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Structural reforms in DSGE models: a case for sensitivity analyses

Abstract

In a standard DSGE model of the Euro Area derived from the Smets and Wouters' core model and comparable to most institutional models (ECB, EC, IMF, etc.), we shed new light on a popular exercise: pro-competitive (structural) reforms evaluation. First, we provide with a detailed analysis of the underlying mechanisms, insisting on the importance of the household's consumption-leisure arbitrage. We then proceed to a quantitative sensitivity analysis. We show that 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 pro-competitive reforms. 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 in that class of models when used for quantitative policy purposes.

Keywords: structural reform, DSGE model, mark-up, sensitivity, welfare

Réformes structurelles et modèles DSGE: un plaidoyer en faveur d'analyses de sensibilité

Résumé

À l'aide d'un modèle DSGE standard inspiré par du modèle de Smets et Wouters et comparable aux principaux modèles institutionnels (BCE, FMI, CE, etc.), nous nous concentrons sur un exercice classique: l'évaluation de réformes pro-concurrentielles (structurelles). Tout d'abord, nous mettons précisément en évidence les mécanismes sous-jacents et insistons sur l'importance de l'arbitrage consommation-loisir des ménages. Dans un deuxième temps, nous présentons une analyse de sensibilité. Nous montrons qu'une simple redéfinition de la fonction d'utilité des ménages peut conduire à des gains ou pertes d'activités supplémentaires de quelques points de pourcentage suite à des réformes pro-compétitives sur les marchés des biens ou du travail. Par ailleurs, une analyse de bien-être montre que des politiques économiques conduites sur la seule base d'une analyse des effets sur la production peuvent diverger de politiques prenant en compte le bien-être des ménages. L'introduction de ménages non-Ricardiens permet une analyse stylisée mais pertinente des inégalités entre ménages. Cette analyse montre que les réformes sur le marché des biens conduisent à une réduction des inégalités, tandis que des réformes du marché du travail sont neutres. Dans l'ensemble, nos résultats plaident en faveur d'une implémentation systématique de tests de sensibilité dans cette classe de modèles quand ceux-ci sont utilisés pour ce type d'exercice.

Mots-clés : réforme structurelle, modèle DSGE, taux de marge, sensibilité, bien-être

Classification JEL : E10, E60, E20

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 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 increased competition affects the economy. Furthermore, despite this consensus numerical differences remain, calling for a thorough sensitivity analysis to identify sources of divergence, as well as their quantitative influence.

These institutional models share a common core, the Smets and Wouters model. As such, these are business cycle models and the question arises of their ability to inform on structural reforms. 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 this neo-Keynesian framework. In particular, we provide a detailed analysis of the underlying mechanisms showing the central role of the consumption-leisure arbitrage.

In line with the existing literature, we indeed find gains from pro competitive reforms in the long run but losses in the transition. However, long term 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-enhancing reforms can have a negative welfare impact with standard calibrations. Also, when financially constrained households are included in the model, goods market reforms lead to a decrease in inequalities both in terms of consumption and utility, whereas inequalities stagnate following labour market reforms.

In this paper, 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 (ECB, IMF, etc.).

This article follows the wide literature on the effects of structural reforms. D'Auria et al. (2009), Roeger et al. (2008) or Varga et al. (2014) conduct evaluations for EU member states in the R&D version of the Quest III model whereas Annicchiarico et al. (2013) do the same for Italy. 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. However, Jonsson (2007) and 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 and give a short presentation of its calibration. In Section 3 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 4 we show 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 labour¹.

$$\begin{aligned} \max E_t \sum_{T=t}^{\infty} \beta^{T-t} \mathcal{U}_T(\tau) \mathcal{V}_T(\tau) \\ \text{with } \mathcal{U}_T(\tau) &= \frac{1}{1-\sigma_c} \left[C_T(\tau) \left(\frac{C_{T-1}}{\mathbb{N}} \right)^{-h_c} \right]^{1-\sigma_c} \\ \mathcal{V}_T(\tau) &= \left[1 - \kappa(1-\sigma_c) \left(l_T(\tau) \left(\frac{L_{T-1}}{\mathbb{N}} \right)^{-h_l} \right)^{1+\sigma_l} \right]^{\sigma_c} \end{aligned} \quad (2.1)$$

subject to the budget constraint:

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

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

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 households τ while C_t and L_t are the aggregate counterparts; $w_t(\tau)$ correspond to the wage. $FA_t(\tau)$ is the financial asset holdings at the end of period t while FA_t is its aggregate counterpart; R_t is the gross interest rate set by the monetary authority. $D_t(\tau)$ are the dividends paid by the firm to its owners. $\Phi_t(\tau)$ is a lump-sum transfer to households. P_t is the price level for both consumption and investment goods which are identical.

In the capital accumulation equation, $I_t(\tau)$ is the investment level with an adjustment cost² $\mathcal{S} \left(\frac{I_t(\tau)}{I_{t-1}(\tau)} \right)$ 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

¹We 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.

²See 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. ϵ_t^I represents an exogenous shock to this cost. r_t^K is the return paid on capital.

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

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

$$1 = q_t(\tau) \epsilon_t^I \left(1 - \mathcal{S} \left(\frac{I_t(\tau)}{I_{t-1}(\tau)} \right) - \mathcal{S}' \left(\frac{I_t(\tau)}{I_{t-1}(\tau)} \right) \frac{I_t(\tau)}{I_{t-1}(\tau)} \right) + \beta E_t \left\{ \frac{\mathcal{U}'_{t+1}(\tau) \mathcal{V}_{t+1}(\tau)}{\mathcal{U}'_t(\tau) \mathcal{V}_t(\tau)} q_{t+1}(\tau) \epsilon_{t+1}^I \mathcal{S}' \left(\frac{I_{t+1}(\tau)}{I_t(\tau)} \right) \left(\frac{I_{t+1}(\tau)}{I_t(\tau)} \right)^2 \right\} \quad (2.5)$$

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

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's supply is a function of the demanded wage ($w_t(\tau)$) over aggregate wage (W_t , Equation 2.7). In this context, households are paid with a mark-up over their marginal disutility of labour which depends on the elasticity of substitution between workers θ_w .

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

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

Linearising the first order condition of households' utility maximisation on the labour market around the steady state yields the following wage Phillips curve:

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

with $\mathcal{B}(\sigma_c)$ a function of the parameters of the model, $\tilde{\beta}$ a function of β and g the exogenous growth rate of TFP.³ \widehat{RW}_t corresponds to the real wage defined as w_t/p_t . γ_w is the degree of indexation of non reset wages on past inflation.

2.2 Firms

Demand for production factors

Firms (a continuum of size \mathbb{P}) produce partially substitutable goods from labour and capital. They hire domestic labour at cost W_t . In addition, firms rent capital $K_t^d(\epsilon)$ from households at cost r^k .⁴ We assume

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

⁴The 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 $r_t^k K_t^d(\epsilon) P_t$.

installation delays so that at market equilibrium and on aggregate $K_t^d = K_{t-1}$.

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

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

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

where ζ is the exogenous labour 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:

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

and the real marginal cost of production:

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

Price setting

Partial substitutability (with elasticity θ) allows firms to price a mark-up over their marginal cost. We assume a *Calvo* price setting. Firm ε resets its price $p_t(\varepsilon)$ 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 (with parameter γ).⁵

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

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

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

where inflation depends positively on past inflation, future expected inflation but also on real wages, capital returns 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 in deviation from its target R^* through a Taylor rule (Taylor, 1993), where it reacts smoothly to both inflation in deviation from its target Π^* (with smoothing parameter ρ) and the output gap (defined as output in deviation from its steady state \bar{Y}).

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

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

⁵This price indexation is necessary in a model with steady state inflation.

2.4 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, 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 reform evaluations, in particular Everaert and Schule (2008). Indeed, the level of mark-ups allows to calibrate parameters θ and θ_w . Everaert and Schule (2008) set mark-ups to 33% and 20% on the labour and goods markets respectively, close to values observed in the European Commission Quest III model. These values are mostly estimated by Bayesian techniques (along with the other parameters of the model) and are therefore calibrated here. Values can also be adjusted based on microeconomic studies as conducted in Everaert and Schule (2008). However, the link between those studies and actual values for the parameters is not straightforward.

Table 1 compares the model at steady state with actual data for the Euro Area (12 countries). Table 2 presents our calibration of structural parameters.

	DATA EA (12)	MODEL 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

3 Understanding the mechanisms of structural reforms on the goods and labour markets

3.1 What should we expect ?

As an introductory warning, it is important to keep in mind that the present 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).

⁶The calibration constraints are further detailed in Campagne and Poissonnier (2016).

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

In addition, Blanchard and Giavazzi (2003) develop a stylized model specifically designed to analytically identify the key mechanisms behind structural reforms. This two periods model is often used as a reference to study the impact of structural reforms on the goods and labour market. Its specificities 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 intertemporal elasticity of substitution of consumption 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.

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.

3.2 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, in the long term, the model is equivalent to a standard RBC model with monopolistic competition and GDP as well as 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 factors by the firms.

Firms' profit maximization implies the following demands

$$\text{for capital } \frac{\theta - 1}{\theta} \alpha \zeta^{1-\alpha} \left(\frac{\bar{K}}{\bar{L}} \right)^{\alpha-1} = \bar{r}^k \quad (3.1)$$

$$\text{for labour } \frac{\theta - 1}{\theta} (1 - \alpha) \zeta^{1-\alpha} \left(\frac{\bar{K}}{\bar{L}} \right)^{\alpha} = \bar{R}\bar{W} \quad (3.2)$$

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 $\bar{r}^k = \bar{r}\bar{r} + \delta$, with $\bar{r}\bar{r}$ the real return on the risk free asset. As for labour, their supply is given by their individual consumption-leisure arbitrage:

$$\bar{R}\bar{W} = \frac{\theta_w}{\theta_w - 1} (1 + \sigma_l) \bar{c} \frac{\sigma_c}{1 - \sigma_c} \frac{\kappa(1 - \sigma_c) \bar{l}^{(1+\sigma_l)(1-h_l)-1}}{1 - \kappa(1 - \sigma_c) \bar{l}^{(1+\sigma_l)(1-h_l)}} = \frac{\theta_w}{\theta_w - 1} (1 + \sigma_l) \bar{c} f(\bar{l}) \quad (3.3)$$

with \bar{c}, \bar{l} individual consumption and labour supply respectively and f an increasing function of labour supply.

Reform on the goods market A decrease in firms' market power on the goods market ($\theta \uparrow$) fosters output in the long run through different channels. First, as the distortion from the perfectly competitive equilibrium is reduced, firms capture less mark-ups 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 by an increase in production : the demand for production factors is then scaled-up (direct effect of θ in Equations (3.1) and (3.2), the demand curves on Figure 1 shift from $D1$ to D').

In a second round effect, the demand for both factors increases (from D' to $D2$) as the productivity of each factor is fostered by the other (effect of L in Equation (3.1) and K in Equation (3.2)).

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 (3.3)). This directly relates to a positive wealth effect in the consumption-leisure arbitrage.⁷

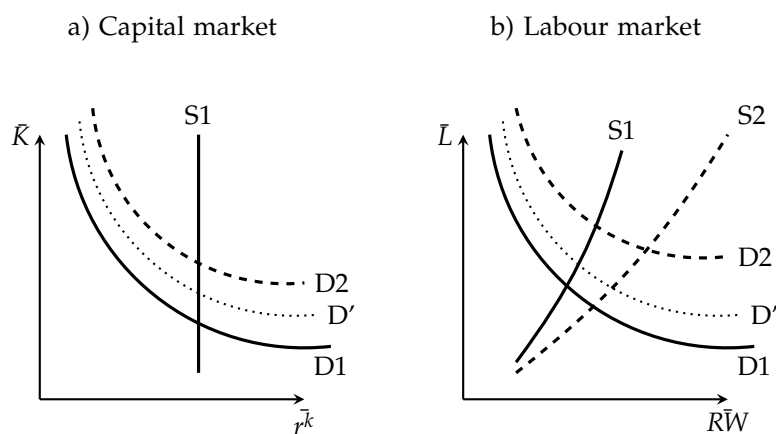


Figure 1: Effect of lower firms' market power ($\theta \uparrow$) on the capital and labour market

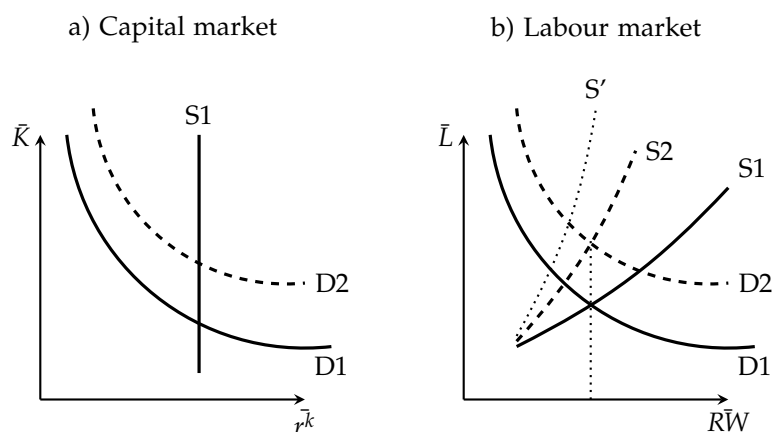


Figure 2: Effect of lower workers' market power $\theta_w \uparrow$ on the goods and labour market

⁷These 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.

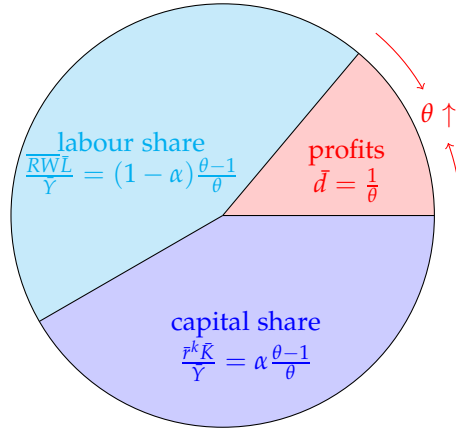


Figure 3: Decomposition of production

Reform on the labour market A decrease in households' market power on the labour market directly affects the labour supply curve (Equation (3.3)). As they lose 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 (3.1)). Consequently the real wage is also unchanged by the reform (Equation (3.2)). 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 elasticities of output to structural reforms to better understand the determinants of the scale of gains. In Campagne and Poissonnier (2016), 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 :

$$\bar{Y} = \bar{\zeta} \left(\alpha \frac{\theta-1}{\theta} \left(\frac{1}{\bar{\beta}} - 1 + \delta \right)^{-1} \right)^{\frac{\alpha}{1-\alpha}} \bar{L} \quad (3.4)$$

From households consumption-leisure arbitrage:

$$\bar{L} = \left(\frac{1}{\bar{\kappa}} \frac{\mathcal{B}(\sigma_c)}{\mathcal{B}(\sigma_c) + 1} \right)^{\frac{1}{(1+\sigma_l)(1-h_l)}} \quad (3.5)$$

where $\bar{\kappa} = \kappa(1 - \sigma_c) (\mathbb{N})^{-(1-h_l)(1+\sigma_l)}$.

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

$$1 = cy + iy + gy \quad (3.6)$$

with the ratio of private consumption to output cy being fully endogenous, 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:

$$\alpha \frac{\theta - 1}{\theta} = \frac{\overline{r} + \delta}{g + \delta} iy \quad (3.7)$$

Finally, in equilibrium the real wage verifies:

$$\overline{RW} = \bar{\zeta} \left(\alpha \frac{\theta - 1}{\theta} \left(\frac{1}{\beta} - 1 + \delta \right)^{-1} \right)^{\frac{\alpha}{1-\alpha}} (1 - \alpha) \frac{\theta - 1}{\theta} \quad (3.8)$$

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

$$\frac{d\bar{Y}}{\bar{Y}} = \left(\frac{\alpha}{1 - \alpha} + \frac{1}{(1 + \sigma_l)(1 - h_l)(1 + \mathcal{B}(\sigma_c))} \left(1 + \frac{iy}{cy} \right) \right) \frac{d\theta}{\theta - 1} \quad (3.9)$$

and to labour market reforms:

$$\frac{d\bar{Y}}{\bar{Y}} = \frac{1}{(1 + \sigma_l)(1 - h_l)(1 + \mathcal{B}(\sigma_c))} \frac{d\theta_w}{\theta_w - 1} \quad (3.10)$$

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

$$\frac{d\bar{U}}{\bar{U}} = (1 - \sigma_c)(1 - h_c) \left[\left(\frac{\alpha}{1 - \alpha} - \frac{iy}{cy} \right) + \frac{1 - \frac{\theta_w - 1}{\theta} \frac{\theta - 1}{\theta} \frac{(1 - \alpha)(1 - h_l)}{(1 - h_c)cy}}{(1 + \sigma_l)(1 - h_l)(1 + \mathcal{B}(\sigma_c))} \left(1 + \frac{iy}{cy} \right) \right] \frac{d\theta}{\theta - 1} \quad (3.11)$$

and on the labour market:

$$\frac{d\bar{U}}{\bar{U}} = (1 - \sigma_c)(1 - h_c) \frac{1 - \frac{\theta_w - 1}{\theta} \frac{\theta - 1}{\theta} \frac{(1 - \alpha)(1 - h_l)}{(1 - h_c)cy}}{(1 + \sigma_l)(1 - h_l)(1 + \mathcal{B}(\sigma_c))} \frac{d\theta_w}{\theta_w - 1} \quad (3.12)$$

In all four cases, the elasticity crucially depends on households utility parametrisation $(\sigma_l, \sigma_c, \mathcal{B})$,⁸ which calls for a detailed sensitivity analysis (Section 4).

The effect of both types of reforms on output and other real variables is positive (Figure 4). Replicating a standard exercise in this literature, decreasing product and labour mark-ups from the average Euro area levels to Europe's best performers levels 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. We give a more detailed explanation of this dependency in section 4.2. However, it is already interesting to see that the absence of unemployment in our model is a key source of this potentially negative externality of structural reforms on utility. Indeed, as mentioned above, the increase in output goes through an increase in hours worked, therefore generating disutility to households. In reality, the increase in output could be channelled through a higher employment at constant per capita hours worked.

⁸Note that the sign of \mathcal{B} is the sign of $1 - \sigma_c$ and equation 3.5 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 $1 - \sigma_c$.

With our calibration, the effect on utility of an output augmenting structural reform is negative (disutility increases, Figure 5).⁹ 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).

3.3 Transition dynamics

Compared to the previous analytical and general explanations of long-term effects, we now focus on specific reforms and simulate labour and goods market 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.

Increased competition on the goods market - Figure 6 Increasing competition on the goods market ($\theta \uparrow$ or price markup $= \theta/(\theta - 1) \downarrow$) induces an immediate change in the distribution of production factors remuneration as explicated in the previous section. As θ 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.¹⁰

In nominal terms, the reform will eventually imply a decrease in prices. In the Phillips curve, that is in the determination of today's price, the expected deflation motive prevails over the increase in the real marginal cost. As such, prices decrease today, inflation temporarily decreases, and so does the nominal interest rate.

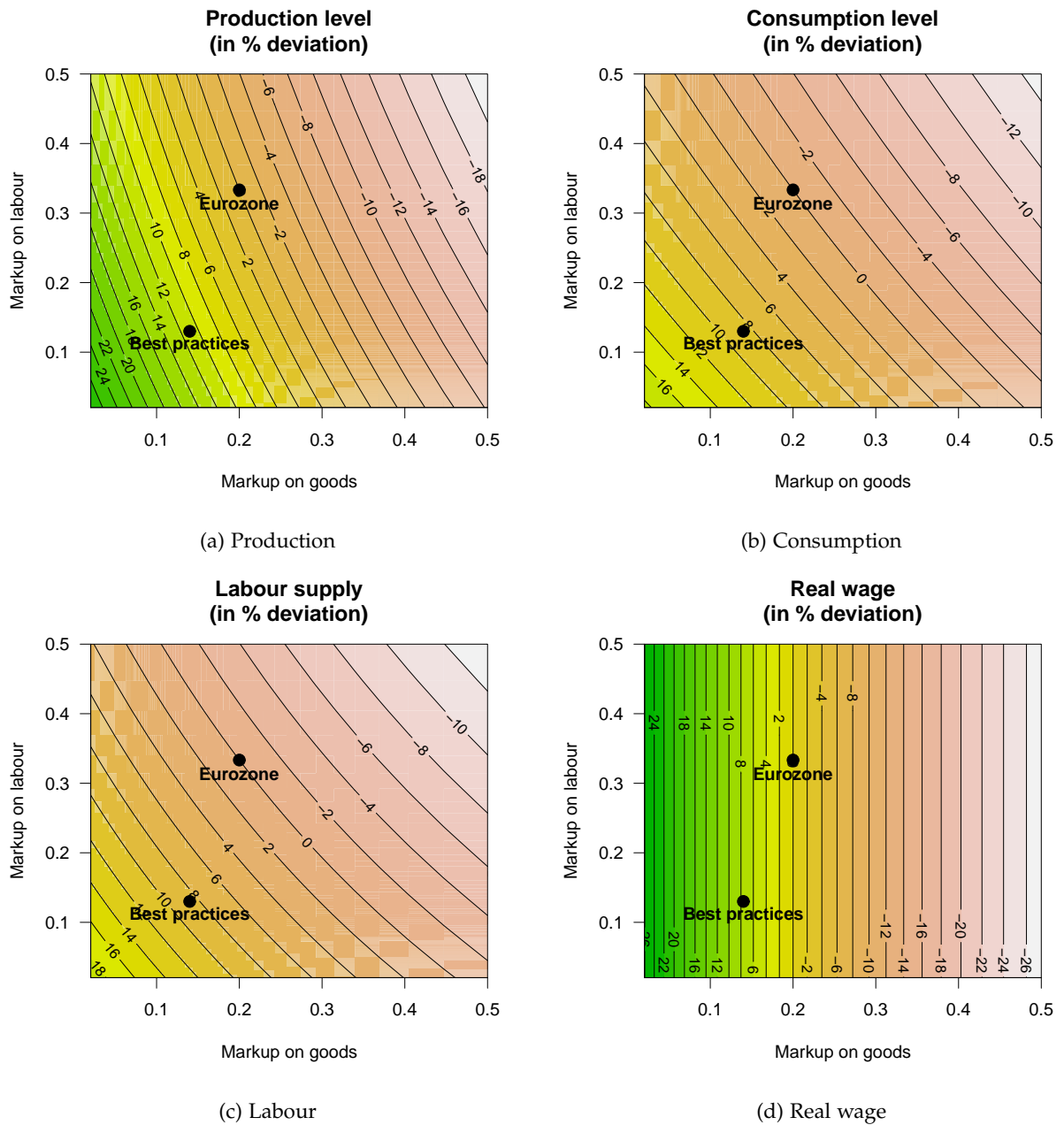
On households' side, the consumption-leisure-investment arbitrage is modified through a mix of substitution and wealth effects, consequence of the particular choice of the utility function as well as its calibration. In all, investment immediately increases upon reform to take advantage of the favourable 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 real 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 (i.e. capital) during the transition and to increased real wages and labour supply.

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 (Equation 3.11). We show how this result depends on the specification of utility in a sensitivity analysis (Section 4).

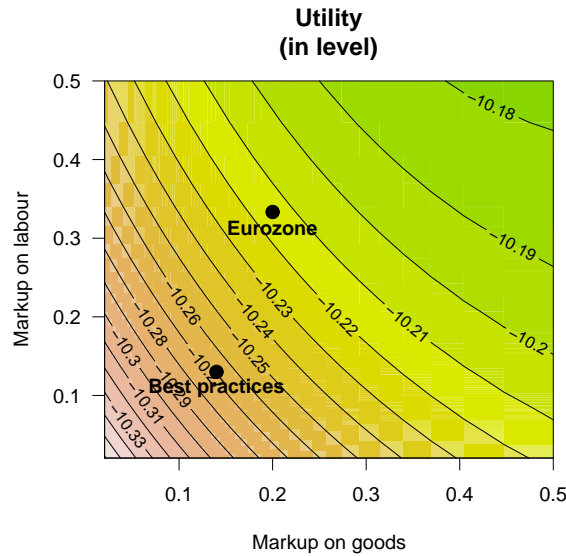
⁹We choose to refer to the disutility as the steady state level of utility is negative. As such, a negative p.p. differential of utility indicates a lesser negative utility level, that is an improvement in utility. An interpretation in terms of disutility is more convenient and intuitive as a negative p.p. differential of disutility is indeed a decrease in the disutility.

¹⁰This 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).

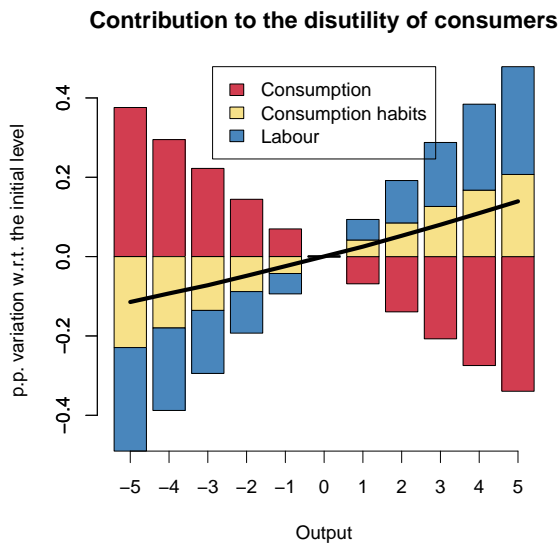


The x-axis represents the level of mark-up on goods (i.e. $1/\theta - 1$) whereas the y-axis represents the mark-up on wages (i.e. $1/\theta_w - 1$). The point named *Eurozone* corresponds to the standard calibration of our model and the point *Best practices* to the level of mark-ups in the three best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

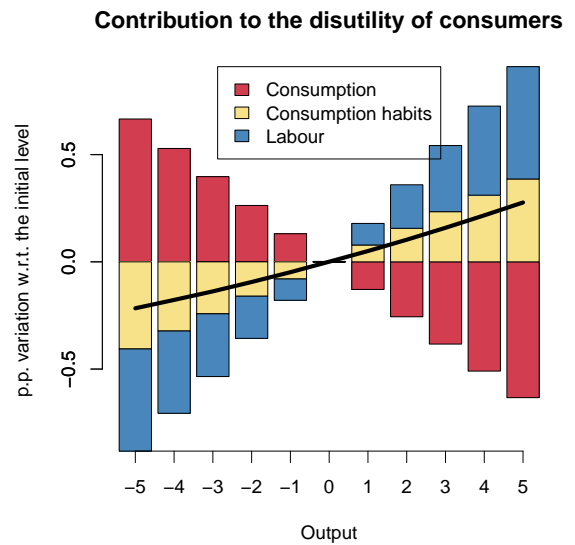
Figure 4: Steady state variations upon reforms in p.p. with respect to the initial calibration



(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 pro-competitive reforms against the output increase induced by the reform. We represent the disutility of households. An 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 in percentage points. The y-axis represents the variation in the disutility in percentage points with respect to its initial level.

This reads as follows : for the left lower figure, for a goods market deregulation that leads to a final increase in output of 5%, the disutility of households increases by 0.14 percentage points. It decomposes in 0.2 p.p. stemming from consumption habits, 0.28 p.p. from labour disutility, mitigated by -0.34 p.p. from consumption.

Figure 5: Steady state utility levels and decomposition upon reforms

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

As for the goods market reform but in a lesser extent, 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 turn causes investment to overshoot. It also generates a small transitory decrease in real wages.¹¹ In all, the real marginal cost temporarily increases which puts upward pressure on prices. Consequently, 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.

In terms of utility (Figure 7), there is also a cost to the reform in the transition and in the long run as utility decreases. In addition, during the transition this cost is higher than in the long-term. We analyse this result more specifically in Section 4.

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

4 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 a permanent increase in production of 4.8 p.p (resp. 5.8 p.p.), whereas this increase is of 1.6 p.p (resp. 6.1 p.p.) in the GEM model (Bayoumi et al., 2004).

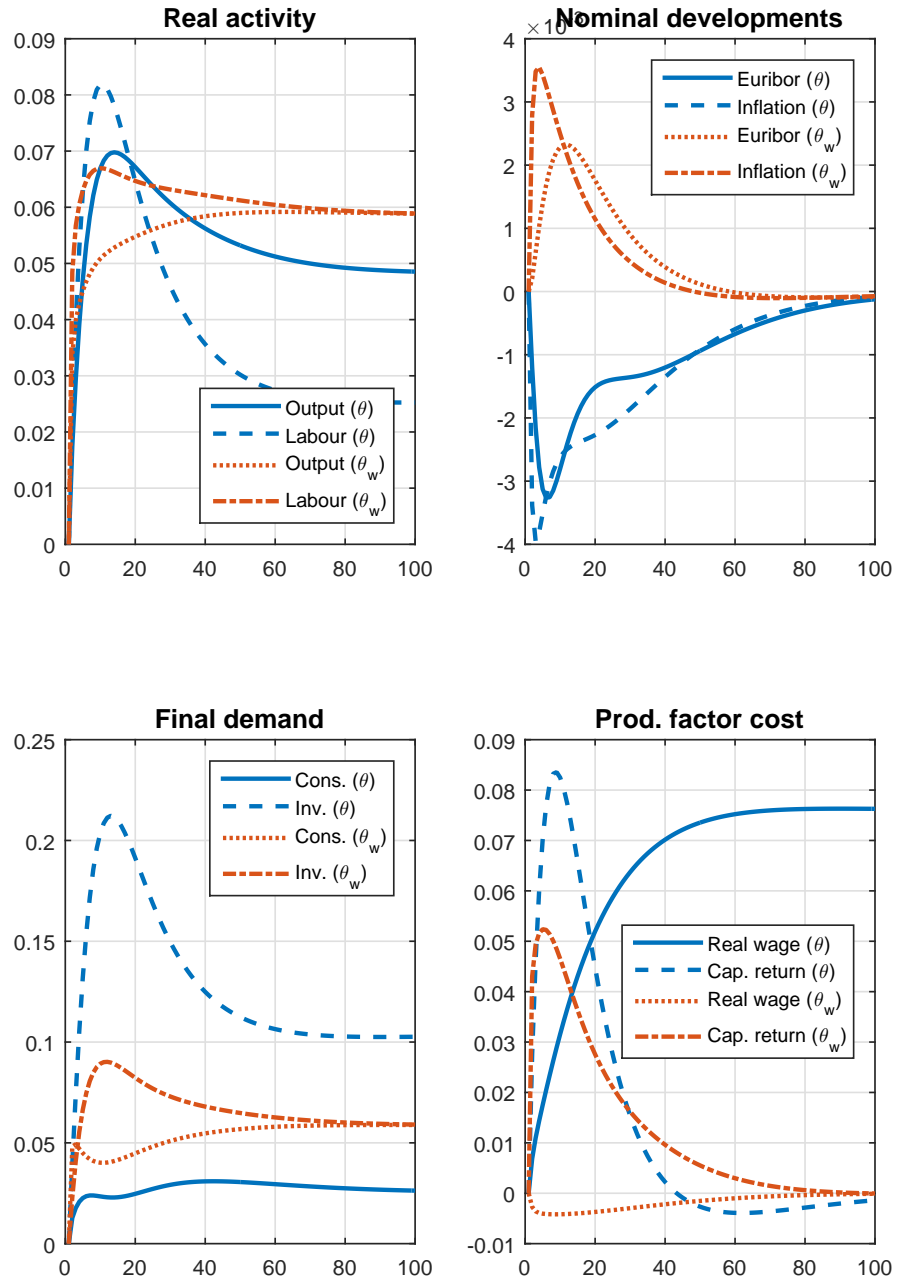
At first sight, structural reforms are output-enhancing in both models. Whereas magnitudes are close for labour market reforms, still with a long term difference of 0.6 p.p in production, this gap widens to more than 3 p.p. of production in the case of product market reforms.

Indeed, the present model remains a medium scale DSGE model *à la 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 3.9 and 3.10 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 households¹² as it is common in institutional DSGE models.

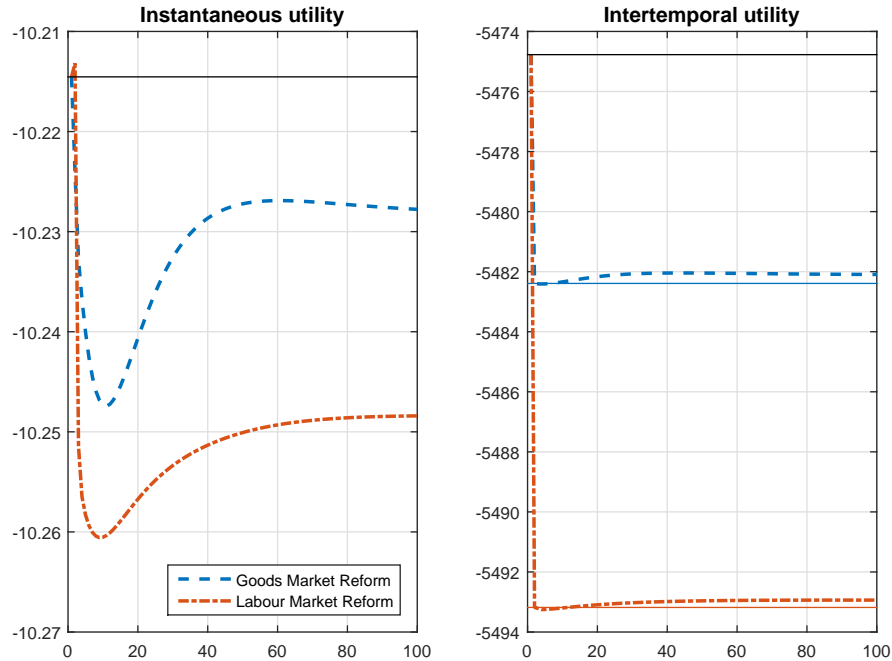
¹¹As mentioned by Blanchard and Giavazzi (2003) there is a trade-off between lower real wages in the short run against higher employment in the long run. However, as wages are sticky in our model, rapid and large gains in labour supply outweigh the small decrease in real wages in terms of income.

¹²That is households that consume their current income at each period and do not have access to savings or credit.



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 mark-up



Structural reforms implemented here are the ones of Everaert and Schule (2006), that is 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.

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

4.1 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 with 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 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 substitution of consumption σ_c , the debate is less fierce and values range from 0.25 (Bayoumi et al., 2004) to 2 (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).

Mechanism Recalling long term elasticities (Equations (3.9) and (3.10)), we can anticipate that both σ_c and σ_l will play a key role in the size of the impact of pro-competitive reforms. In particular, the inverse Frisch elasticity 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, that is a lower response of labour to variations in real wages (there is less consumption-leisure arbitrage). Recall that the consumption-leisure arbitrage rewrites as follows from Equation 3.3

$$\frac{\theta_w - 1}{\theta_w} \overline{RW} = (1 + \sigma_c) \bar{C}f(\bar{L}) \quad (4.1)$$

When conducting a pro-competitive reform on the labour market (Figure 2), the left-hand side term 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 from 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 applications 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 the gains from increased competition (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.

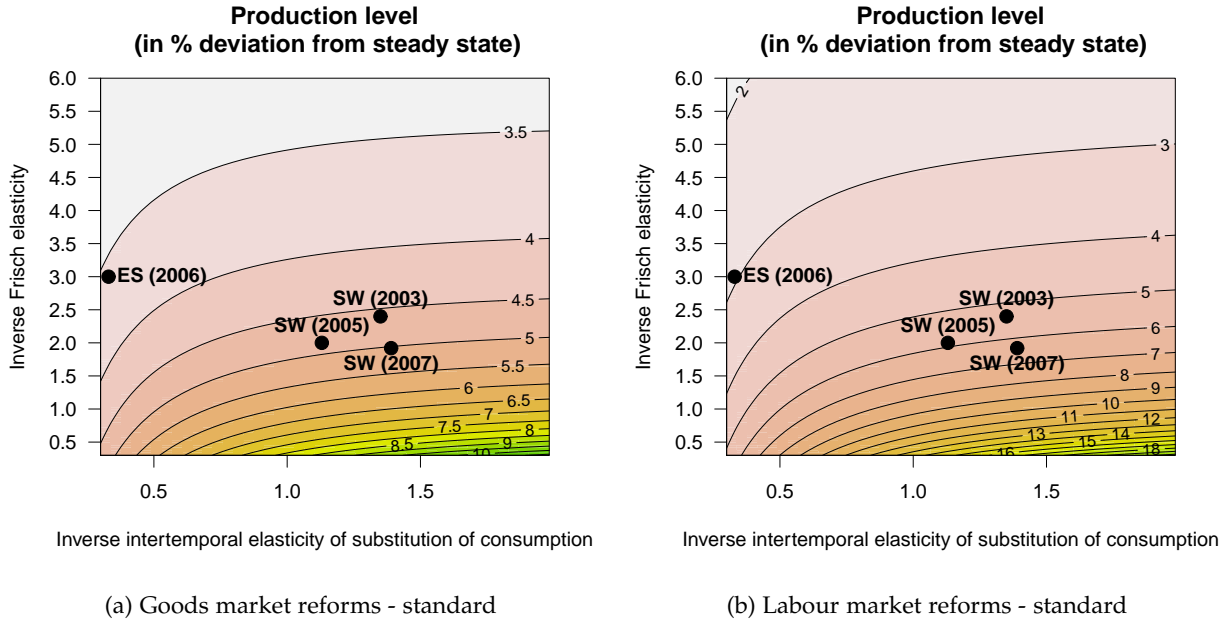
Similarly for $h_c = 0$, Figures 16 and 20 in the Appendix, show that the role of habits on the transition is non-existent, and negligible in the long-run for consumption habits. For labour habits ($h_l = 0.5$) (Figures 17 and 20), the effect is also a scale effect, the existence of habits scales the *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 3 p.p. of production (resp. 6 p.p.) for product(resp. labour) market reforms, in comparison to Figure 8.

4.2 Welfare costs - welfare gains

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. A negative effect on welfare is rather unusual in the literature. Indeed, Jonsson (2007), Matheron (2002), or Matheron and Maury (2004) insist on the welfare cost of imperfect competition, whereas Everaert and Schule (2006), Gomes et al. (2013) and Forni et al. (2010) show based on institutional model simulations that structural reforms are welfare enhancing.

Mechanism The main mechanism behind the positive welfare impact of structural reforms is as follows: as output increases so does households' revenues, consumption and therefore welfare. Indeed, the increase in output also translates into an increase in the disutility incurred from labour. However, in most standard

¹³Indeed, 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 lower.



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 indicates the calibration of the model following Smets and Wouters for the Euro area. Our standard calibration relies on Smets and Wouters (2005). *ES (2006)* corresponds to Everaert and Schule (2006).

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

calibrations, this detrimental effect is dominated by the beneficial consumption effect.

Nevertheless, there exists calibrations for which welfare is negatively impacted by the pro-competitive reforms in our model. In particular, recalling the analytical expressions for the long term elasticities (Equations (3.11) and (3.12)), we observe that this conclusion can arise through two mechanisms: habits on consumption or labour, and government consumption.

Let first focus on the latter, and consider a no habit formation case ($h_c = h_l = 0$). In this case, the sign of long-term utility elasticities for both goods and labour markets reforms partly depends on the sign of $\mathcal{A} = 1 - (\theta_w - 1/\theta_w)(\theta - 1/\theta)((1 - \alpha)/c_y) = 1 + \mathcal{U}_l L/\mathcal{U}_c C$, where \mathcal{U}_x is the derivative of the utility function with respect to x . This term depends on the markup level in both goods and labour markets, as well as on the share of private consumption in GDP. It can also be rewritten to show a direct dependency on the ratio of the marginal disutility of labour to the marginal utility of consumption. If \mathcal{A} becomes negative, structural reforms can imply welfare losses.

In particular, it is interesting to note that we can show analytically that without public consumption \mathcal{A} is never negative, and households never incur welfare losses. The main mechanism is as follows : by adding public consumption, the gains in output following structural reforms are shared between households (either through consumption or investment) and the public sector. That is the mere decomposition of GDP into C+I+G. However, the increase in output is sustained by an increase in hours worked that is fully borne by households. As such, the crowding out effect of public consumption introduces a wedge for households between their welfare gains from consumption and their welfare loss from labour.

Moreover, we notice that \mathcal{A} can only turn negative when $\theta_w - 1/\theta_w$ or $\theta - 1/\theta$ are high, that is when markups are already low.

For goods market reforms, if markups on prices are low, households are already consuming close to the optimum at equilibria, and their marginal utility of consumption is low. Therefore, as goods markets are further deregulated, households indeed consume more but derive relatively less utility from consumption than what they lose from working more.

Similarly, for labour markets reforms, if wage markups are low, households already demand wages close to their marginal cost. Therefore, as wage markups are further decreased, their initial marginal disutility of labour is high, and increasing output will be more detrimental to their welfare than what they gain from consumption. For labour markets reforms, the loss in welfare for households is analogous to the loss in profits for firms when price markups are reduced.

Habit formation In addition to the previous mechanism, habit formation plays a crucial role through the term $1 - h_l / 1 - h_c$.

First, the higher h_c , i.e. the more habits on consumption, the closer to zero the \mathcal{A} term is. For strong consumption habits, this \mathcal{A} term might even turn negative inducing welfare losses in the long-term. This decline in welfare logically comes from the fact that an increased aggregate consumption level also means stronger negative externalities at the household level, as they compare to the aggregate level.

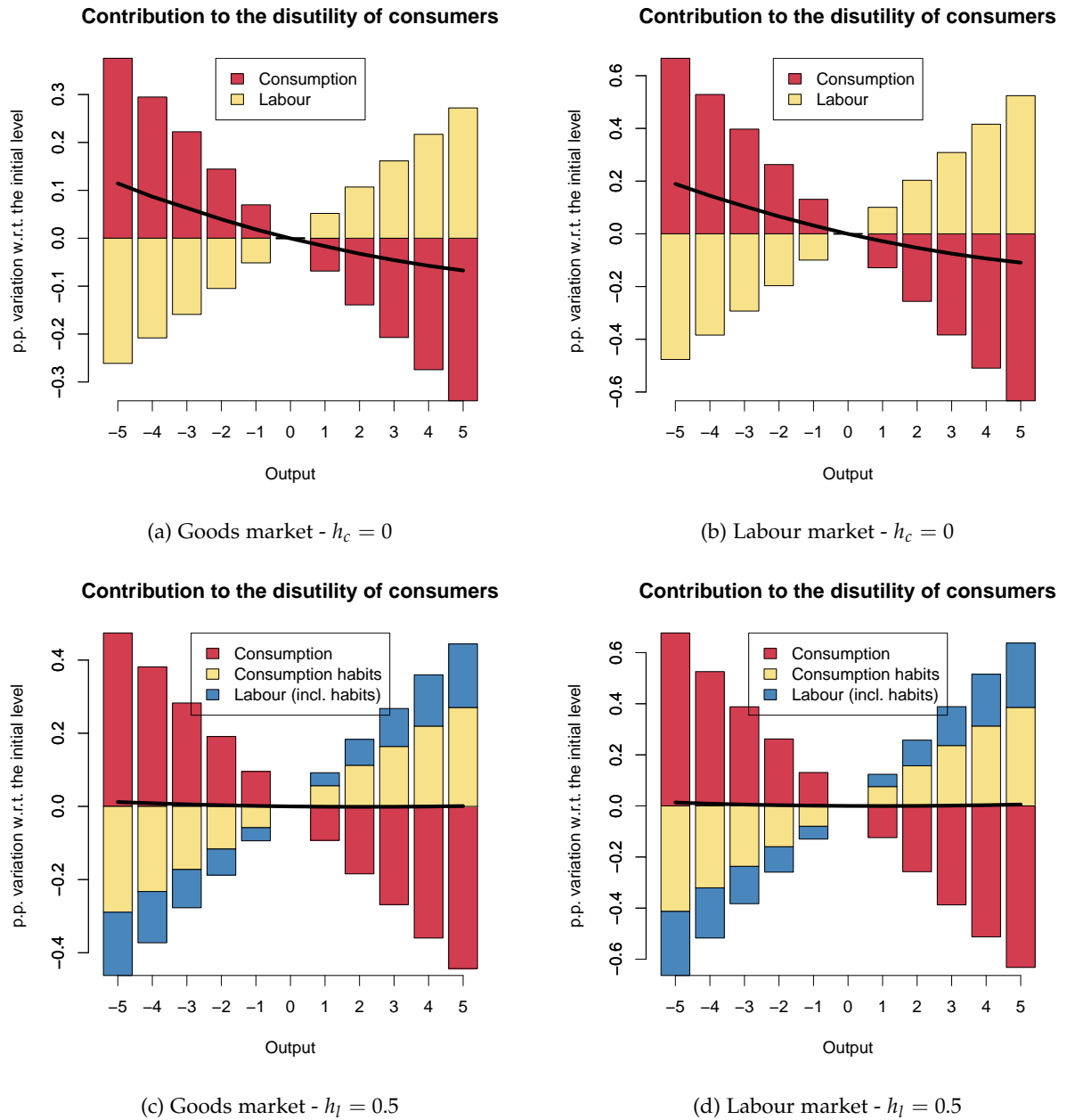
Similarly, habits on labour (Bayoumi et al., 2004; Ratto et al., 2009) work in a similar fashion as consumption habits, that is as a *social norm* to which households compare. Following a general increase in labour supply, each household incurs a lesser disutility from working longer hours. However, while consumption habits are detrimental to welfare, labour habits are therefore welfare enhancing. Therefore, the higher h_l is, i.e. the more habits on labour, the further away from zero \mathcal{A} is.

Note that we introduce habit formation in a multiplicative manner (a choice also made by Abel (1990); Galí (1994); Carroll et al. (2000); Fuhrer (2000)) and only consider external habits (i.e. *Catching up with the Joneses*).¹⁴ However, Carroll (2000) shows that in the business cycle (i.e. in the linearised equations), multiplicative and additive habits can not be distinguished. However, habit modelled in a multiplicative way affect the long-term elasticity of utility whereas additive habits would be neutral on the long term elasticity of utility to a reform.

Numerical applications As shown on Figure 5, utility decreases upon reform in our baseline model. This stems from the introduction of consumption habits that mitigate (and actually offset) the gains from increased consumption. Indeed, considering a recalibration of the model without consumption habits ($h_c = 0$), we find a positive welfare impact of pro-competitive reforms (disutility decreases, Figure 9a and 9b). The transitions to the post reform steady state are almost identical (Figure 16 in the Appendix), and transitional costs remain (Figure 19). These costs (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).

Considering labour habits ($h_l = 0.5$) in our model yields very similar shape of transitions (yet different levels, see Figure 17 in the Appendix) but greatly impacts long term effect of the reforms as it is equivalent to a large reduction of the inverse Frisch elasticity at steady state. 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).

¹⁴Internal habit formation would therefore require further sensitivity tests.



Decomposition of changes in disutility following pro-competitive 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

4.3 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 are 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 disposable 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.

We calibrate this share to estimated values in QUEST III, that is $\mu = 40\%$, a value close to the upper bound but rather standard in institutional DSGE models.

Utility and inequalities between households The introduction of heterogeneous households allows to study the effect of increased competition on inequalities. Figure 10 presents the long-term responses of *Ricardian* and *non-Ricardian* consumption, labour supply and real wages to both types of pro-competitive reforms. Transitional dynamics and level ratios between both types of households are presented on Figure 18 and 21 in the Appendix.

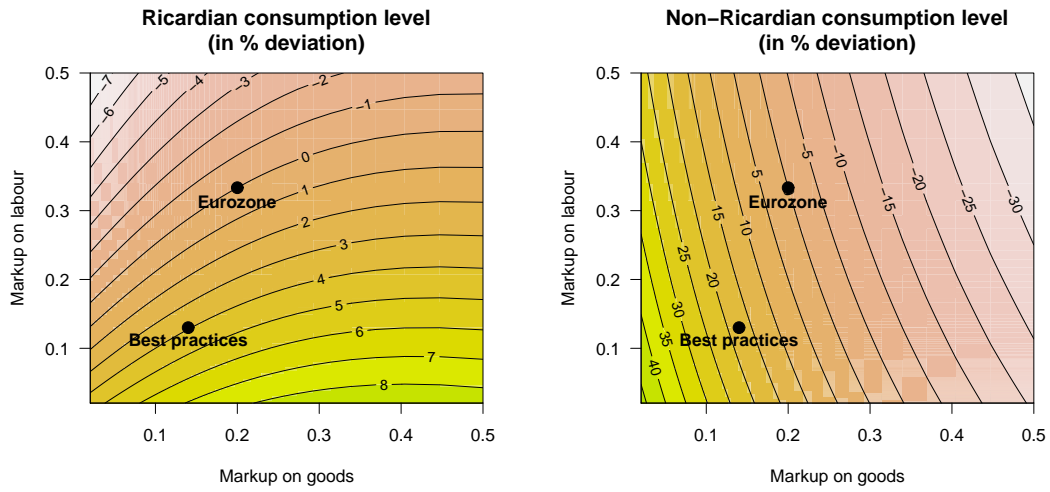
Deregulating the product market leads to a decrease in consumption and welfare disparities. Indeed both types of households are affected by a wealth effect, positive for *non-Ricardians* as the real wage goes up; negative for *Ricardians* as dividends shrink. Therefore, *non-Ricardians'* consumption markedly increases while *Ricardians'* consumption decreases slightly. On the labour market, *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.

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

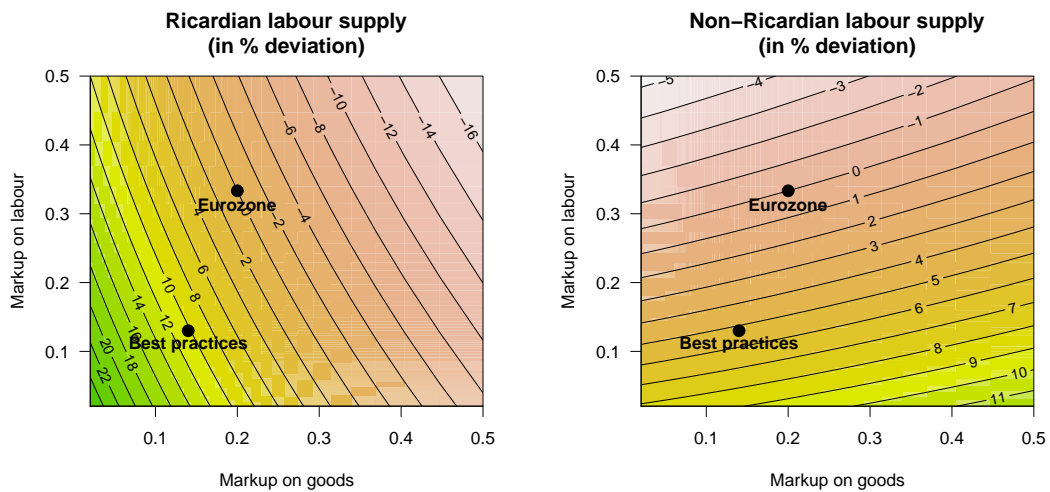
In addition, Figure 11 presents the steady state variation in the disutility of agents following a mark-up reform (indexed by the corresponding variations in production), as well as the contribution of each variable to this disutility: namely individual consumption, external consumption habits, and labour.

In the case of a product market deregulation (left column), disutility of the representative consumer decreases slightly (the utility therefore increases) with increasing output gains. Therefore, in the long term,



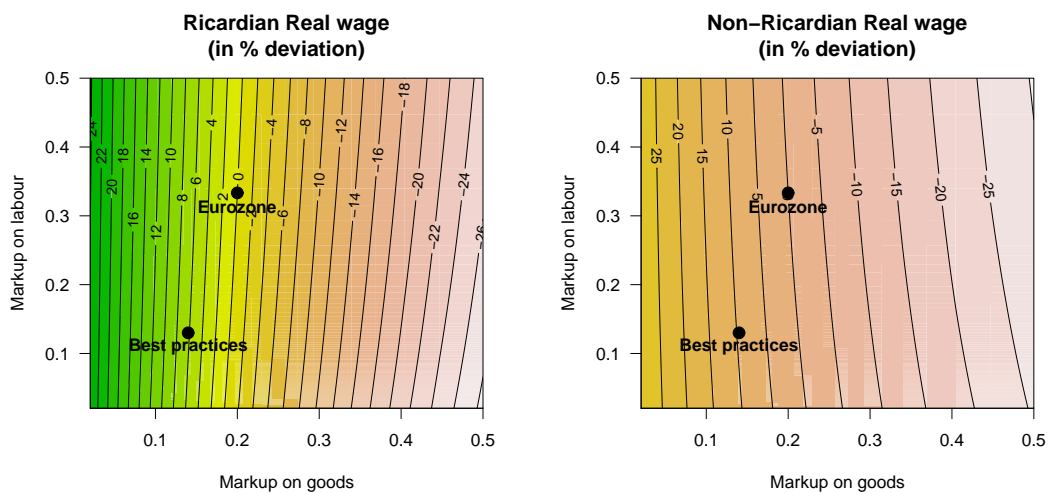
(a) Ricardian consumption

(b) non-Ricardian consumption



(c) Ricardian labour

(d) non-Ricardian labour

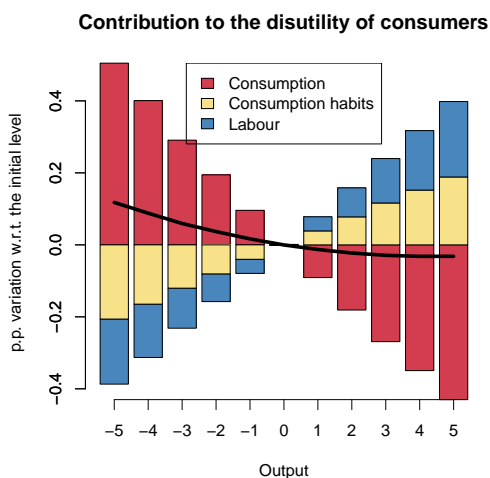


(e) Ricardian real wage

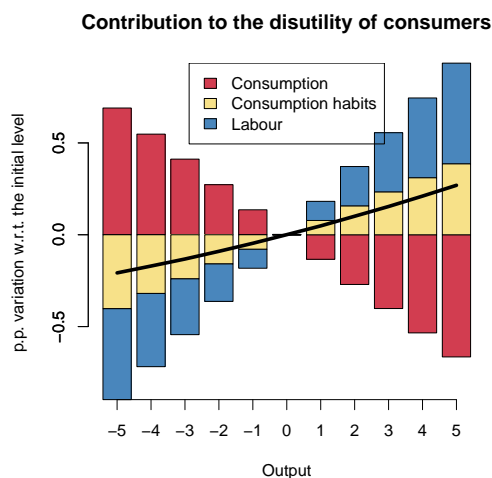
(f) non-Ricardian real wage

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).

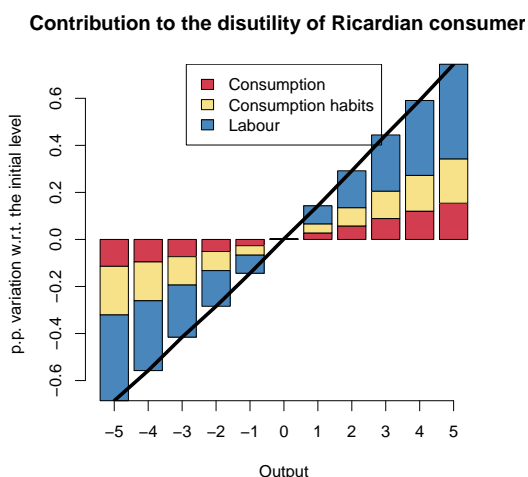
Figure 10: Steady state variations upon reforms in p.p. with respect to the initial calibration the presence of non-Ricardian households



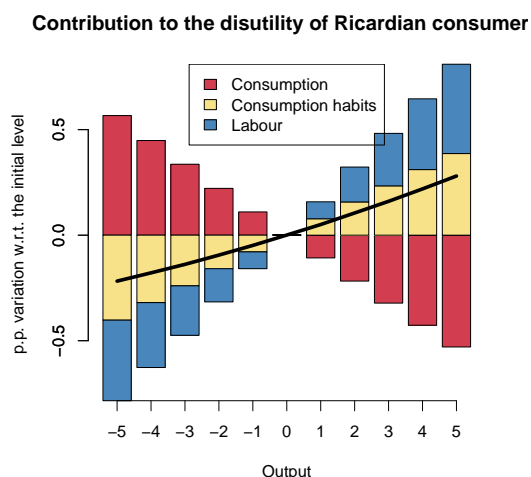
(a) Goods market reform - Representative



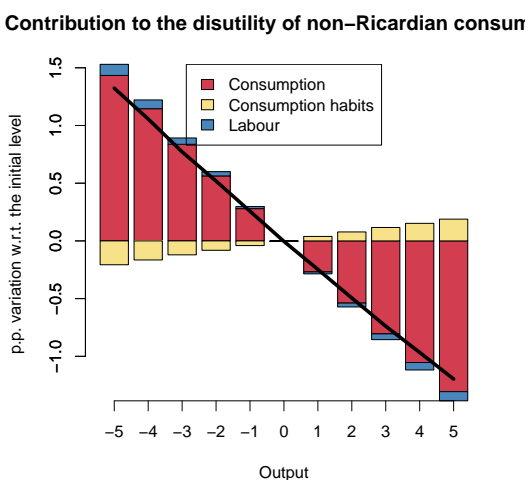
(b) Labour market reform - Representative



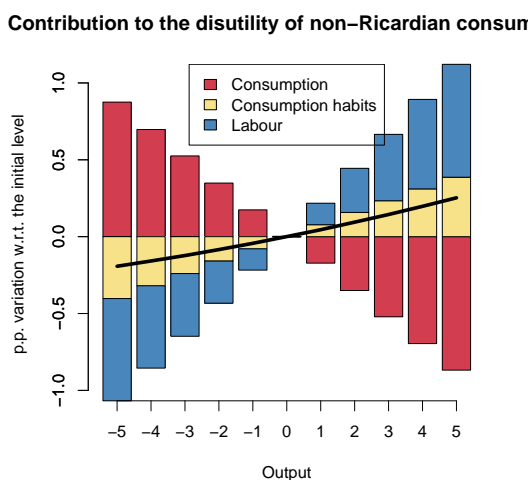
(c) Goods market reform - Ricardian



(d) Labour market reform - Ricardian



(e) Goods market reform - non-Ricardian



(f) Labour market reform - non-Ricardian

Decomposition of changes in disutility following pro-competitive 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.

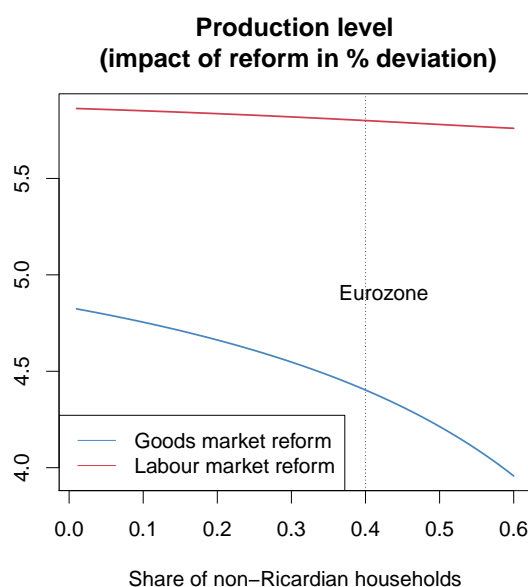
Figure 11: Steady state utility levels and decomposition upon reforms in the presence of constrained households

the economic desirability of an increased output goes along with an increased utility. However, implications are very different across households. Indeed, *Ricardian* households are adversely affected by the reform as labour, individual consumption and consumption habits work in the same way of an increased disutility.

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). All in all, the net effect of consumption (individual consumption minus consumption habits) is strongly welfare improving. The decrease in labour supply, following the positive permanent income effect of the reform, 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. Nevertheless, the total effect of consumption, net of habits, is welfare enhancing, while the increase in labour supply results in a long-term decrease in the utility level. This decomposition is quasi identical across households.

Numerical implications for reforms' impact Increasing competition on both the labour and goods markets, in the presence of an increasing share of constrained households (Figure 12) goes for both types of reforms towards weaker long-term production gains. In the presence of liquidity-constrained agents, the effect of product market reforms can be mitigated by more than 0.5 p.p., whereas this effect is negligible for labour market reforms.



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

5 Conclusion

In a standard neo-Keynesian model which is at the core of most large scale institutional models, we evaluate the impact of structural reforms.

The long term gains in output following pro-competitive reforms are well documented in this class of model. Qualitatively, these models provide results in line with stylized facts obtained in deregulation-oriented models such as Blanchard and Giavazzi (2003). However, these similarities hide quite different economic mechanisms. We explain these mechanisms, stressing in particular the importance of the households' leisure-consumption arbitrage. Quantitatively, we proceed to a sensitivity analysis: whereas qualitative results, including in the transition, are robust to changes in the specification of the model, quantitative results differ across specifications. The simple recalibration of households' utility can lead to additional gains or losses of a few percentage points in output following pro-competitive goods or labour markets reforms.

However, policy recommendations based on welfare analyses are less clear-cut in the long run than recommendations solely based on output analyses. In the transition, welfare losses are large despite the increase in permanent income. Introducing *non-Ricardian* agents allows stylized yet informative inequality analyses showing that goods market reforms reduce inequalities while labour market reforms are neutral between Ricardian and non Ricardian agents.

These results imply two main recommendations: first, and at the very least, an extensive use of sensitivity analyses when building policy recommendations from these models, second, and more fundamentally, a rethink of the mechanisms at play in the long run (and in particular on the labour market) and of differences in elasticities (Frisch and intertemporal substitution of consumption) between the long run and over the business cycle.

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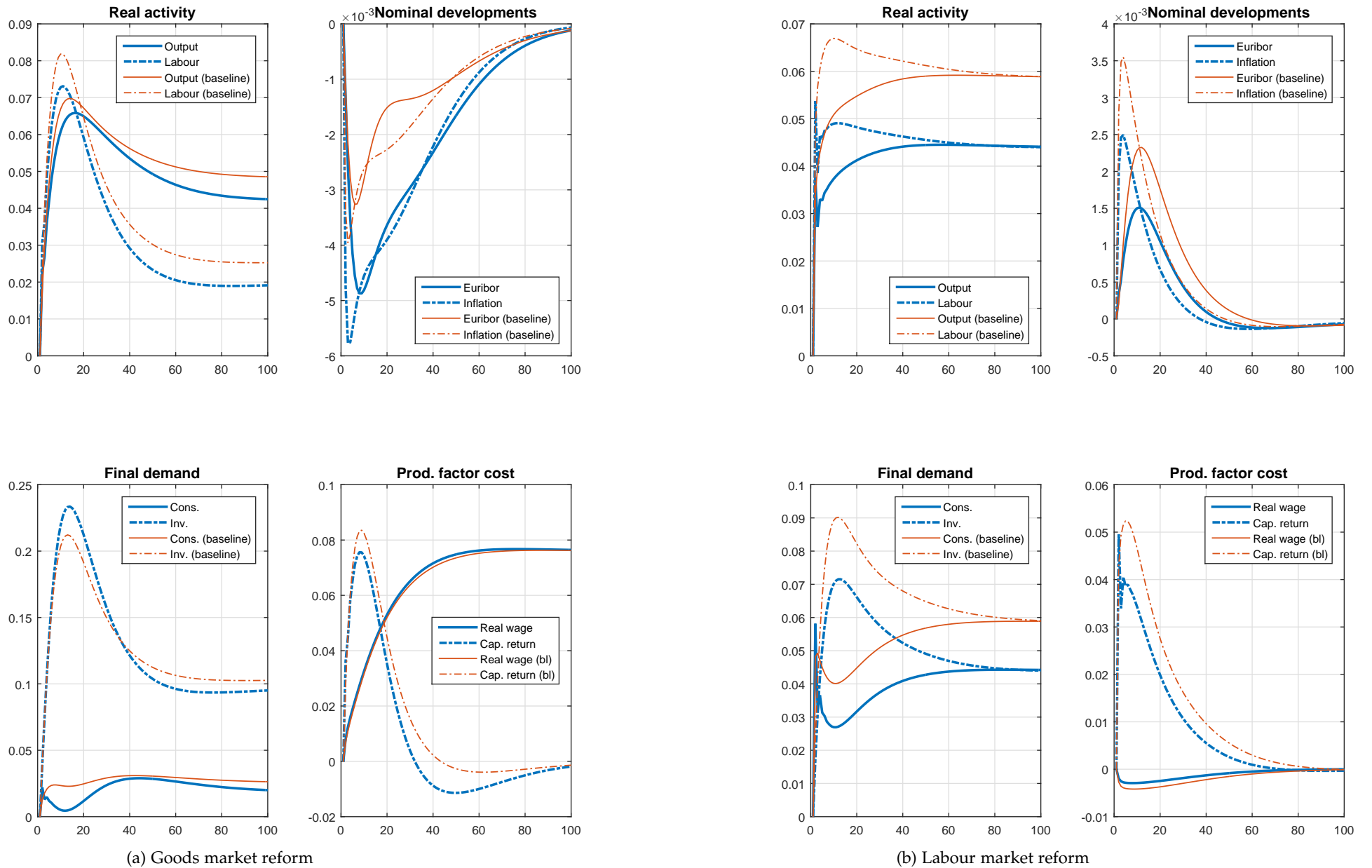


Figure 13: Sensitivity of the transition following mark-up reforms to the calibration ($\sigma_c = 0.5$ compared to baseline)

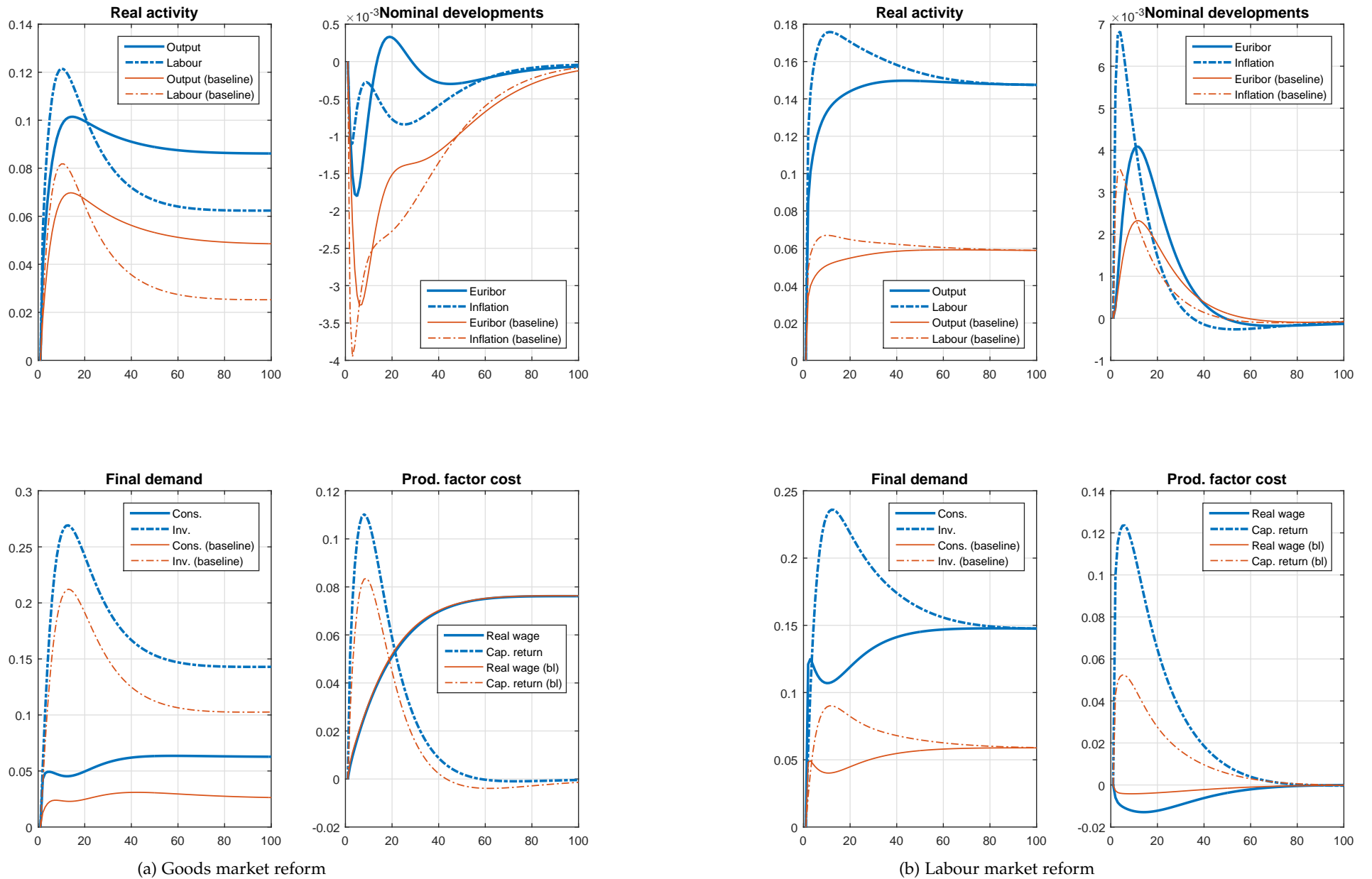


Figure 14: Sensitivity of the transition following mark-up reforms to the calibration ($\sigma_1 = 0.3$ compared to baseline)

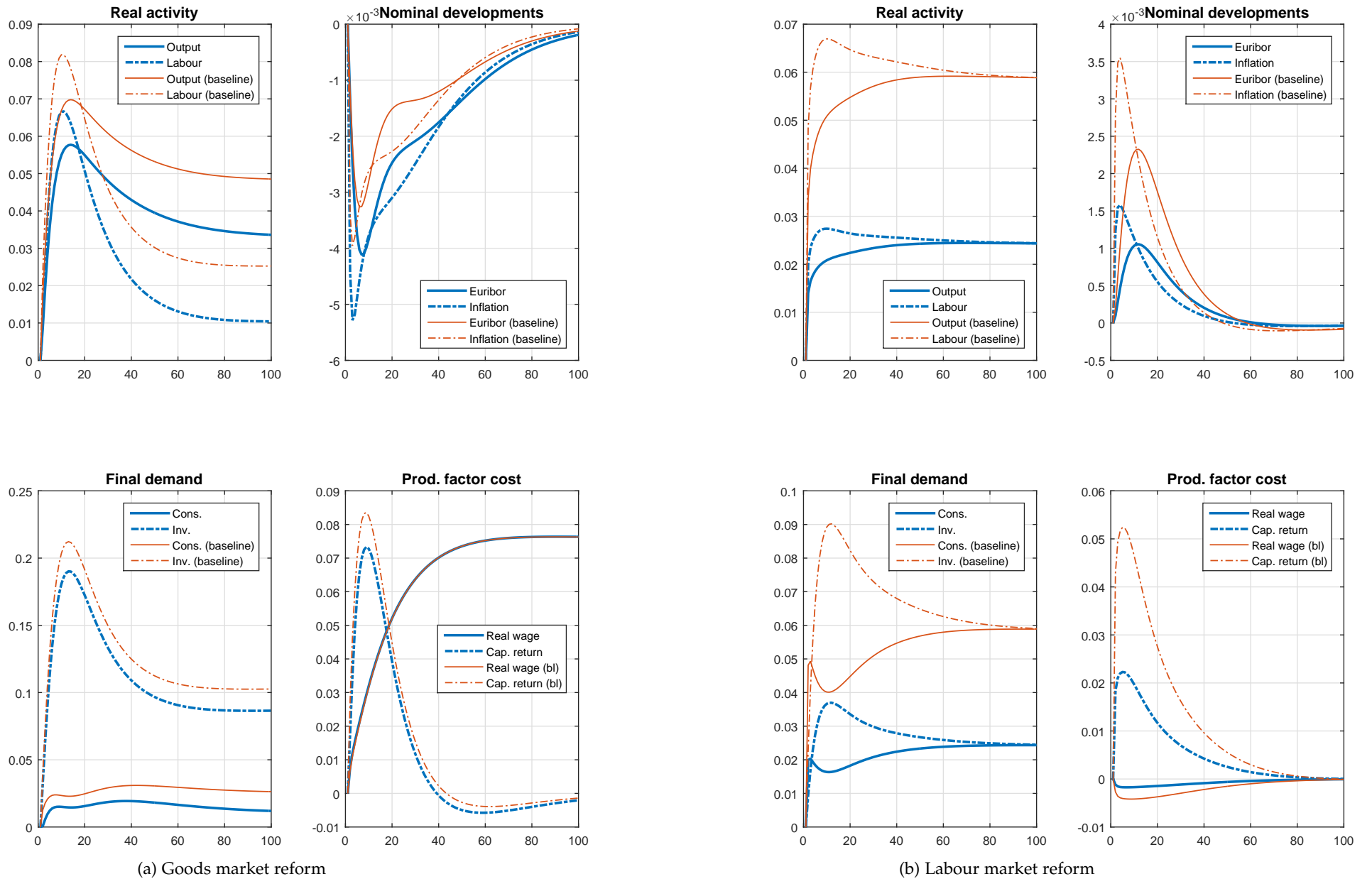
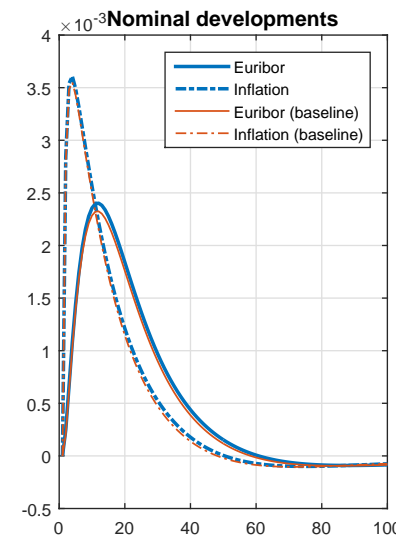
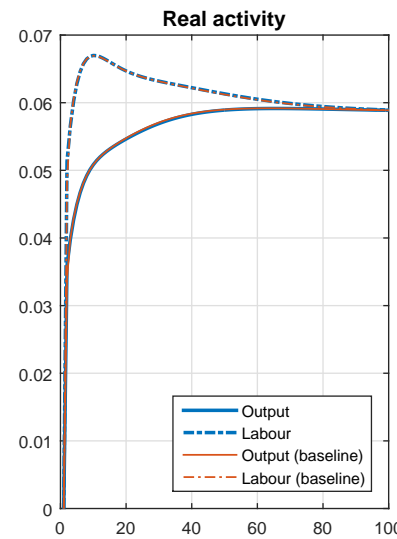
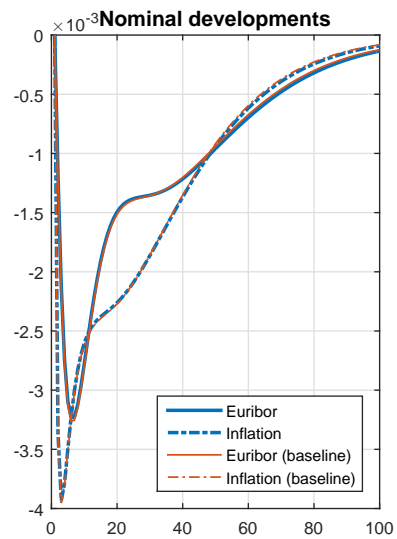
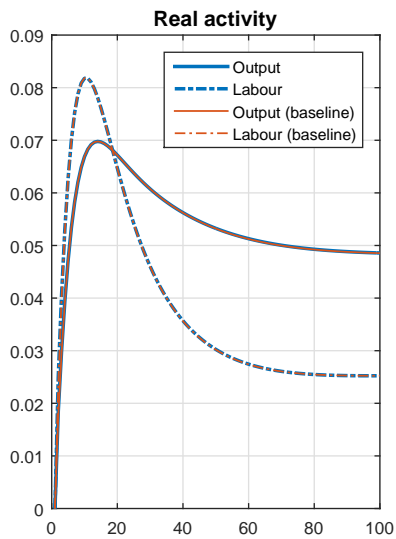
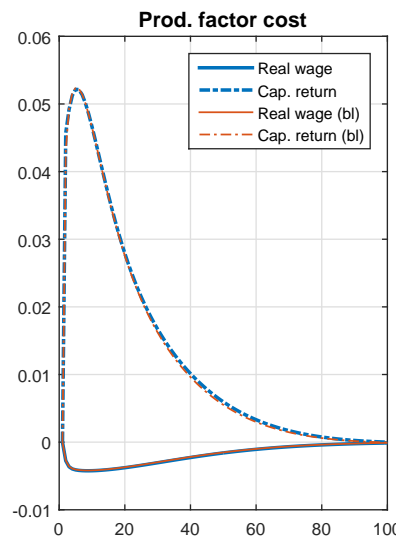
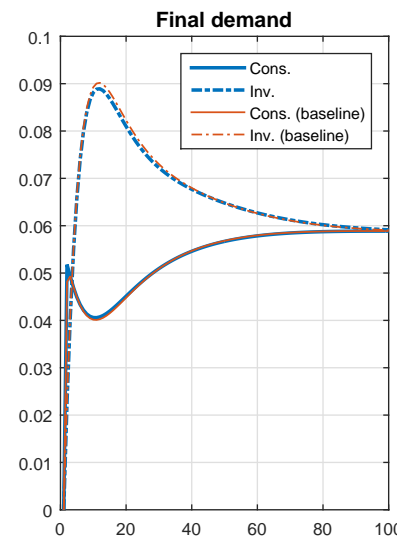
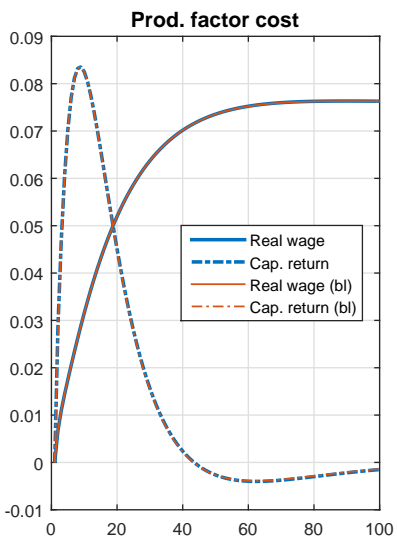
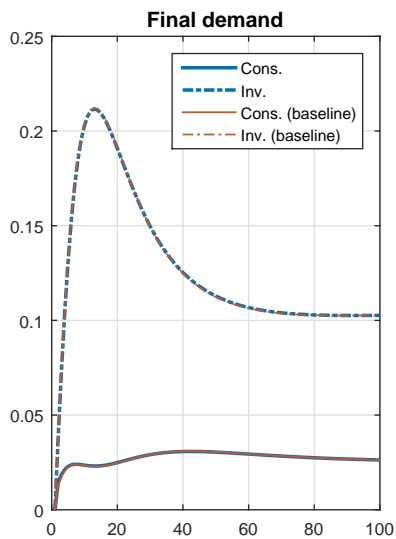


Figure 15: Sensitivity of the transition following mark-up reforms to the calibration ($\sigma_l = 6$ compared to baseline)



33



(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)

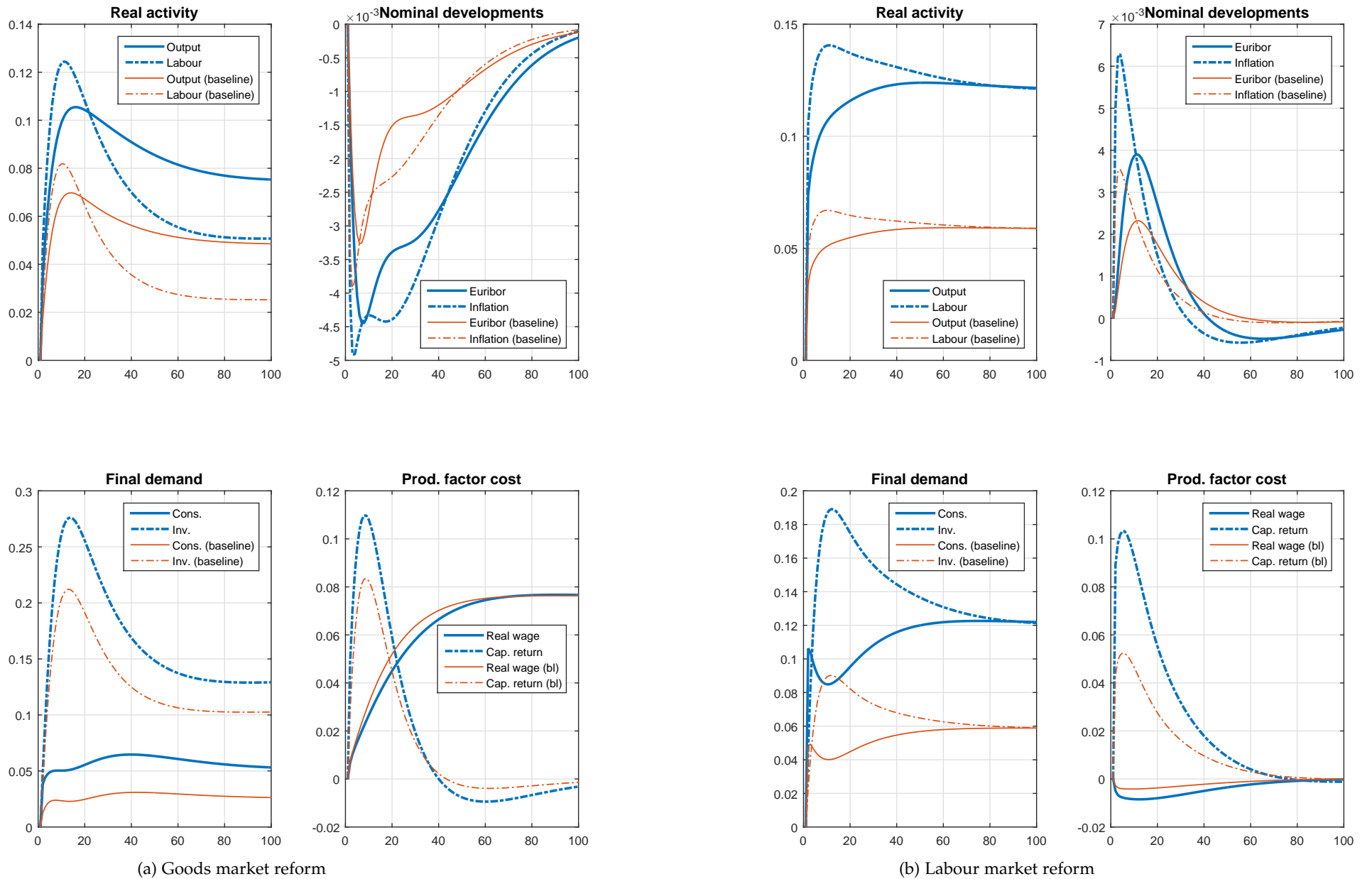


Figure 17: Sensitivity of the transition following mark-up reforms to the calibration ($h_1 = 0.5$ compared to baseline)

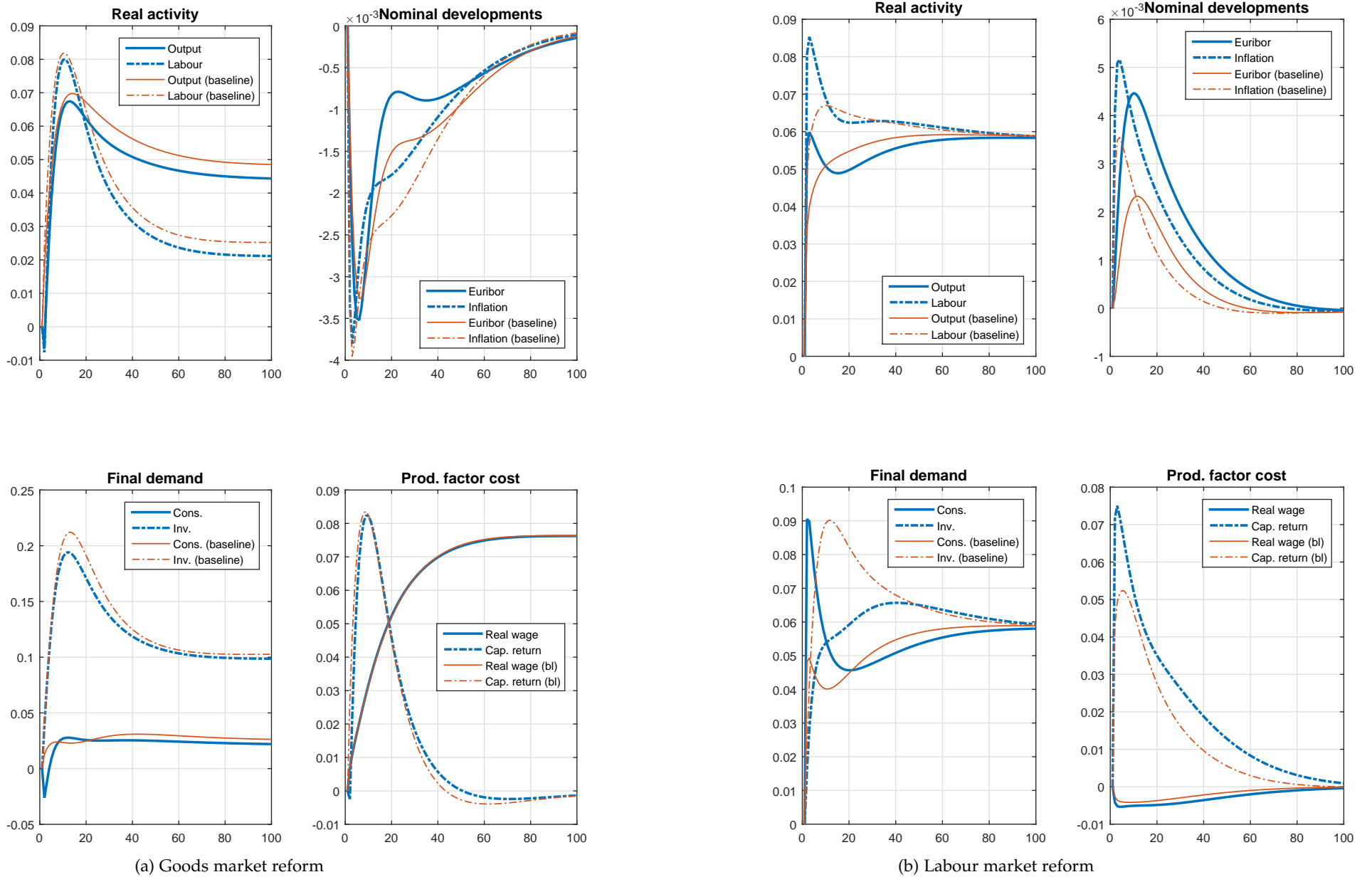
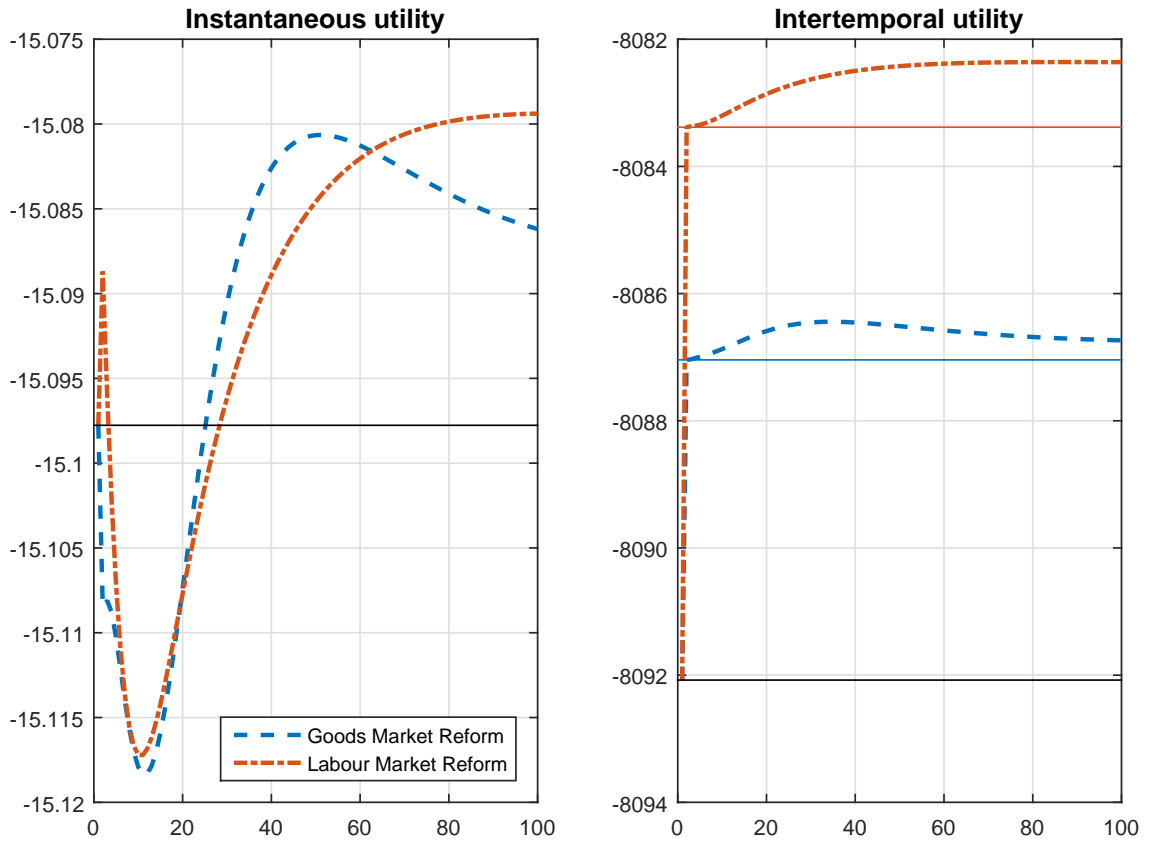
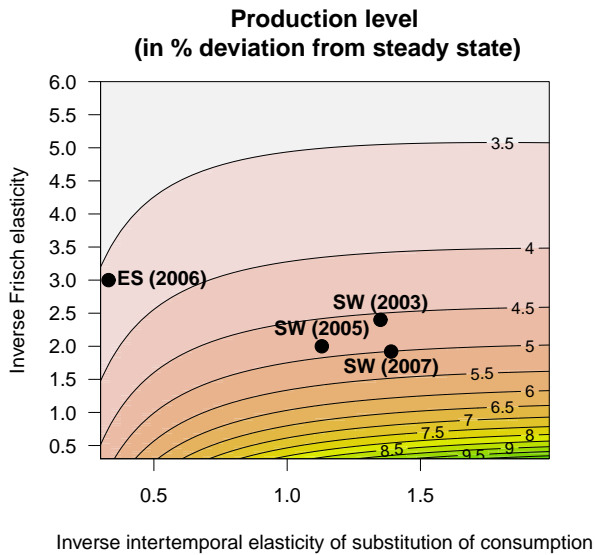


Figure 18: Sensitivity of the transition following mark-up reforms to the introduction of *non-Ricardian* households ($\mu = 0.4$ compared to baseline)

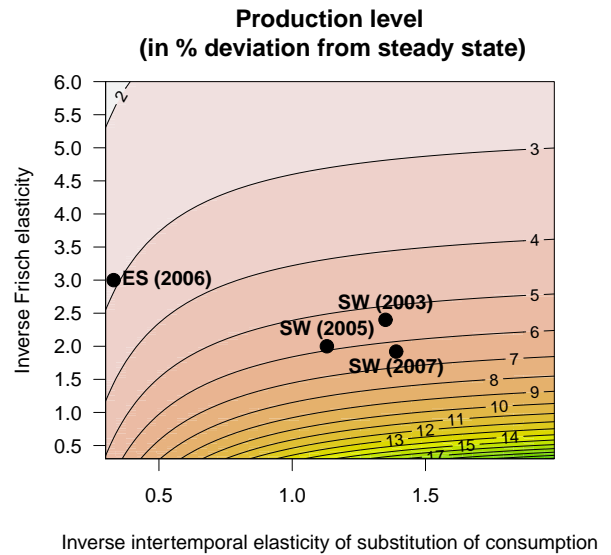


Structural reforms implemented here are the ones of Everaert and Schule (2006), that is of an alignment of mark-ups on the level of the three best European performers. Solid black lines correspond to utilities without reforms, i.e. initial steady state. Coloured solid lines represent the intertemporal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

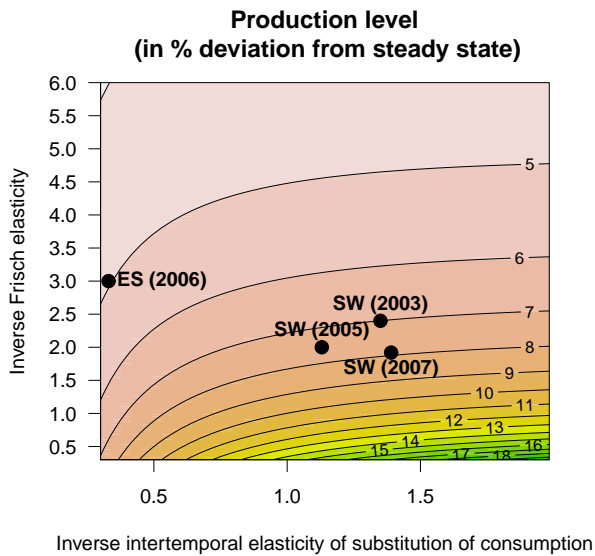
Figure 19: Utility in the transition following a decrease in the price or wage mark-up without consumption habits ($h_c = 0$)



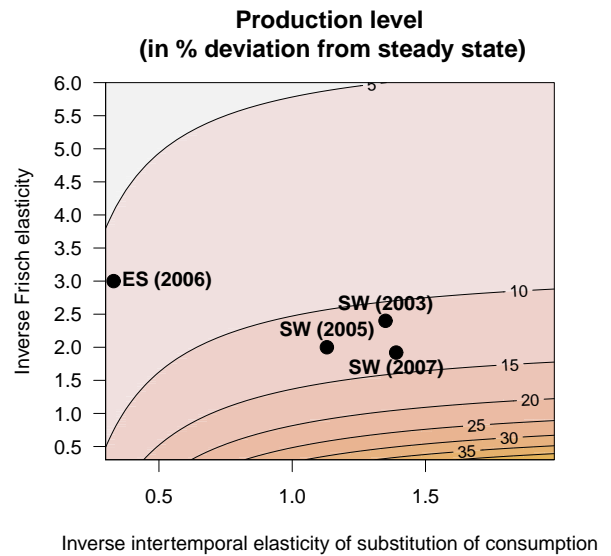
(a) Goods market reforms - $h_c = 0$



(b) Labour market reforms - $h_c = 0$



(c) Goods market reforms - $h_l = 0.5$

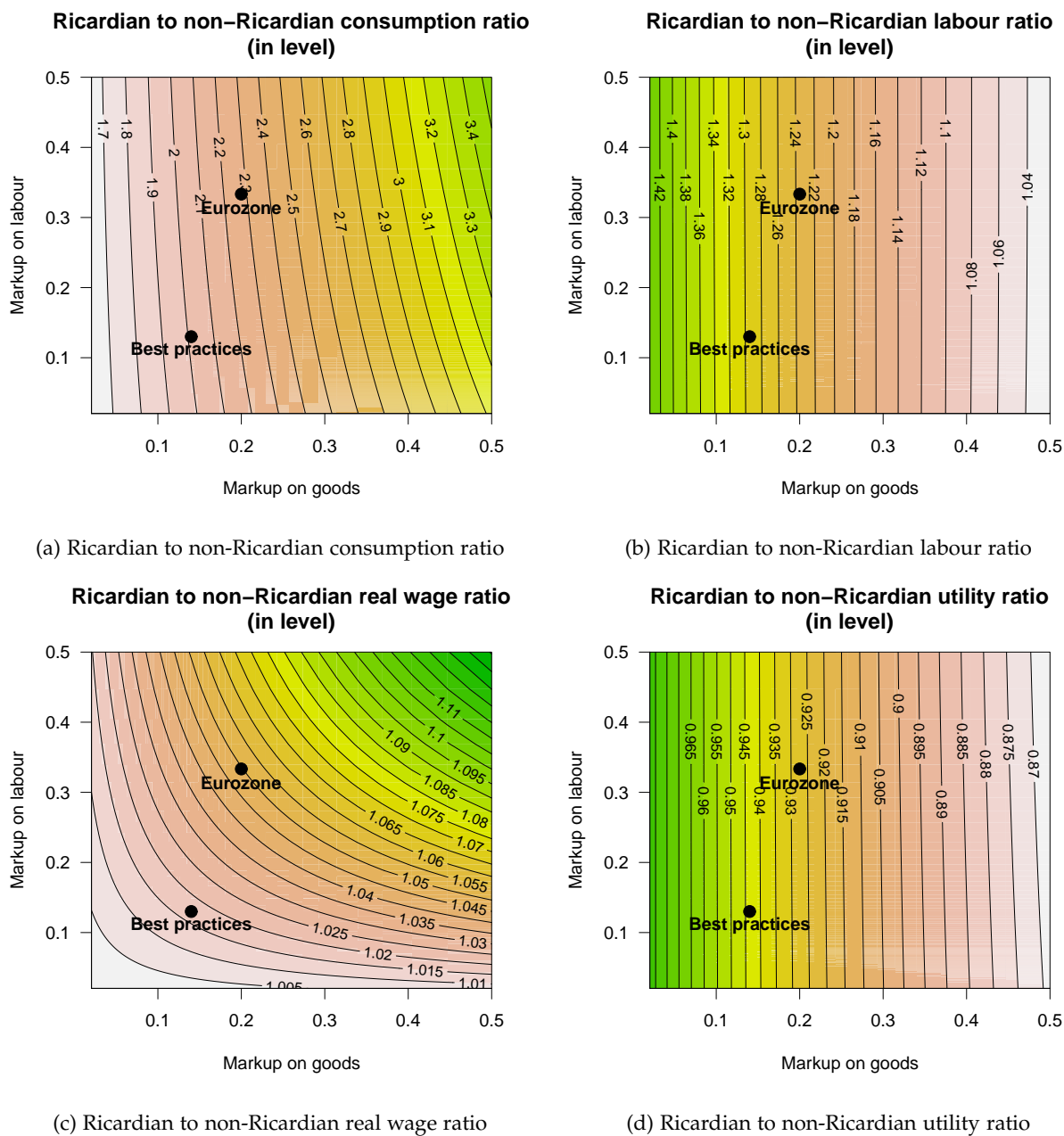


(d) Labour market reforms - $h_l = 0.5$

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. Our standard calibration relies on Smets and Wouters (2005). ES (2006) corresponds 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



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

Liste des documents de travail de la Direction des Études et Synthèses Économiques

ii

G 9001	J. FAYOLLE et M. FLEURBAEY Accumulation, profitabilité et endettement des entreprises	G 9203	Macro-economic import functions with imperfect competition - An application to the E.C. Trade	G 9311	J. BOURDIEU - B. COLIN-SEDILLOT Les décisions de financement des entreprises françaises : une évaluation empirique des théories de la structure optimale du capital	G 9412	analyse économique des politiques française et allemande J. BOURDIEU - B. CŒURÉ - B. COLIN-SEDILLOT
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G 9101	Équipe AMADEUS Le modèle AMADEUS - Première partie - Présentation générale	G 9208	A. MAGNIER et J. TOUJAS-BERNATE Technology and trade: empirical evidences for the major five industrialized countries	G 9316	D. BLANCHET - C. BROUSSE Deux études sur l'âge de la retraite	G 9504	D. GOUX - E. MAURIN Les transformations de la demande de travail par qualification en France Une étude sur la période 1970-1993
G 9102	J.L. BRILLET Le modèle AMADEUS - Deuxième partie - Propriétés variétales	G 9209	B. CREPON, E. DUGUET, D. ENCAOJA et P. MOHNNEN Cooperative, non cooperative R & D and optimal patent life	G 9317	D. BLANCHET Répartition du travail dans une population hétérogène : deux notes	G 9505	N. GREENAN Technologie, changement organisationnel, qualifications et emploi : une étude empirique sur l'industrie manufacturière
G 9103	D. GUELLEC et P. RALLE Endogenous growth and product innovation	G 9301	B. CREPON et E. DUGUET Research and development, competition and innovation: an application of pseudo maximum likelihood methods to Poisson models with heterogeneity	G 9318	D. EYSSARTIER - N. PONTY AMADEUS - an annual macro-economic model for the medium and long term	G 9506	D. GOUX - E. MAURIN Persistance des hiérarchies sectorielles de salaires: un réexamen sur données françaises
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G 9106	B. CREPON Innovation, taille et concentration : causalités et dynamiques	G 9304	H. ERKEL-ROUSSE Union économique et monétaire : le débat économique	G 9402	J. GAUTIE Le chômage des jeunes en France : problème de formation ou phénomène de file d'attente ? Quelques éléments du débat	G 9507	G. CETTE - S. MAHFOUZ Le partage primaire du revenu Constat descriptif sur longue période
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G 9706	M. HOUDEBINE - A. TOPIOL-BENSAÏD Les entreprises internationales en France : une analyse à partir de données individuelles	G 9802	J. ACCARDO Une étude de comptabilité générationnelle pour la France en 1996	G 9905	B. CREPON - Ch. GIANELLA Wages inequalities in France 1969-1992 An application of quantile regression techniques	G 2000/05	B. CREPON - F. ROSENWALD Investissement et contraintes de financement : le poids du cycle
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G 9905	B. CREPON - Ch. GIANELLA Wages inequalities in France 1969-1992 An application of quantile regression techniques	G 9905	B. CREPON - Ch. GIANELLA Wages inequalities in France 1969-1992 An application of quantile regression techniques	G 2000/05	B. CREPON - F. ROSENWALD Investissement et contraintes de financement : le poids du cycle
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G2001/02	
G2001/03	
G2001/04	
G2001/05	
G2001/06	
G2001/07	
G2001/08	
G2001/09	
G2001/10	
G2001/11	
G2001/12	
G2001/13	
G2001/14	
G2001/15	
G2001/16	

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G2002/01	
G2002/02	
G2002/03	
G2002/04	
G2002/05	
G2002/06	
G2002/07	
G2002/08	
G2002/09	
G2002/10	
G2002/11	
G2002/12	
G2002/13	
G2002/14	

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G2002/16	
G2003/01	
G2003/02	
G2003/03	
G2003/04	
G2003/05	
G2003/06	
G2003/07	
G2003/08	
G2003/09	
G2003/10	
G2003/11	
G2004/01	
G2004/02	
G2004/03	
G2004/04	

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G2004/07	
G2004/08	
G2004/09	
G2004/10	
G2004/11	
G2004/12	
G2004/13	
G2004/14	
G2005/01	
G2005/02	
G2005/03	
G2005/04	
G2005/05	
G2005/06	
G2005/07	
G2005/08	

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