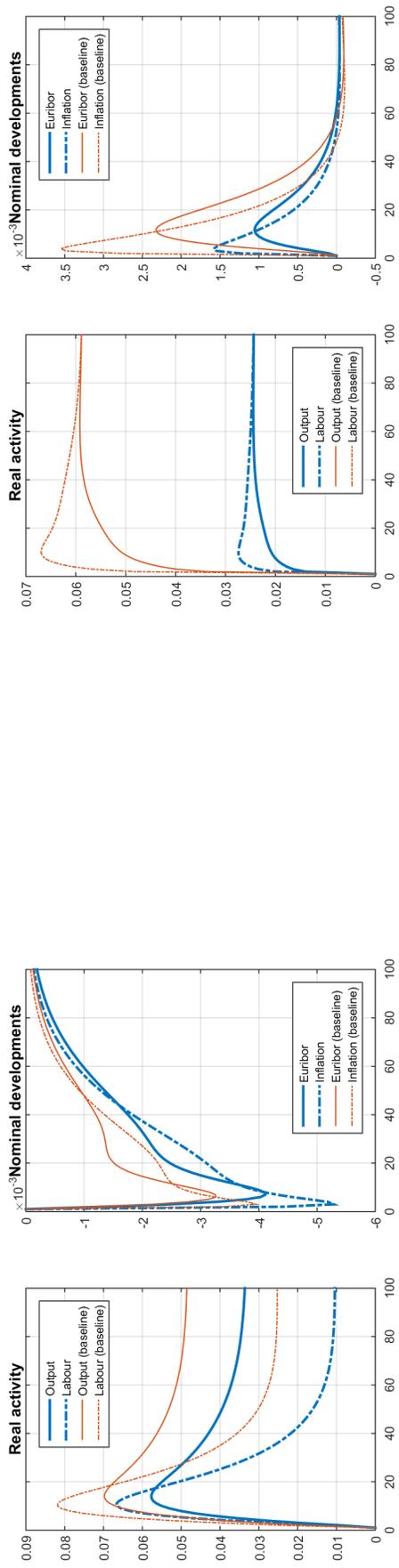
(a) Goods market reform
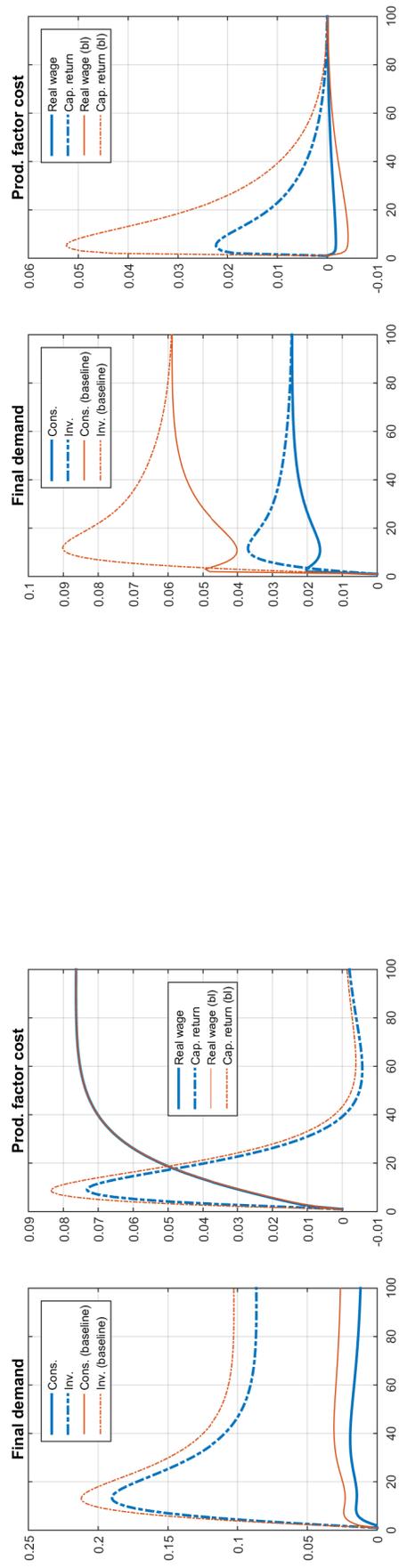
(b) Labour market reform

Figure 15: Sensitivity of the transition following mark-up reforms to the calibration ($\sigma_l = 6$ compared to baseline)
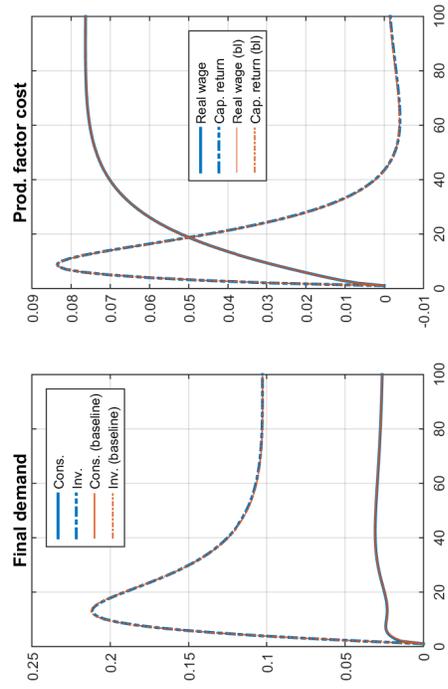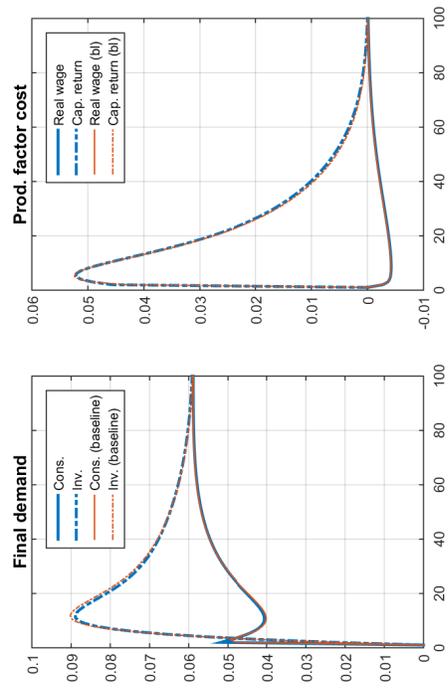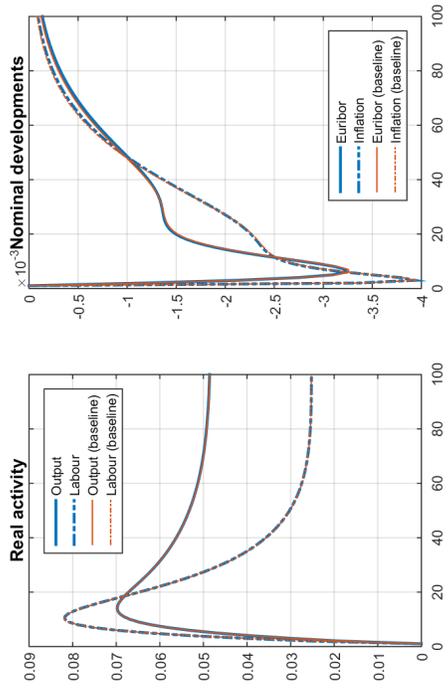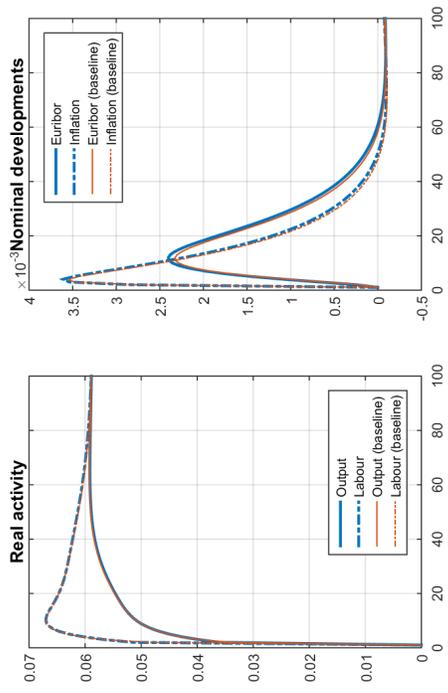
(a) Goods market reform

(b) Labour market reform

Figure 16: Sensitivity of the transition following mark-up reforms to the calibration ($h_c = 0$ compared to baseline)
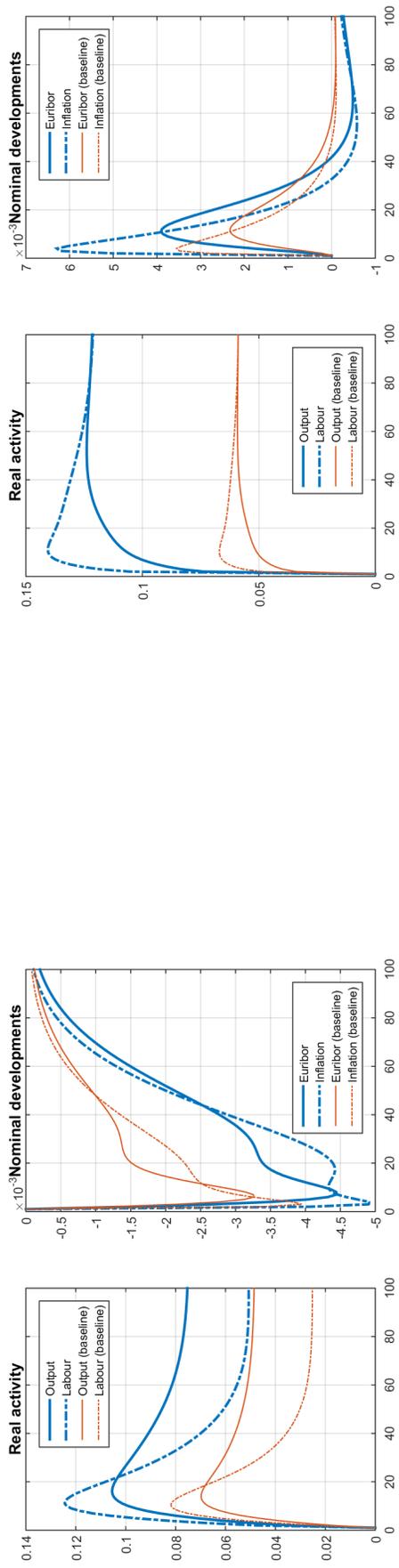
(a) Goods market reform
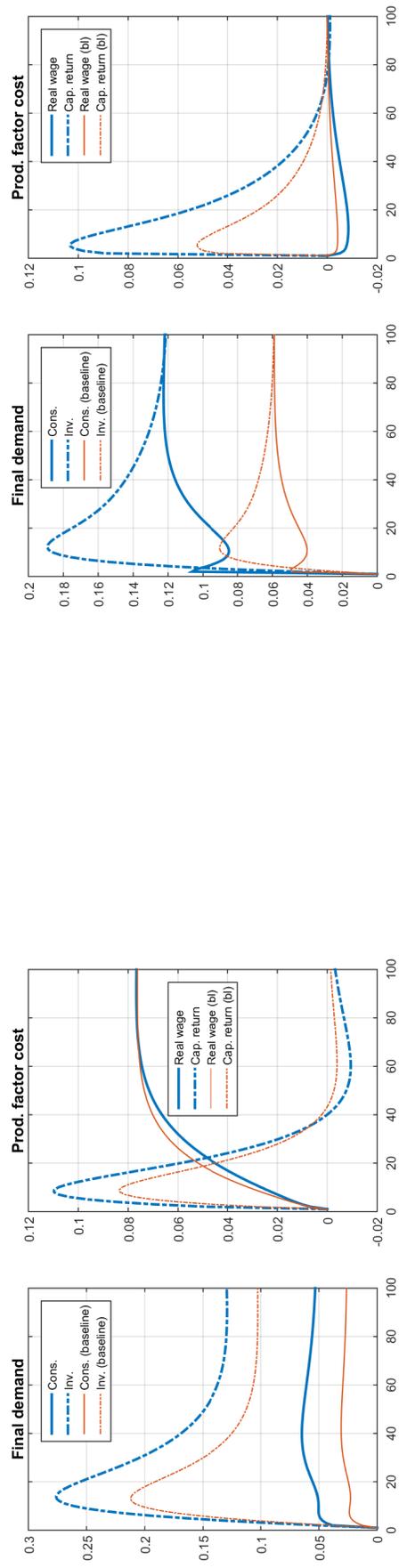
(b) Labour market reform

Figure 17: Sensitivity of the transition following mark-up reforms to the calibration ($h_l = 0.5$ compared to baseline)

(a) Goods market reform

(b) Labour market reform
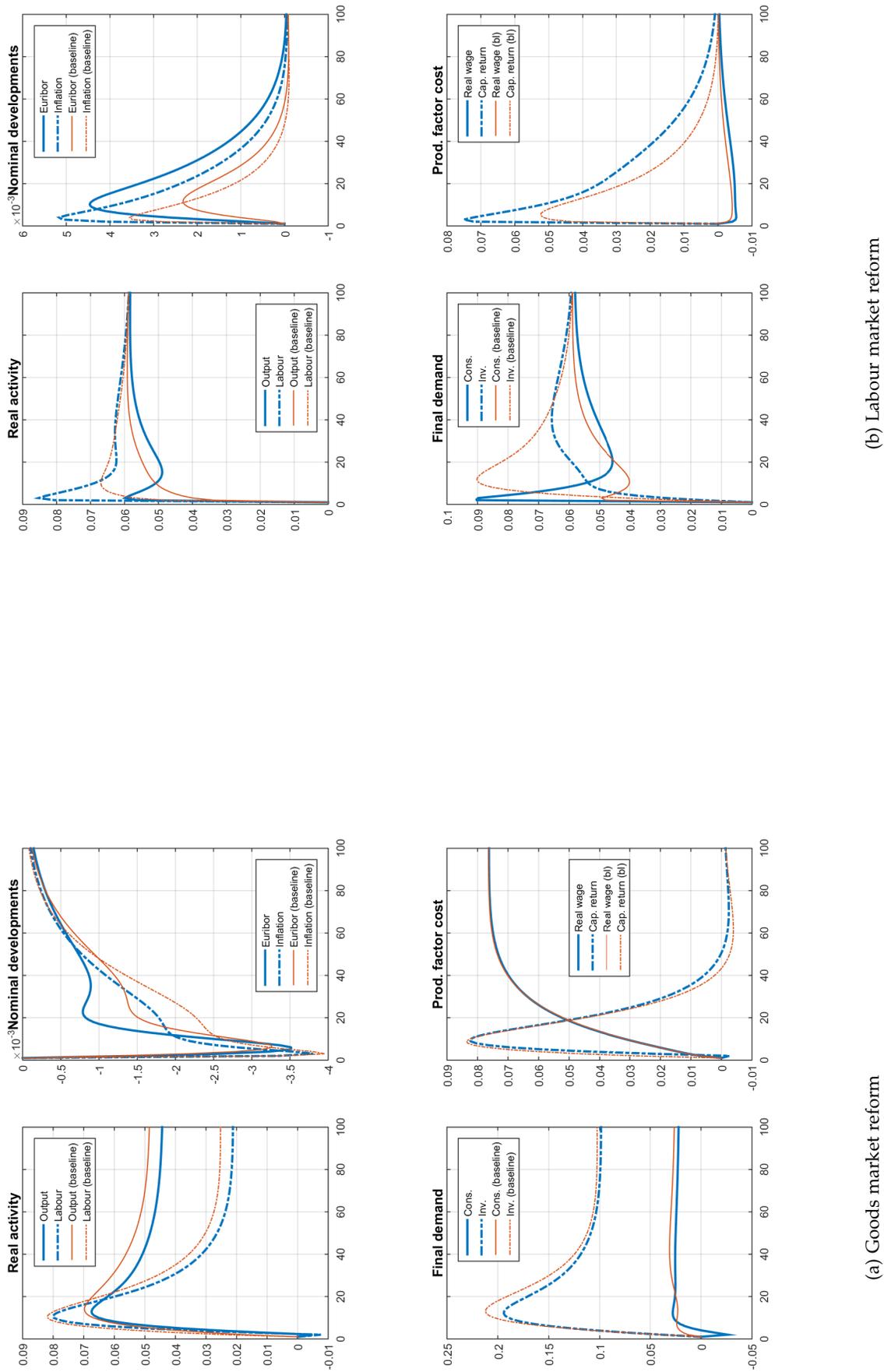
Figure 18: Sensitivity of the transition following mark-up reforms to the introduction of *non Ricardian* households ($\mu = 0.4$ compared to baseline)
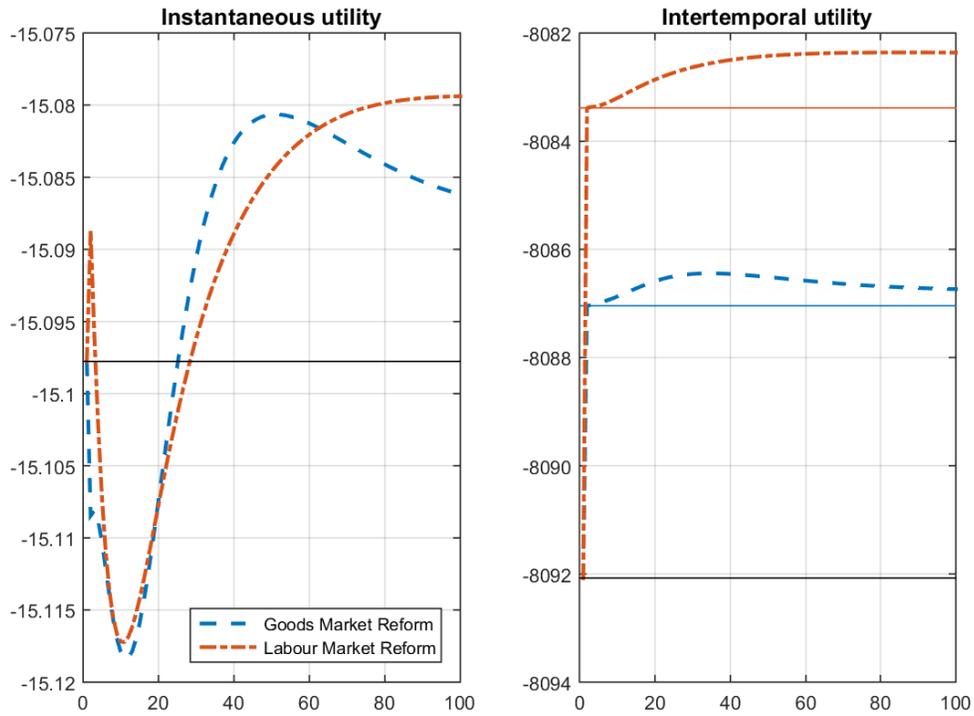
Structural reforms implemented here are the ones of (Everaert and Schule, 2006), that is of an alignment of mark-ups on the level of the three best European performers. Solid black lines correspond to utilities without reforms, i.e. initial steady state. Coloured solid lines represent the intertemporal utility once the reform is implemented. The difference between this line and the final steady state is the transition cost to the reform.

Figure 19: Utility in the transition following a decrease in the price or wage mark-up without consumption habits
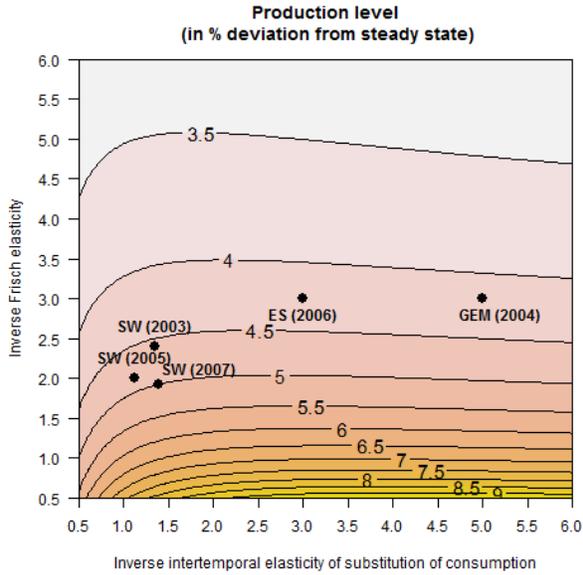
(a) Goods market reforms - $h_c = 0$
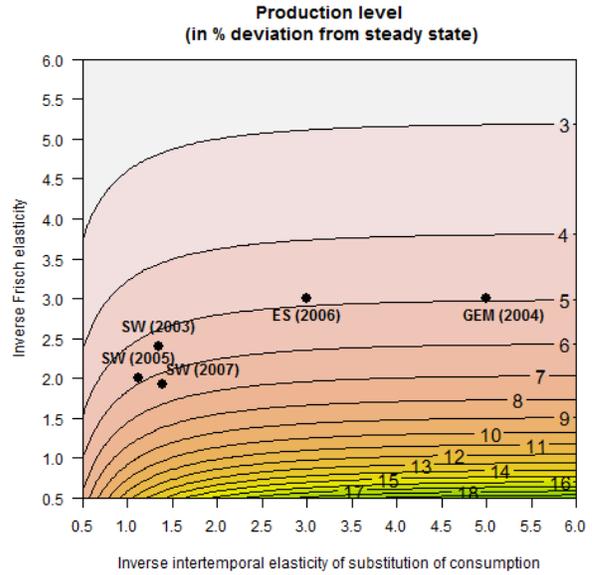
(b) Labour market reforms - $h_c = 0$
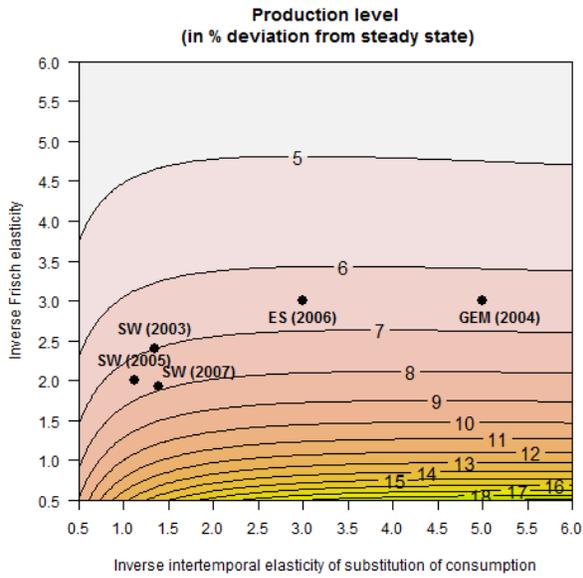
(c) Goods market reforms - $h_l = 0.5$
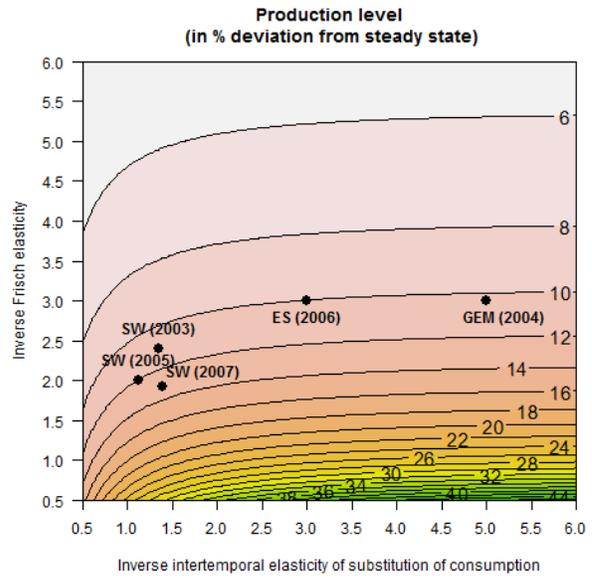
(d) Labour market reforms - $h_l = 0.5$

The inverse intertemporal elasticity of substitution of consumption corresponds to σ_c, and the inverse Frisch elasticity to σ_l. Structural reforms implemented here are the ones of (Everaert and Schule, 2006), that is of an alignment of markups on the level of the three best European performers.

SW (YYYY) indicates the calibration of the model following Smets and Wouters (YYYY) for the Euro area, expect for 2005 focusing on the US. Our standard calibration relies on (Smets and Wouters, 2005). *GEM (2004)* corresponds to (Bayoumi et al., 2004) and *ES (2006)* to (Everaert and Schule, 2006).

Figure 20: Impact of structural reforms in p.p. depending on the calibration of the utility function for alternative calibrations of the model
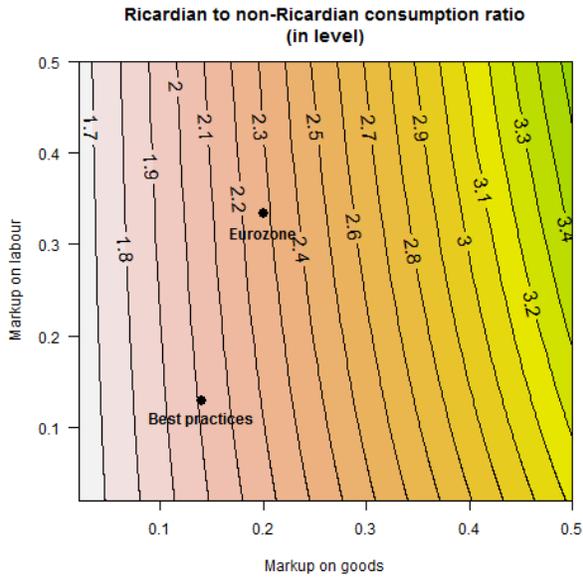
(a) Ricardian to non-Ricardian consumption ratio
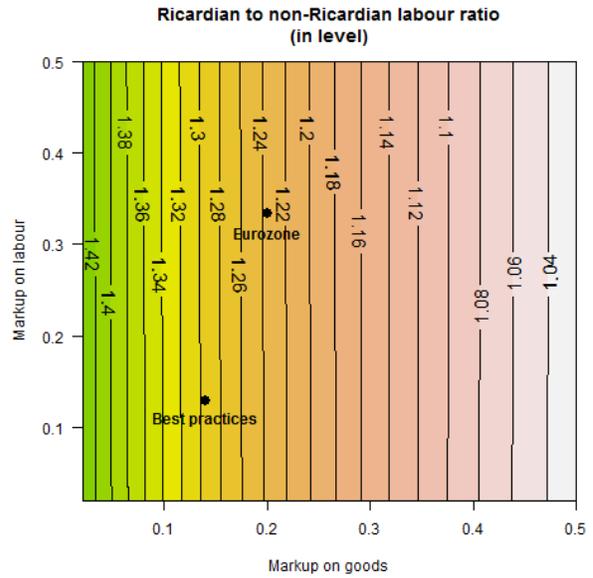
(b) Ricardian to non-Ricardian labour ratio
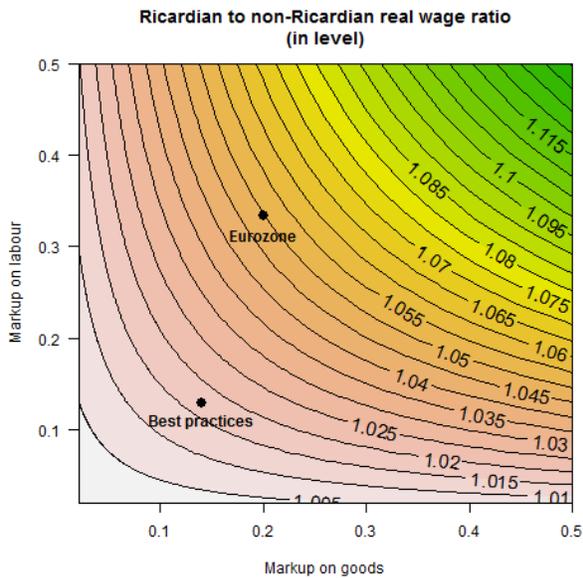
(c) Ricardian to non-Ricardian real wage ratio
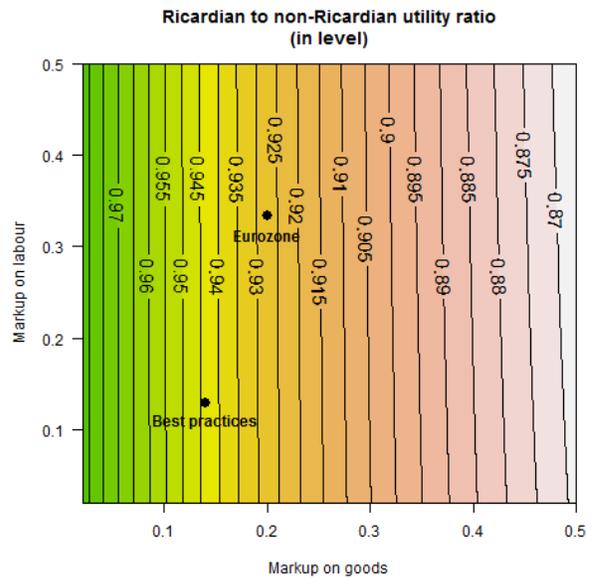
(d) Ricardian to non-Ricardian utility ratio

The x-axis represents the level of mark-up on goods (i.e. $1/\theta - 1$) whereas the y-axis represents the mark-up on wages (i.e. $1/\theta_w - 1$). The point named *Eurozone* corresponds to the standard calibration of our model and the point *Best practices* to the level of mark-ups in the three best European practices, namely Denmark, Sweden and the United Kingdom, as defined in (Everaert and Schule, 2006). For the utility ratio, it is crucial to know that the steady state utility level is negative. As such, a ratio below one indicates a higher utility level for Ricardian households. The closer it is to one, the less inequality.

Figure 21: Steady state Ricardian to non-Ricardian level ratios