Essays on Endogenous Product Creation and Market (De)regulation

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Abstract

This thesis examines fiscal policy in a dynamic stochastic general equilibrium (DSGE) model and the effects of market (de)regulation. Chapter 1 summarizes the thesis.

Chapters 2 and 3 investigate different aspects of fiscal policy in a DSGE model with endogenous producer entry and labour market frictions. Chapters 2 studies optimum product diversity and optimal fiscal policy. I find that marginal cost pricing is optimal when market regulation is absent. However, in the presence of regulation, there are efficiency trade-offs from using fiscal instruments to eliminate one or more distortions which exist in the competitive equilibrium.

Chapter 3 investigates the macroeconomic effects of fiscal shocks in economies with high and low regulation, respectively. I find that an expansion in government spending reduces product creation and is recessionary. In addition, a positive shock to labour and capital income tax rates, respectively, also generates recessionary effects due to the dynamics of entry, investment and labour market conditions.

Chapter 4 examines the macroeconomic and welfare effects of market deregulation in the context of optimized unemployment benefits. Results show that benefit optimization does not generate significant overall welfare gains following deregulation. However, following labour market deregulation, an optimized path of unemployment benefits generates positive short run welfare in contrast to the non-optimized status quo.

Chapter 5 empirically examines the macroeconomic effects of deregulation and interactions between regulation and reform. Results show that reducing entry barriers and employment protection, respectively, negatively affects consumption in the short run. Evidence also suggests that product market deregulation leads to a larger rise in unemployment in the short run when unemployment benefits are high.

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Author's declaration

I declare that this thesis is a presentation of original work and I am the sole author. Chapter 4 results from collaboration with Dr. Michal Horvath. An earlier version of Chapter 4 was presented at the Royal Economics Society 2019 Annual Conference, Warwick, UK.

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Chapter 1

Introduction

Recent developments in dynamic stochastic general equilibrium (DSGE) models, made to account for macroeconomic stylized facts, have seen the introduction of important features into the standard real business cycle (RBC) model. This richer structure of DSGE models has increased our understanding of key interactions within the economy and has provided a superior framework to study a range of macroeconomic policy questions.

Chapters 2 and 3 of this thesis deal with selected topics in fiscal policy in the context of a DSGE model which incorporates endogenous producer entry and labour market frictions, with endogenous job creation and job destruction, into the standard RBC model. Chapter 4 also adopts this framework to study the macroeconomic effects of market reforms under an optimized unemployment benefit policy. Finally, inspired by the theoretical results, Chapter 5 empirically assesses the macroeconomic effects of deregulation and interactions between reform and regulation.

Bilbiie et al. (2012), hereafter BGM, develop a DSGE model which features endogenous producer entry and product variety. The authors find that the model matches key empirical moments at least as well as the traditional RBC model. The performance of the model, relative to the baseline model without capital and the standard RBC model, is further enhanced by the introduction of capital investment. The authors show that, under translog preferences, which imply that the elasticity of substitution across goods increases with the number of goods on the market, and endogenous product creation, the model can simultaneously generate countercyclical markups and procyclical profits.

Cacciatore and Fiori (2016), hereafter CF, augment the BGM model with labour market frictions, endogenous job creation and job destruction. In a baseline model with goods and labour market regulation, the authors show that their model matches the observed volatility of key macroeconomic and labour market variables well, and is able to generate a negative Beveridge curve. In addition, the model is able to jointly reproduces stylized facts related to firm entry, profits and markups, as in BGM.

Bilbiie et al. (2008) examine the efficiency properties of the BGM model and optimal fiscal policy in this framework. The authors show that the optimal degree of product variety is not achieved in the competitive equilibrium under translog preferences. This results from two distortions. The first, which is a dynamic distortion, is associated with the non-synchronization of markups across time. This distortion arises because firm entry creates a divergence between markups across periods which distorts the intertemporal allocation of resources. The second, the 'misalignment distortion', is a static distortion which occurs due to a divergence between a new entrant's profit rate and the benefit to consumers from additional product variety. This distortion leads to socially inefficient entry in a given period.

As in BGM, the misalignment distortion creates inefficiency in product creation in the CF framework. However, in contrast to BGM, firm monopoly power also generates distortions, along margins which are absent in the baseline BGM model. Firm monopoly power distorts capital accumulation, job creation and job destruction. In addition, market regulation also generates distortions. Three dimensions of market regulation are considered by the authors, including, barriers to entry, firing costs, and unemployment benefits, respectively. Barriers to entry distort product creation by increasing the sunk costs associated with market entry beyond that which obtains in the planner equilibrium. Firing costs create distortions along the job creation and job destruction margins, respectively. Unemployment benefits also distort job destruction by raising the worker's outside option. Firing costs and entry barriers create an additional inefficiency wedge in the resource constraint for consumption output by diverting resources away from other uses. These distortions generate five inefficiency wedges in the decentralized CF equilibrium.

Chapter 2 "*Monopoly power and regulation: distortions and efficiency*" examines the fiscal polices which generate optimum product variety in two versions of the CF model. It also investigates optimal fiscal policy in a version of the CF model without regulation. Finally, it examines the effect of market regulation in the decentralized CF equilibrium on the ability of fiscal policy to raise overall efficiency. Under the first perspective considered, the 'flexible perspective', market regulation is not a feature of the economy. Therefore, under this perspective, I focus on how taxes should be set to eliminate non-regulation related distortions, thereby restoring efficiency in the competitive equilibrium. I also investigate the taxation schemes which restore efficiency in product creation, as in Bilbiie et al. (2008). Under the second model variant, the 'rigid perspective', which corresponds to the baseline CF model, market regulation is present. Under this perspective, I study the implications of regulation for the ability of fiscal policy instruments to eliminate distortions and raise efficiency in the decentralized equilibrium.

I find that marginal cost pricing restores overall efficiency under the flexible perspective of the CF economy, as in BGM. Also, there are taxation schemes under all policies for which efficiency in product creation can be restored. However, the optimality of marginal cost pricing does not extend to the rigid perspective. I show in a numerical exercise that under this perspective, there is no policy which is able to lower all inefficiency wedges. This indicates that when regulation is present in the economy, there may be efficiency trade-offs which result from implementing fiscal policies which would restore efficiency in the absence of regulation.

Chapter 3 "*Fiscal Policy Shocks: endogenous entry and labour market frictions*" investigates the effects of fiscal policy shocks in the CF framework. The literature on the effects of government spending shocks is rather unsettled with regards to the effect of an expansion in government spending on consumption and investment. In addition, little is known about the implications of labour market frictions for the propagation of fiscal shocks. Realistic aspects of fiscal policy are incorporated into the CF model to investigate the extent to which the presence of labour market frictions matter for aggregate outcomes following fiscal shocks in economies with low and high regulation, respectively. Three fiscal policy shocks are considered, namely: i) a shock to government consumption; ii) a capital income tax shock; iii) a labour income tax shock.

Results show that private consumption reacts negatively following a positive shock to government spending which is financed by lump sum taxes. In addition, investment in capital and new products also falls. This is consistent with the theoretical predictions of the standard RBC model. The results show that a rise in government spending can lead to a persistent decline in wages due to entry and capital investment dynamics. Output also shows a persistent decline, in contrast to standard RBC theory. Results also show that positive shocks to the capital and labour income tax rates are also recessionary due to the dynamics of entry, investment and labour market conditions.

Chapter 4 "*Optimized Unemployment Benefits and Market Deregulation*" examines welfare and transitional adjustment following deregulation with optimized unemployment benefits. CF investigate the macroeconomic and welfare effects of lowering sunk entry costs and firing costs, respectively, in a calibrated model of the Euro Area. Following deregulation, the authors assume that unemployment benefits are immediately changed to their long run levels. In contrast, this chapter investigates whether there is scope for welfare improvements from optimizing the path of unemployment benefits and/or its final equilibrium value.

In order to investigate the relative importance of the transition phases and final equilibria, respectively, for overall welfare, three scenarios under which optimization can occur following deregulation are considered. In the first scenario, unemployment benefits are immediately changed to their optimized steady-state level following deregulation, similar to CF (however, here the final equilibrium is optimized). In the second scenario, unemployment benefits are optimized as the economy transitions to its new equilibrium, but not in the new equilibrium itself. In the final scenario, unemployment benefits are optimized both in transition and in the final steady state.

The key policy change introduced in this chapter is a novel unemployment benefit rule which determines the path of unemployment benefits in transition. Optimization of unemployment benefits in transition involves implementing an unemployment benefit rule in which parameter values are chosen to maximize the overall welfare effect of deregulation. Two variants of the benefit rule are considered. In the first variant of the rule, the unemployment benefit level depends solely on the pre- and post-deregulation benefit levels. The second variant, on the other hand, includes an additional term which responds to GDP growth. From this version of the rule, we can examine the welfare implications of relating the benefit path to changes in economic conditions and consider whether unemployment benefits should vary following deregulation.

The results show that product market deregulation always leads to short run welfare losses irrespective of the dynamics of unemployment benefits due to the negative adjustment of consumption in the short run. Following both product and labour market deregulation, respectively, overall welfare is highest when optimization occurs in transition, under the second variant of the benefit rule. However, the welfare gains are relatively small. The short run welfare effects of lowering firing costs however become positive when the unemployment benefit path is optimized which could lower political aversion to its implementation.

Chapter 5 "*The macroeconomic effects of deregulation: Evidence from panel VAR*" empirically examines the macroeconomic effects of deregulation and explores interactions using a panel vector autoregressive (VAR) model. Most studies in the literature focus on labour market outcomes following deregulation. Empirical studies on the effect of market deregulation, particularly those examining interactions between regulation policies, have largely focused on the effect of regulation/deregulation on labour market variables. Fiori et al. (2008), for example, examine the effect of market regulation on unemployment in a panel fixed effects model using data on OECD countries. The authors find that more stringent product and labour market regulation lower employment. Griffith et al. (2007) find supporting evidence for the effect of product market deregulation on unemployment.

Fewer studies, with the exception of Nicoletti and Scarpetta (2003), Griffith and Harrison (2004), and Cacciatore and Fiori (2016) have considered the effect of market deregulation on aggregate outcomes. Griffith and Harrison (2004) in a panel of 12 European Union countries over the 1980s and 1990s find that labour market reform lowers the average level of economic rents and is associated with higher employment and investment. Nicoletti and Scarpetta (2003), using panel regression methods, show that entry liberalization in the service sector has a statistically significant positive effect on economy-wide total factor productivity growth. A few studies, such as, Bassanini and Cingano (2017) and Cacciatore and Fiori (2016), have examined the short run effects of deregulation. These studies find that increasing competition and easing employment protection can entail sizeable short run employment losses.

CF show, using their DSGE model, that a reduction in barriers to entry and firing restrictions, respectively, leads to declines in market consumption and capital investment due to the diversion of resources towards the creation of new products, in addition to, the combination of instantaneous job destruction and slow job creation. In this chapter, I empirically investigate the macroeconomic effects of individual market deregulation with a focus on private consumption. Secondly, I consider whether the level of labour market regulation (firing restrictions and unemployment benefits, respectively) has implications for the macroeconomic effects of deregulation along another dimension.

The results show that a reduction in barriers to entry has a negative effect on consumption in the short run. I find similar results for a reduction in the stringency of employment protection. These results support the theoretical prediction of the CF model. The results also show that the impact of product market deregulation on consumption in the short run is independent of the benefit level. This is supported by findings from Chapter 4 which compare transition dynamics across different levels of unemployment benefits following product market deregulation. The results also indicate that product market deregulation leads to a larger rise in short run unemployment in a high replacement rate setting, as well as when employment protection is high.

In the course of this thesis, I investigate the implications of fiscal policy for welfare and macroeconomic outcomes in a DSGE framework which captures important aspects of product and labour markets. I also examine different aspects of (de)regulation, empirically and theoretically. In particular, I investigate the extent to which the macroeconomic and welfare effects of deregulation depend on unemployment benefit policy. I also empirically examine interactions between reform and regulation, finding evidence which support the theoretical results. A better understanding of the effects of government policies is crucially important as it can improve policy decisions and help with the design of policy. I hope this thesis adds to current knowledge on the aspects of fiscal policy examined and on the macroeconomic effects of (de)regulation.

Chapter 2

Monopoly power and regulation: Distortions and efficiency

2.1 Introduction

How should taxes be set to restore efficiency in a dynamic stochastic general equilibrium (DSGE) model characterized by endogenous firm entry, labour market frictions, and endogenous job creation and destruction? In addition, which fiscal instruments can meet this objective? Bilbiie et al. (2008) examine optimal (first-best) fiscal policies in the framework developed by Bilbiie et al. (2012), hereafter BGM, which features monopolistic competition and endogenous firm entry. Cacciatore and Fiori (2016), here after CF, extend the BGM framework to incorporate labour market frictions, in addition to, endogenous job creation and job destruction, as in Mortensen and Pissarides (1994) and Den Haan et al. (2000).

CF show that the BGM model extended to account for these additional features of the labour market matches the observed volatility of key macroeconomic variables well and jointly reproduces stylized facts related to firm entry, profits and markups. This chapter investigates optimal fiscal policy and the taxation schemes which restore optimum product variety in a variant of the CF framework which abstracts from market regulation. This "flexible economy" is defined as in CF but with the exclusion of goods and labour market regulation. A "rigid economy" is also examined. In this economy, three dimensions of regulation, namely barriers to entry, firing restrictions and unemployment benefits, respectively, are present as in the baseline CF model. The effect of a range of fiscal instruments on the inefficiency wedges present under both scenarios are also considered.

Two distortions are present in the BGM model as identified by Bilbiie et al. (2008). The first, which is a dynamic distortion, results from the non-synchronization of markups across time. This distortion arises because firm entry creates a divergence between markups across periods which distorts the intertemporal allocation of resources. The second, the 'misalignment distortion' is a static distortion which leads to socially inefficient entry in a given period. This distortion occurs due to a divergence between an entrant's profit incentive to produce an additional variety and the benefit to consumers from that additional variety.

The flexible CF model also features two sources of distortions which result in four inefficiency wedges. In addition to the misalignment distortion, CF show that monopoly power creates inefficiency along the job creation and job destruction margins, respectively, in addition to, sub-optimal capital investment. Therefore, in contrast to BGM, monopoly power constitutes a distortion under this perspective. Under the rigid perspective, entry barriers distort product creation. Firing costs, on the other hand, create distortions along the job creation and job destruction margins, respectively. Finally, unemployment benefits distort job destruction by raising the worker's outside option. In addition to the four margins of adjustment affected by distortions under the flexible perspective, firing costs and entry barriers, respectively, affect the resource constraint for consumption output by diverting resources away from other uses. This results in the additional consumption output inefficiency wedge.

Four fiscal instruments are considered. These include i) an entry tax/subsidy or (de)regulation policy; ii) a sales subsidy; iii) a dividend tax; and iv) marginal cost pricing. i), ii) and iv) are BGM-optimal policies. That is, these instruments are shown in Bilbiie et al. (2008) to restore efficiency in product creation. Given that the product creation/misalignment distortion in the flexible economy is a subset of that in BGM, it is expected that these policies can also implement optimum product variety. I determine the taxation schemes which restore optimum product variety under the flexible perspective. I also investigate the effect of these policies on the inefficiency wedges present in the rigid economy.

This chapter contributes to the literature on optimal taxation and optimum product variety in general equilibrium macroeconomic models with endogenous entry. Studies have examined optimal fiscal policy in the BGM framework and in variants of the model. Chugh and Ghironi (2011) examine Ramsey-optimal fiscal policy in the BGM framework. Lewis and Winkler

(2015) investigate optimum product diversity and optimal fiscal policy in the first and second-best environments under alternative demand structures in a static variant of the BGM setup. Colciago (2016), on the other hand, examine Ramsey-optimal policy in an oligopolistic setting but in a dynamic framework in contrast to Lewis and Winkler (2015).

I find that marginal cost pricing is able to restore efficiency in the flexible CF equilibrium, as in BGM. However, in contrast to BGM where marginal cost pricing is not compulsory, this policy is necessary under the flexible perspective due to the distortion created by monopoly power. Also, there are taxation schemes under all policies considered for which efficiency in product creation can be restored. I show in a numerical exercise that under the rigid perspective, there is no policy which is able to lower all inefficiency wedges. The product creation wedge rises with all policies due to the distortion from entry barriers. The chapter is organized as follows. Section 2.2 presents the model. The inefficiency wedges are reviewed in Section 2.3. Section 2.4 investigates the effect of a range of taxation schemes on efficiency in the decentralized equilibrium under the flexible perspective. Section 2.5 examines taxation schemes under the rigid perspective. Section 2.6 concludes.

2.2 The Model

This section details the CF model framework. Prices and contracts are written in nominal terms. Prices are fully flexible. Money acts as a convenient unit of account and serves no other role in the economy. The framework follows Woodford (2003) in assuming a cashless economy.

2.2.1 Household preferences

The economy is populated by a unit mass of atomistic households, each composed of a [0,1] continuum of members. The measure of workers who work within the household is not determined by the household but by a labour market matching process. The model assumes full consumption insurance, so that consumption is the same for employed and unemployed members of the household. Each unemployed worker produces an amount h_p of home production. Following Andolfatto (1996) and Merz (1995), family members insure each other against variation in labour income that result from changes in employment status so that no expost-heterogeneity exists across individuals within the household. The representative household maximizes the expected intertemporal utility function:

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\beta^t\frac{C_t^{1-\gamma}}{(1-\gamma)}\right] \tag{2.1}$$

where $\beta \in (0,1)$ is the discount factor, and C_t represents the consumption of market and home produced goods. The consumption of market goods, ${C_t}^M$ consists of a variety of goods defined over a continuum Ω. At any point in time, a subset of goods, $\Omega_t \in \Omega$ is available. The aggregator ${C_t}^M$ takes a translog form as proposed by Feenstra (2003). As a result, the elasticity of substitution across varieties is a function of the number of goods available. Translog preferences are represented by the unit expenditure function which is equal to the price index. The unit expenditure function of a basket of goods ${C_t}^M$ is given by:

$$\ln(P_t) = \frac{1}{2\sigma}(\frac{1}{N_t}-\frac{1}{\tilde{N}})+\frac{1}{N_t}\int_{\omega\in\Omega_t}\ln(p_{\omega t})d\omega+\frac{\sigma}{2N_t}\int_{\omega\in\Omega_t}\int_{\omega'\in\Omega_t}\ln(p_{\omega t})(\ln(p_{\omega t})-\ln\big(p_{\omega' t}\big))d\omega d\omega', \tag{2.2}$$

where σ represents the price-elasticity of the spending share on an individual good, and P_t is the welfare based price index. N_t is the measure of the set Ω_t. Household consumption, C_t, is given by $C_t = {C_t}^M + (1-L_t)h_p$.

2.2.2 Production

There is a continuum of monopolistically competitive firms, each producing a different variety $\omega \in \Omega$. There is a one-to-one identification between a producer, product and a firm. Following Bilbiie et al. (2012), each unit in the model is best interpreted as a production line within a multi-product firm whose boundary is left undetermined. There is a continuum of jobs within each firm performed by one worker. Production requires labour and capital. Entry of new firms is endogenously determined following Bilbiie et al. (2007). Firms must post a vacancy in order to hire a worker incurring a real fixed cost κ.

Job creation is subject to matching frictions. The probability of finding a worker is determined by a Cobb-Douglas matching technology which converts aggregate vacancies into aggregate matches: $M_t = \chi {U_t}^{\varepsilon} {V_t}^{1-\varepsilon}$, where $0 < \varepsilon < 1$. Each firm meets workers at a rate $q_t(\theta_t) \equiv \frac{M_t}{V_t}$. $\theta = \dfrac{V_t}{U_t}$ denotes labour market tightness. Each filled job produces $Z_t z_{it} k^{\alpha}_{i\omega t}$ units of output. Z_t, aggregate productivity is common to all firms, while z_{it}, the match-specific productivity of a job is subject to idiosyncratic shocks. $k_{i\omega}$ is the stock of capital allocated to the job. The level of idiosyncratic productivity is a draw from a time-invariant log normal function $g(z)$. Z_t follows an AR(1) process in logs.

Producer ω's output is given by:

$$y_{\omega t} = Z_t l_{\omega t}[1 - G(z^c_{\omega t})]^{-1} \int_{z^c_{\omega t}}^{\infty} k_{\omega t}(z) z g(z) dz, \tag{2.3}$$

where $l_{\omega t}$ represents the measure of jobs within the firm and $z^c_{\omega t}$ is an endogenously determined critical threshold which determines the measure of jobs endogenously destroyed, $G(z^c_{\omega t})$. This occurs when $z_t < z^c_{\omega t}$. Firms incur a real cost of F from terminating a job which constitutes an administrative cost.

The evolution of firm employment is given by:

$$l_{\omega t} = (1 - \lambda_{\omega t})(l_{\omega t-1} + q_{t-1} v_{\omega t-1}) \tag{2.4}$$

where $\lambda_{\omega t} \equiv \lambda^x + (1 - \lambda^x)G(z^c_{\omega t})$ is the total fraction of jobs destroyed within the firm. The timing of events is as follows. At the beginning of each period: (i) jobs are exogenously destroyed; (ii) aggregate and idiosyncratic shocks are realized; (iii) the productivity cut-off z^c is determined and unprofitable matches are endogenously destroyed. In addition, wage bargaining takes place and new firms enter into the market; (iv) production and market clearing occur; (v) new matches are formed; (vi) at the end of the period, exogenous producer exit takes place.

2.2.2.1 Profit maximization

Y_t denotes aggregate demand in the economy, which has the same translog form as household consumption. Each producer ω faces the following demand for its output:

$$y_{\omega t} = \sigma ln(\frac{\bar{p}}{p_{\omega t}}) \frac{P_t Y_t}{p_{\omega t}}, \tag{2.5}$$

where $\ln \bar{p} = \frac{1}{\sigma N_t} + \frac{1}{N_t} \int_{\omega \in \Omega_t} \ln p_{\omega t} d\omega$ is the maximum price a producer can charge to retain a positive market share.

Total output for producer ω, denoted with $y_{\omega t}$, exhibits constant returns to scale in labour and capital:

$$y_{\omega t} = Z_t \tilde{z}_{\omega t} {k_{\omega t}}^{\alpha} {l_{\omega t}}^{1-\alpha} \tag{2.6}$$

where $\tilde{z}_{\omega t} \equiv [\frac{1}{1-G(z^c_{\omega t})}] \int_{\omega t}^{\infty} z^{\frac{1}{1-\alpha}} g(z)dz]^{1-\alpha}$ is the weighted average of the idiosyncratic productivity of jobs within the firm.

The firm's per period real profit is given by:

$$d_{\omega t} = \rho_{\omega t} y_{\omega t} - \tilde{w}_{\omega t} l_{\omega t} - r_t k_{\omega t} - \kappa v_{\omega t} - G(z^c_{\omega t})(1-\lambda^x)(l_{\omega t-1} + q_{t-1} v_{\omega t})F, \tag{2.7}$$

where $\rho_{\omega t} = \frac{p_{\omega t}}{P_t}$ denotes the relative price of ω in units of consumption and r_t is the rental rate of capital. $\tilde{w}_{\omega t} \equiv \tilde{z}_{\omega t} \equiv [\frac{1}{1-G(z^c_{\omega t})}] \int_{\omega t}^{\infty} w_{\omega t}(z) g(z)dz$ is the average wage. The firm chooses the price of its product $\rho_{\omega t}$, employment $l_{\omega t}$, capital $k_{\omega t}$, the number of vacancy postings $v_{\omega t}$, and the job destruction threshold $z^c_{\omega t}$, to maximize the present discounted value of real profit: $E_t[\Sigma_{s=t}^{\infty} \beta_{s,t}(1-\delta)^{s-t} d_{\omega s}]$, subject to (2.4), (2.5), and (2.6).

The job creation equation for producer ω is derived from combining the first-order conditions for $l_{\omega t}$ and $v_{\omega t}$:

$$\frac{\kappa}{q_t} = (1-\delta)(1-\lambda^x)\mathbb{E}\left[\beta_{t,t+1}[(1-G(z^c_{\omega t}))(\tilde{\Pi}_{\omega t+1} - \tilde{w}_{\omega t+1} + \frac{\kappa}{q_{t+1}}) - G(z^c_{\omega t+1} F]\right] \tag{2.8}$$

where $\tilde{\Pi}_{\omega t} \equiv (1-\alpha)\varphi_{\omega t} y_{\omega t}/l_{\omega t}$. $\varphi_{\omega t}$ denotes the real marginal cost of the firm. Equation (2.8) shows that optimality in job creation requires that the marginal cost of posting a vacancy is equal to its marginal benefit. The first order condition for the job-productivity threshold $z^c_{\omega t}$ leads to the following job destruction equation:

$$\Pi(z^c_{\omega t}) - w(z^c_{\omega t}) + \frac{\kappa}{q_t} = -F \tag{2.9}$$

where $\Pi(z^c_{\omega t} \equiv \tilde{\Pi}_{\omega t}(z^c_{\omega t}/\tilde{z}_{\omega t})^{\frac{1}{1-\alpha}}$ is the marginal revenue product of a match. Optimality requires that the value of the firm of a job with productivity $z^c_{\omega t}$ is equal to zero.

The first order condition for $k_{\omega t}$ equalizes the marginal cost of capital to its marginal revenue product: $r_t = \alpha \varphi_{\omega t} y_{\omega t}/k_{\omega t}$. The first order condition with respect to $p_{\omega t}$ implies that the relative price of a variety is a markup over marginal costs: $\rho_{\omega t} = \varphi_{\omega t} \mu_{\omega t}$, where $\mu_{\omega t} = \theta_{\omega t}/(\theta_{\omega t} - 1)$. The model features a symmetric equilibrium therefore incumbents charge the same price.

2.2.2.2 Wage setting

Wage setting follows Krause and Lubik (2007). Workers and firms bargain over the match surplus (the sum of the gains to the worker from employment and to the firm employing the worker). The exogenous bargaining weight $\eta \in (0, 1)$ determines the workers' bargaining power. The wage paid to each worker is a weighted average between the marginal revenue of labour (plus a firing cost term) of the match and the worker's outside option, ϖ_t. It is given by:

$$w_{\omega t} = \eta[\pi_{\omega t} + [1 - (1 - \delta)(1 - \lambda^x)E_t\beta_{t,t-1}]F] + (1 - \eta)\varpi_t \quad (2.10)$$

This leads to the following equation for the average wage:

$$\tilde{w}_{\omega t} = \eta[\tilde{\pi}_{\omega t} + [1 - (1 - \delta)(1 - \lambda^x)E_t\beta_{t,t-1}]F] + (1 - \eta)\varpi_t \quad (2.11)$$

The worker's outside option, ϖ_t, corresponding to the value of unemployment is given by the following expression:

$$\varpi_t \equiv h_p + ub + \int_{\omega \subset \Omega_t}^{\infty} s_t \frac{v_{\omega t}}{V_t} E_t[\tilde{\beta}_{t,t-1}(1 - G(z^c_{\omega t+1}))\tilde{\Delta}^W_{\omega t+1}]d\omega, \quad (2.12)$$

where s_t is the job finding probability and $\tilde{\Delta}^W_{\omega t}$ is the average worker surplus. The value of unemployment includes ub, which are are lump-sum financed unemployment benefits from the government in units of the consumption basket. It also includes home production, h_p, and the expected discounted value of searching for other jobs, the third term in the expression.

2.2.2.3 Firm entry and symmetry among producers

Firm entry and exit decisions follow Bilbiie et al. (2012), and Ghironi and Melits (2005). In every period, there is an unbounded mass, N_{Et}, of prospective entrants and a mass N_t of producing firms. Prospective entrants are forward-looking and correctly anticipate their future profits $d_{\omega s}$ in every period s > t. The model features a one-period time-to-build lag, such that, firms who enter in period t, do not start production until t+1. Prospective entrants compute their expected post-entry value, equal to the present discounted value of their stream of future profits: $e_{\omega t} \equiv E_t[\Sigma^{\infty}_{s=t+1}\beta_{s,t}(1 - \delta)^{s-t}d_{\omega s}]$. Prior to entry, firms face a sunk entry cost which must be paid before production commences, $f_{E,\omega t} \equiv f_R + f_T + \kappa v^e_{\omega t}$. It is formed of three components: f_R and f_T represent regulatory and administrative barriers to entry and the technological entry cost (in terms of goods and services), respectively. The last term, $\kappa v^e_{\omega t}$ represents the cost of posting vacancies in order to recruit workers for production. In equilibrium, $v^e_{\omega t} = (l_t + q_t v_t)/q_t$, which means that the cost of posting vacancies for new entrants responds to aggregate labour market conditions.

The model features a symmetric equilibrium. The outside option of firms depend only on aggregate shocks which means that, in equilibrium, firms choose identical job-productivity thresholds $z^c_{\omega t} = z^c_t$. This also implies that marginal costs, and thus, prices, quantities, and firm values are identical across firms. Entry occurs until firm value is equalized to the entry cost, leading to the free entry condition, $e_t = f_{E,t}$, which is independent of the length of time which has been spent in the market.

2.2.2.4 Household budget constraint and first-stage budgeting

Households hold shares in a mutual fund of firms and own the economy's stock of capital, K_t. x_t represents the share in the mutual fund held by the representative household entering period t, and x_{t+1} the amount of shares in a mutual fund of firms consisting of incumbent firms and new entrants $(N_t + N_{Et})$ purchased by the representative household in $t + 1$. The date-t price of a share in the mutual fund is equal to the price of claims to future firm real profits, e_t. Physical capital, K_t obeys a standard law of motion:

$$K_{t+1} = (1 - \delta_K)K_t + I_{Kt}[1 - (\nu/2)(I_{Kt}/I_{Kt-1} - 1)^2], \tag{2.13}$$

where $\nu > 0$ is a scale parameter. The per-period household's budget constraint is given by:

$$C_t + e_t(N_t + N_{Et})x_{t+1} + I_{Kt} = (d_t + e_t)N_t x_t + \tilde{w}_t L_t + r_t K_t + (h_p + ub)(1 - L_t) + T_t, \tag{2.14}$$

where T are lump-sum taxes. The household maximizes its expected intertemporal utility subject to the above budget constraint and law of motion for physical capital. The Euler equation for share holdings is given by: $e_t = E_t[\beta_{t,t+1}(d_{t+1} + e_{t+1})]$; the Euler equation for capital accumulation requires the following condition: $\zeta_{Kt} = E_t \beta t, t + 1[r_{t+1} + (1 - \delta_K)\zeta_{Kt+1}]$, where ζ_{Kt} represents the shadow value of capital in units of consumption. The first-order condition for investment, I_{Kt} is given by:

$$1 = \zeta_{Kt}[1 - \frac{\nu}{2}(\frac{I_{Kt}}{I_{Kt-1}})^2 - \nu(\frac{I_{Kt}}{I_{Kt-1}} - 1)(\frac{I_{Kt}}{I_{Kt-1}})] + \nu\beta_{t,t+1}E_t[\zeta_{Kt+1}(\frac{I_{Kt}}{I_{Kt-1}} - 1)(\frac{I_{Kt}}{I_{Kt-1}})^2] \quad (2.15)$$

2.2.3 Equilibrium

The elasticity of substitution across varieties in the symmetric equilibrium is given by: $\Theta_t = 1+\sigma N_t$. Aggregate employment can be written as: $L_t = N_t L_t$. Aggregate vacancies is given by the sum of vacancy postings by existing firms and new entrants: $V_t = (N_t + N_{Et})v_t + N_{Et}l_t/q_t$. The law of motion of aggregate employment can be written as:

$$L_t = (1-\delta)(1-\lambda^x)[1 - G(z_t^c)][L_{t-1} + q_{t-1}V_{t-1}] \quad (2.16)$$

The aggregate resource constraint can be expressed as:

$$Y_t = C_t^M + I_{Kt} + N_{Et}(f_R + f_E) + \kappa V_t + F_t, \quad (2.17)$$

where F_t denotes aggregate firing costs. The main model equations are summarized in Table 2.1. The model features 10 endogenous variables: C_t, ρ_t, N_{t+1}, L_t, V_t, M_t, z_t^c, K_{t+1}, I_t, ξ_K. Also, the model has one exogenous variable, aggregate productivity Z_t.

2.3 Fiscal policy and inefficiency in the decentralized CF economy

2.3.1 Inefficiency wedges

In the BGM model, two distortions, namely, the misalignment distortion and the non-synchronization of markups across time, respectively, create a divergence between the planner and competitive equilibria. In contrast, in the CF model, five distortions (and inefficiency wedges) exist [1]. The difference in the number of inefficiency wedges across models results from important differences. Firstly, markup non-synchronization across time is not a distortion in the CF framework because firm entry costs are not a function of marginal costs in contrast to the BGM setup. Secondly, capital is a factor of production in the CF model. Firm's monopoly

[1] The inefficiency wedges outlined in CF include the distortionary effects of regulation. Therefore, these are the inefficiency wedges which are present under the rigid perspective.

Table 2.1: Model Summary

Adjusted Discount Factor	$\beta_{t,t+1} = \beta(\frac{C_{t+1}}{C_t})^{-\gamma}$
Firm-level job separation	$\lambda_t = \lambda^x + (1-\lambda^x)G({z_t}^c)$
Law of motion of aggregate employment	$(1-\lambda_t)(1-\delta)(L_{t-1} + q(\theta_{t-1})V_{t-1})$
Law of motion of physical capital	$K_{t+1} = (1-\delta_K)K_t + I_{Kt}[1-(\nu/2)(I_{Kt}/I_{Kt-1}-1)^2]$
Aggregate Unemployment	$U_t = (1-L_t)$
Average wage	$\tilde{w}_{\omega t} = \eta[\tilde{\pi}_{\omega t} + [1-(1-\delta)(1-\lambda^x)E_t\beta_{t,t-1}]F] + (1-\eta)\varpi_t$
Vacancies by entrants	$v_t^e = (l_t + q_t v_t)/q_t$
Aggregate matching function	$M_t = \chi(1-L_t)^{\varepsilon}{V_t}^{-\varepsilon}$
Probability of filling a vacancy	$q_t = M_t/V_t$
Job finding probability	$s_t = M_t/U_t$
Job creation	$\frac{\kappa}{q_t} = (1-\delta)(1-\lambda^x)\mathbb{E}\left[\beta_{t,t+1}[(1-G(z_{\omega t}^c))(\tilde{\Pi}_{\omega t+1} - \tilde{w}_{\omega t+1} + \frac{\kappa}{q_{t+1}}) - G(z_{\omega t+1}^c F]\right]$
Job destruction	$\Pi(z_{\omega t}^c) - w(z_{\omega t}^c) + \frac{\kappa}{q_t} = -F$
Pricing	$\rho_t = \mu_t\varphi_t$
Markup	$\mu_t(N_t) = \mu_t = 1 + \frac{1}{\sigma N_t}$
Variety effect	$\rho_t = e^{-\frac{\tilde{N}-N_t}{2\sigma\tilde{N}N_t}}$
Profits	$d = (1-\frac{1}{\mu_t})\frac{Y_t}{N_t} + \psi_t l_t - \kappa(v_t + \frac{l_t}{q_t}) - [\frac{G({z_t}^c)}{1-G({z_t}^c)}]$
Free entry	$v_t = f_{E,t}$, where $f_{E,t} = f_R + f_T + \kappa {v^e}_t$
Number of firms	$N_t = (1-\delta)(N_{t-1} + N_{Et-1})$
Euler equation (shares)	$v_t = (1-\delta)E_t\beta_{t,t+1}(v_{t+1} + d_{t+1})$
Euler equation (physical capital)	$\zeta_{Kt} = E_t\beta t, t+1[r_{t+1} + (1-\delta_K)\zeta_{Kt+1}]$
Aggregate Output	$Y_t = C_t^M + I_{Kt} + N_{Et}(f_R + f_T) + \kappa V_t + F_t$
Aggregate Accounting	$C_t^M + I_{Kt} + N_{Et}(f_R + f_T) = \tilde{w}_t L_t + r_t K_t + N_t d_t$

power creates a divergence between the first order condition for capital accumulation in the decentralized and planner equilibria, respectively. Thirdly, CF features endogenous job creation and job destruction in contrast to BGM. Firm's monopoly power and market regulation in the decentralized economy create distortions in the labour market. Finally, the presence of entry barriers (product market regulation) and firing costs generate an additional inefficiency wedge along the consumption output margin.

CF outline the five inefficiency wedges which characterize the competitive equilibrium. These are as follows:

$$\Sigma_{PC,t} \equiv (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\frac{Y_{t+1}}{N_{t+1}}[\frac{1}{2\sigma N_{t+1} f_T} - \frac{(1-1/\mu_{t+1})}{f_T + f_R}]\right]$$

$$\Sigma_{JC,t} \equiv E_t \frac{q_t}{\kappa}\beta_{t,t+1}(1-\lambda^{tot}_{t+1})[(1-\varepsilon)(1-\alpha)\frac{Y_{t+1}}{L_{t+1}}[1-\frac{z^c_{t+1}}{\tilde{z}_{t+1}})^{\frac{1}{1-\alpha}}\Upsilon_{\mu,t+1} + \frac{\Upsilon_F}{[1-G(z^c_t)]}]$$

$$\Sigma_{JD,t} \equiv \frac{q_t}{\kappa(q_t\varepsilon\theta_t - 1)}(1-\varepsilon)(1-\alpha)\frac{Y_t}{L_t}(\frac{z^c_t}{\tilde{z}_t})^{\frac{1}{1-\alpha}}\Upsilon_{\mu,t} + (1-\varepsilon)\Upsilon_b - [1-\eta(1-E_t\tilde{\beta}_{t,t+1}(1-s_t))]\Upsilon_F$$

$$\Sigma_{K,t} \equiv \alpha E_t \beta_{t,t+1}\frac{Y_{t+1}}{\zeta_{Kt}K_{t+1}}\Upsilon_{\mu,t+1}$$

$$\Sigma_{Y,t} \equiv \frac{G(z^c_t)}{1-G(z^c_t)}L_t\Upsilon_F + \Upsilon_R N_{E,t},$$

where $\Upsilon_{\mu,t} \equiv 1-1/\mu_t$, $\Upsilon_F \equiv F$, $\Upsilon_b \equiv ub$, $\tilde{\beta}_{t,t+1} \equiv (1-\delta)(1-\lambda^x)\beta_{t,t+1}$.

All five inefficiency wedges with the exception of $\Sigma_{K,t}$ are created by multiple distortions. The first inefficiency wedge, $\Sigma_{PC,t}$, is the product creation wedge. It results from two distortions. The first is the distortion created by regulation-related barriers to entry or product market regulation, f_R. The second is the misalignment of the profit rate $(1-1/\mu_t)$ and the welfare benefit product variety $(\frac{1}{2\sigma N_t})$. As explained by Bilbiie et al. (2008), this distortion occurs if entrants do not take into account the benefit of an additional variety to consumers, on the one hand, and the negative effect entry has on the profit of incumbent firms, on the other. When there are no barriers to entry ($f_R = 0$), and the profit incentives of firms match the variety benefit ($1-1/\mu_t = \frac{1}{2\sigma N_t}$), the level of product creation is efficient. The only distortion common to both CF and BGM is the misalignment distortion.

In the CF framework, the first order conditions for firm-level employment and vacancies, respectively, determine job creation. In addition, the optimal job-productivity threshold, z^c_t, determines the measure of jobs which are endogenously destroyed. Endogenous job creation and destruction create two additional margins along which distortions occur. The inefficiency wedges in job creation and job destruction, $\Sigma_{JC,t}$ and $\Sigma_{JD,t}$, respectively, both feature the distortionary effect of firm's monopoly power (indicated by the profit rate, $1 - \frac{1}{\mu}$), and firing costs, Υ_F. Monopoly power, by generating a sub-optimal marginal revenue product of a match, creates distortions in job creation and job destruction, respectively. In addition, unemployment benefits, Υ_b, are an additional distortion along the job destruction margin as it raises the workers' outside option above its efficient level. Bilbiie et al. (2008) assume labour supply is either exogenously determined or determined by households [2]. In addition, job destruction is also exogenously determined. Therefore, these inefficiency wedges are absent.

The wedge in capital accumulation, $\Sigma_{K,t}$, occurs due to firm's monopoly power, leading to an inefficient level of investment. Given that capital is absent in Bilbiie et al. (2008), inefficiencies in capital accumulation do not exist. Lastly, the consumption-output inefficiency wedge, $\Sigma_{Y,t}$, results from regulation along two dimensions, namely, f_R and Υ_F, which lead to the diversion of resources away from consumption and other economic activities including, product and vacancy creation. As previously mentioned, $\Sigma_{Y,t}$ is the only wedge which is the result of distortions created by regulation alone. Given the absence of regulation in the BGM framework, there is no distortion in the resource constraint for consumption output.

2.3.2 Fiscal policy and inefficiency in the CF framework

I consider the effect of four fiscal policy instruments which can restore efficiency in product creation in the market equilibrium of a decentralized flexible and rigid economy, respectively. The flexible perspective refers to the CF model without regulation-related distortions. Under the rigid perspective, on the other hand, regulation creates distortions in the competitive equilibrium. The market economy and planner allocations coincide when all inefficiency wedges are eliminated at all points in time. This can only occur under the flexible perspective as the presence of regulation under the rigid perspective means that the efficient allocation is not achievable.

Under the flexible perspective, the consumption-output inefficiency wedge, $\Sigma_{Y,t}$, which occurs only as a result of regulatory entry barriers and firing costs, does not exist. Therefore, only four inefficiency wedges are present. Given that economies are often modelled as facing market regulation as in CF (also representing the rigid economy), among others, [3] it is impor-

[2] I focus on the optimal policy results in Bilbiie et al. (2008) for which labour supply is exogenous.

[3] see for example, Cacciatore et al. (2012), Cacciatore et al. (2016a), Cacciatore et al. (2016b), Ebell and Haefke (2003), Fiori et al. (2007).

tant to consider the effect of fiscal policy on inefficiency when regulation is present. All five inefficiency wedges detailed above are initially present prior to the implementation of any fiscal instrument under the rigid perspective. Also, under this perspective, the consumption-output inefficiency wedge, $\Sigma_{Y,t}$, which contains only regulation-related distortions, is always present.

The fiscal instruments considered include i) an entry tax/subsidy or (de)regulation policy; ii) a sales subsidy; iii) a dividend tax; [4] and iv) marginal cost pricing. i), ii) and iv) are shown in Bilbiie et al. (2008) to restore efficiency in product creation. It is expected that the policies considered can implement optimum product creation in the flexible variant of the CF framework given that the product creation wedge in CF is the result of a distortion also present in BGM, and regulation does not create a distortion in product creation under this perspective.

The entry conditions in BGM and CF are almost identical. The major difference is that sunk entry costs are in terms of effective labour units in BGM, while in CF entry costs are in terms of the consumption basket. This means that the misalignment distortion, which leads to inefficiency in product creation, manifests in a similar way in both. Although, it is expected that the fiscal polices which eliminate inefficiency in product creation in BGM can do so in CF, the optimal values of the fiscal instruments are likely to differ given that there is an additional distortion in product creation in BGM owing to the non-synchronization of markups across time. In addition, it is possible to assess whether marginal cost pricing, which can address the distortionary effect of firm's monopoly power, can implement the planner allocation under the flexible perspective.

Under the rigid perspective, I can examine the effect of eliminating non-regulation related distortions on the inefficiency wedges present in the decentralized equilibrium. In addition, it is possible to numerically evaluate the effect of the fiscal instruments considered on the magnitude of the inefficiency wedges and overall efficiency. Eliminating the misalignment distortion does not restore efficiency in product creation under the rigid perspective because f_R will still be present in the product creation equation. I can also numerically examine whether eliminating the misalignment distortion in product creation can reduce the product creation wedge. In

[4] In Bilbiie et al. (2008), the optimal policy is a combination of dividend taxation and a consumption tax. This is because there are two distortions in product creation - the misalignment distortion and the non-synchronization of markups, respectively. However, the second distortion in product creation is absent in the CF framework. Therefore, only the dividend tax needs to be considered.

addition, I can assess whether the instrument used to eliminate the misalignment distortion matters for the magnitude of other wedges and overall efficiency.

2.4 Flexible Perspective

As previously mentioned, I examine the effect of four fiscal instruments on the inefficiency wedges present in the decentralized equilibrium. The flexible perspective is similar to BGM in that there are only two sources of distortion in the decentralized economy. However, in contrast to BGM where both distortions create inefficiency in product creation/firm entry, in the flexible CF economy, one distortion (the misalignment distortion) affects product creation while the other (firm's monopoly power) creates distortions in job creation, job destruction and capital accumulation, respectively. First, I explore a marginal cost pricing policy (in conjunction with lump-sum taxation). I then examine the impact of other fiscal policies targeting inefficiency in product creation and their impact on the other inefficiency wedges. As previously mentioned, the consumption output constraint, $\Sigma_{Y,t}$, which contains only regulation-related distortions, is absent under this perspective.

Three policies, namely a sales subsidy, an entry subsidy, and a dividend tax, respectively, are expected to restore efficiency in product creation. I find that there are tax/subsidy rates for which optimality in product creation is achieved in the decentralized equilibrium. For overall efficiency to be realized, the distortions created by firm's monopoly power needs to be eliminated while at the same time inducing the optimal degree of product variety - that is, eliminating the misalignment distortion. When this occurs, the competitive and planner equilibria coincide.

When fiscal policies which have no effect on firm pricing are implemented, namely an entry subsidy or a dividend tax, the consequence is that only the wedge in product creation can be eliminated. In addition, the other inefficiency wedges are unaffected. On the other hand, I find that marginal cost pricing is able to restore efficiency in the decentralized equilibrium. Although the sales subsidy affects firm pricing, its implementation is not designed to ensure marginal cost pricing which means it does not eliminate the distortionary effect of firm's monopoly power. I first show that marginal cost pricing is able to restore efficiency in the decentralized equilibrium. I then define the subsidy/tax rates which restore efficiency in product creation under the other fiscal policies.

2.4.1 Marginal cost pricing

I examine the policy of a sales subsidy to firms with lump sum taxation of firms and households which implements marginal cost pricing. As mentioned previously, marginal cost pricing eliminates the two distortions present in the decentralized equilibrium. As in Bilbiie et al. (2008), under this policy, firm sales are taxed/subsidized at a rate τ_t. In addition, each firm is taxed lump sum to finance a fraction, γ_t, of the sales tax.

Proposition 1: *The competitive equilibrium resulting from a sales tax which implements marginal cost pricing, financed by lump sum taxes on firms and households, coincides with the planner allocation if and only if households pay half of the sales tax burden. This means that the proportion of taxes paid by households, γ_t satisfies:*

$$\gamma_t^* = 1 - \frac{\epsilon_t}{\mu_t - 1},$$

where $\epsilon_t = \frac{1}{2\sigma N_t}$.

Proof. With no firing costs and a sales subsidy, τ_t, firm profits are given by:

$$d_t = (1+\tau_t)\rho_t y_t - \tilde{w}_t l_t - r_t k_t - \kappa v_t - T_t^F$$

where the first term is the sales revenue inclusive of the subsidy and the final term is the portion of lump sum taxes paid by the firm to finance the sales subsidy. Optimal pricing implies that the relative price, ρ_t, is equal to $\frac{\mu_t}{(1+\tau_t)}\varphi_t$. The profit function can be re-written as:

$$d_t = (1+\tau_t)\rho_t y_t - \tilde{w}_t l_t - \alpha\varphi_t y_t - \frac{\rho_t(1+\tau_t)}{\mu_t} y_t + \varphi_t y_t - \kappa v_t - T_t^F$$

The total sales subsidy is equal to $\tau_t \rho_t N_t y_t$. Therefore, the share of taxes paid by the firm, T_t^F, is given by $\gamma_t \tau_t \rho_t y_t$, where γ_t represents the share paid by firms. Substituting in the expression for the share of the sales tax paid by the firm, profits are then given by:

$$d_t = (1+\tau_t)\rho_t y_t - \frac{(1+\tau_t)\rho_t y_t}{\mu_t} - \gamma_t \tau_t \rho_t y_t + (1-\alpha)\varphi_t y_t - \tilde{w}_t l_t - \kappa v_t$$

The Euler equation for shares is given by:

$$f_T + \kappa(\frac{l_t}{q_t} + v_t) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[f_T + \kappa(\frac{l_{t+1}}{q_{t+1}} + v_{t+1}) + d_{t+1}\right]$$

This can be re-written as the following product creation equation after substituting the profit function into the expression:

$f_T = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[f_T + (1-\frac{1}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$

The corresponding equation under the planner equilibrium is given by:

$f_T = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[f_T + (\frac{1}{2\sigma N_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$

Plugging the above expression for profits into the product creation equation under the competitive equilibrium transforms it into the following expression:

$f_T = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[f_T + (1+(1-\gamma_{t+1})\tau_{t+1} - \frac{1+\tau_{t+1}}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$

The misalignment distortion is eliminated when the sales subsidy and the share of taxes paid by firms, respectively, are set such that the profit rate is aligned with the benefit of variety. As in Bilbiie et al. (2008), the optimal value of $1+\tau_t = \mu_t$. In addition, the optimal share of taxes paid by firms is given by $\gamma_t = \frac{1}{2}$. This makes the product creation equation in the decentralized economy equivalent to the planner's. Also, the distortionary effect of firm's monopoly power no longer exists because the optimal tax rate generates marginal cost pricing.

The results are consistent with the findings of Bilbiie et al. (2008). Marginal cost pricing in combination with an equal split of the sales subsidy between households and firms to finance the sales subsidy eliminates the misalignment distortion. In Bilbiie et al. (2008), marginal cost pricing also eliminates the distortion created by the non-synchronization of markups across time, a distortion which is not present in the CF framework because sunk entry costs are not a function of marginal costs. Similarly, marginal cost pricing eliminates a distortion which exists in CF but not in the BGM framework - the distortion of firm's monopoly power which creates inefficiency in the labour market and in capital accumulation. In the flexible CF model, marginal cost pricing therefore implements the planner allocation. That is, all four inefficiency wedges in the decentralized economy are equal to zero following the implementation of this policy.

2.4.2 Fiscal policies and inefficiency in the flexible economy

In this section, I examine other fiscal policies considered in Bilbiie et al. (2008). I show that these instruments will still allow the distortion from firm's monopoly power to persist under the flexible competitive CF equilibrium and that these policies will only eliminate inefficiency in product creation. The fiscal policies discussed include: 1) A dividend tax; 2) An entry subsidy/tax; 3) A sales subsidy.

Bilbiie et al. (2008) show that a dividend tax implemented in conjunction with a consumption tax restores efficiency in the BGM economy. The dividend tax addresses the misalignment distortion, whereas the consumption tax addresses the distortion created by the non-synchronization of markups. As previously mentioned, the second distortion does not feature in the CF economy, therefore, I only consider the effect of the dividend tax. Both the dividend tax and the sales subsidy have identical effects on inefficiency wedges. These policies are only able to restore efficiency in product creation, leaving the distortions in other wedges unaffected.

2.4.2.1 Dividend taxation and inefficiency

A dividend (profit) tax imposed on firms can be used to bring entry incentive in line with the benefit of variety. Suppose the planner imposes a dividend tax on firms at a rate τ^D, the following Proposition identifies the path of the dividend tax which eliminates the misalignment distortion, or equivalently, restores efficiency in product creation:

Proposition 2: *A dividend tax eliminates the product creation wedge if*:

$$1 - \tau_t^D * = (\frac{1}{2\sigma N_t})(\frac{\mu_t}{\mu_t - 1}).$$

Proof. The dividend tax affects the misalignment distortion through the Euler equation for share holdings, which will now feature this tax instrument:

$$e_t = E_t[\beta_{t,t+1}((1 - \tau_{t+1}^D)d_{t+1} + e_{t+1})]$$

The product creation equation becomes:

$$f_T = (1 - \delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[f_T + (1 - \tau_{t+1}^D)(1 - \frac{1}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$$

Optimality in product creation, that is, equality of the welfare benefit of variety and the profit rate, requires:

$$1 - \tau_t^D * = (\frac{1}{2\sigma N_t})(\frac{\mu_t}{\mu_t - 1}),$$

Implementing a dividend tax does not affect price setting by firms. The relative price is still a markup over marginal cost. Therefore, the optimal price is unaffected by this instrument which means that the distortion $\Upsilon_{\mu,t}$ still exists. As shown below, the only wedge which is eliminated is the product creation wedge. All other inefficiency wedges are unaltered. [5]

[5] The superscript *fl* denotes the flexible economy.

$$\Sigma^{fl}_{PC,t} \equiv 0$$

$$\Sigma^{fl}_{JC,t} \equiv E_t \frac{q_t}{\kappa} \beta_{t,t+1}(1-\lambda^{tot}_{t+1})[(1-\varepsilon)(1-\alpha)\frac{Y_{t+1}}{L_{t+1}}[1-\frac{z^c_{t+1}}{\tilde{z}_{t+1}})^{\frac{1}{1-\alpha}}\Upsilon_{\mu,t+1}]$$

$$\Sigma^{fl}_{JD,t} \equiv \frac{q_t}{\kappa(q_t \varepsilon \theta_t - 1)}(1-\varepsilon)(1-\alpha)\frac{Y_t}{L_t}(\frac{z^c_t}{\tilde{z}_t})^{\frac{1}{1-\alpha}}\Upsilon_{\mu,t}$$

$$\Sigma^{fl}_{K,t} \equiv \alpha E_t \beta_{t,t+1} \frac{Y_{t+1}}{\zeta_{Kt} K_{t+1}} \Upsilon_{\mu,t+1}$$

2.4.2.2 Entry Subsidy/Tax and inefficiency

I examine a policy whereby the technological entry costs, f_T, is subsidized at a rate, ϕ_t. In the CF framework, in contrast to BGM, the cost of recruiting labour is part of the sunk entry cost firms face. I, however, focus on f_T as the result is not affected by this assumption. Proposition 3 finds the optimal path of the entry tax which restores efficiency in product creation.

Proposition 3: *In order for a subsidy to firm entry to restore efficiency in product creation, the following condition must be satisfied*:

$$1-\phi^*_t = (1-\frac{1}{\mu_t})2\sigma N_t.$$

Proof. A firm subsidy of ϕ_t transforms the product creation equation into:

$$(1-\phi_t)(f_T) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(1-\phi_t)f_T + (1-\tfrac{1}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$$

Comparing the above equation with the product creation equation in the planner economy shows that a value of ϕ_t satisfying the above proposition generates the optimal path for the entry subsidy. Plugging the expression for the optimal subsidy $(1-\phi^*_t = (1-\frac{1}{\mu_t})2\sigma N_t)$ into the product creation equation:

$$((1-\frac{1}{\mu_{t+1}})2\sigma N_t)(f_T) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[((1-\frac{1}{\mu_{t+1}})2\sigma N_t)f_T + (1-\tfrac{1}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$$

This implies:

$$(2\sigma N_t)(f_T) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(2\sigma N_{t+1})(f_T) + \frac{Y_{t+1}}{N_{t+1}}\right]$$

Simplifying the above expression leads to the product creation equation given by the planner allocation:

$$f_T = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[f_T + (\tfrac{1}{2\sigma N_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$$

Again, because this instrument does not affect pricing, as in the case of dividend taxation, it has no effect on the profit rate of firms, which means that the distortionary effect of firm's monopoly power persists. Also, because no other inefficiency wedge features the misalignment distortion present in product creation, an entry subsidy has no effect on any other inefficiency wedges.

2.4.2.3 A Sales Subsidy and inefficiency

A sales subsidy can also eliminate inefficiency along the product creation margin. As shown by Bilbiie et al. (2008), this can be achieved through implementing an optimal subsidy rate in combination with the lump-sum taxation of firms, whereby firms bear the total burden of the subsidy. The subsidy rate which restores efficiency in product creation is derived for the flexible perspective. It is shown that there is no way to implement a sales subsidy in a way which simultaneously eliminates the misalignment distortion and the distortion from monopolistic pricing without inducing marginal cost pricing in the way discussed above - by setting $\tau_t = \mu - 1$ and γ_t, the fraction of the lump sum tax paid by firms, to a half. With the sales subsidy, as detailed in this section, the subsidy rate is unable to simultaneously eliminate both distortions given that the subsidy rate which restores efficiency in product creation differs from that which eliminates the distortionary effect of firm's monopoly power. Therefore, a sales subsidy financed by a lump sum tax on firms either eliminates the misalignment distortion or firm's monopoly power but not both. This is be shown below. However, because the subsidy rate affects firm pricing, it also affects the distortionary effect of firm's monopoly power in other inefficiency wedges.

Proposition 4: *A sales subsidy, financed by a lump sum tax on firm profits, eliminates the product creation wedge if*:

$$1 + \tau_t^* = \frac{\mu_t(2\sigma N_t - 1)}{2\sigma N_t}.$$

Proof. As in the case of marginal cost pricing, the optimal pricing equation, $\rho_t = \frac{\mu_t}{(1+\tau_t)}\varphi_t$, implies that firm profits are given by:

$$d_t = (1+\tau_t)\rho_t y_t - \tilde{w}_t l_t - \alpha\varphi_t y_t - \frac{\rho_t(1+\tau_t)}{\mu_t} y_t + \varphi_t y_t - \kappa v_t - T_t^F,$$

where $T_t^F = \tau_t \rho_t y_t$ is the total sales tax imposed on the firm. The profit function can be written as:

$$d_t = (1+\tau_t)\rho_t y_t - \frac{(1+\tau_t)\rho_t y_t}{\mu_t} - \tau_t \rho_t N_t y_t + (1-\alpha)\varphi_t y_t - \tilde{w}_t l_t - \kappa v_t$$

This transforms the product creation equation into:

$f_T = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[f_T + (1 - \frac{1+\tau_{t+1}}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$

In order to eliminate the misalignment distortion, thereby restoring efficiency in product creation, the subsidy rate τ_t should satisfy the following equation:

$1 + \tau_t^* = \frac{\mu_t(2\sigma N_t - 1)}{2\sigma N_t}$

This is the subsidy rate detailed in Proposition 4. The distortion from monopoly power is eliminated when the profit rate, $1 - \frac{1+\tau_t}{\mu_t} = 0$ or $1 + \tau_t = \mu_t$. This condition cannot be satisfied under the subsidy rate for optimum product creation. That is, there is no value of τ_t which satisfies both optimum product creation and eliminates the distortionary effect of firm's monopoly power by implementing marginal cost pricing. The subsidy rate which restores efficiency in product creation in the flexible CF economy differs from that in the BGM framework due to the additional dynamic distortion (non-synchronization of markups) that exists in BGM.

The other four inefficiency wedges in the CF economy still exist under this policy given that the distortionary effect of firm's monopoly power persists. However, this policy has implications for pricing which affects the profit rate (in contrast to the previous two policies). Therefore, implementing this policy will have an effect on the distortionary effect created by firm's monopoly power in the other three inefficiency wedges. The magnitude of the wedges at any point in time will depend on the rate of subsidy.

As with the previous fiscal policies, the sales subsidy, as defined above, eliminates the product creation wedge. However, in contrast to a dividend tax and an entry tax, it also affects the distortion from firm's monopoly power in other inefficiency wedges through the profit rate. The inefficiency wedges are defined as follows:

$\Sigma_{PC,t}^{fl} \equiv 0$

$\Sigma_{JC,t}^{fl} \equiv E_t \frac{q_t}{\kappa}\beta_{t,t+1}(1 - \lambda_{t+1}^{tot})[(1-\varepsilon)(1-\alpha)\frac{Y_{t+1}}{L_{t+1}}[1 - \frac{z_{t+1}^c}{\tilde{z}_{t+1}})^{\frac{1}{1-\alpha}}\Upsilon_{\mu,t+1}]$

$\Sigma_{JD,t}^{fl} \equiv \frac{q_t}{\kappa(q_t\varepsilon\theta_t - 1)}(1-\varepsilon)(1-\alpha)\frac{Y_t}{L_t}(\frac{z_t^c}{\tilde{z}_t})^{\frac{1}{1-\alpha}}\Upsilon_{\mu,t}$

$\Sigma_{K,t}^{fl} \equiv \alpha E_t \beta_{t,t+1}\frac{Y_{t+1}}{\zeta_{Kt}K_{t+1}}\Upsilon_{\mu,t+1}$

where $\Upsilon_{\mu,t}$, the profit rate, is now given by: $1 - [\frac{2\sigma N_t - 1}{2\sigma N_t}]$. The magnitude of this distortion still depends solely on the number of goods in the economy (and the price-elasticity of the spending share on an individual good, σ), as in the baseline flexible economy, but is now given by a different expression.

In summary, there are tax/subsidy rates which restore efficiency in product creation in the flexible variant of the CF framework. These differ from the tax/subsidy rates in Bilbiie et al. (2008) given differences in the characterization of entry costs. Overall efficiency can only be achieved via marginal cost pricing (in combination with lump-sum taxation) which can also address the distortionary effect created by firm's monopoly power in contrast to the other fiscal policies. Implementing an entry tax or a dividend tax has no effect on other inefficiency wedges because it has no effect on price setting. In addition, although pricing is affected under a sales tax, this policy does not eliminate the distortions in job creation, job destruction and capital accumulation, respectively, created by firm's monopoly power.

2.5 Rigid perspective

I examine the impact of fiscal policy instruments, in combination with lump sum taxation, on the inefficiency wedges in the baseline CF equilibrium. This is the decentralized equilibrium that occurs when three dimensions of regulation are introduced into the flexible variant of the CF economy. Market regulation includes firing costs, F, sunk entry costs from regulatory requirements, f_R, and unemployment benefits, ub. As mentioned previously, in contrast to the flexible perspective, a consumption output inefficiency wedge, $\Sigma_{Y,t}$, features in the rigid CF equilibrium. It is defined as $\dfrac{G(z_t^c)}{1-G(z_t^c)}L_t\Upsilon_F + \Upsilon_R N_{E,t}$.

As under the flexible perspective, there are tax/subsidy rates for the instruments considered under the flexible perspective which can be used to align the entry incentive of firms with the benefit consumers derive from an additional variety. It can be shown that the same tax/subsidy rates which eliminate the misalignment wedge obtain under the rigid perspective. However, in contrast to the flexible perspective, these rates do not restore efficiency in product creation due to the distortionary effect of f_R.

The Euler equation for shares under the rigid perspective, prior to the implementation of fiscal policy instruments, is given by:

$$(f_T + f_R) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T + f_R) + (1-\tfrac{1}{\mu_t})\frac{Y_{t+1}}{N_{t+1}}\right]$$

The only difference with the corresponding equation under the flexible perspective is the presence of f_R on both sides of the equation, as an additional component of sunk entry costs,

$f_{E,t}$. Following the elimination of the misalignment distortion, the presence of f_R means that there is now a residual product creation wedge which persists under the fiscal instruments considered. The (residual) product creation wedge owing solely to the distortion from f_R is given by:

$$\Sigma_{PC,t}^{rig} \equiv \frac{(1-\delta)}{f_T}\mathbb{E}\left[\beta_{t,t+1}\frac{Y_{t+1}}{N_{t+1}}[-\frac{\Upsilon_R}{(1+\sigma N_{t+1})(f_T+\Upsilon_R)}]\right].$$

2.5.1 Marginal cost pricing

As under the flexible perspective, a marginal cost pricing policy which eliminates the misalignment distortions involves a sales subsidy to firms, a proportion, γ_t, of which is financed by imposing a lump sum tax on firms. The burden of tax on households is given by: $T_t = -ub(1-L_t) + (1-\gamma_t)\rho_t y_t N_t$.

The Euler equation for shares becomes:

$$(f_T + f_R) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T+f_R) + (1+(1-\gamma_t)\tau_t - \tfrac{1+\tau}{\mu_t})\frac{Y_{t+1}}{N_{t+1}}\right]$$

As before, optimal pricing implies: $\rho_t = \dfrac{\mu}{(1+\tau_t)}\varphi$, where τ_t is the subsidy rate. Also, the values of τ_t and γ_t, which eliminate the distortionary effect of monopoly power and the misalignment distortion, respectively, from the decentralized economy, are given by $1+\tau_t = \mu_t$ and $\gamma_t = \frac{1}{2}$. This is because the presence of f_R neither affects firm pricing nor profits. Since the subsidy rate implements marginal cost pricing, the distortionary effect of firm's monopoly power along the job creation, job destruction, and capital accumulation margins, respectively, will be eliminated. Marginal cost pricing implies the following inefficiency wedges:

$$\Sigma_{JC,t}^{rig} \equiv E_t\frac{q_t}{\kappa}\beta_{t,t+1}(1-\lambda_{t+1}^{tot})\frac{\Upsilon_F}{[1-G(z_t^c)]}$$

$$\Sigma_{JD,t}^{rig} \equiv \frac{q_t}{\kappa(q_t\varepsilon\theta_t - 1)}[(1-\varepsilon)\Upsilon_b - [1-\eta(1-E_t\tilde{\beta}_{t,t+1}(1-s_t))]\Upsilon_F]$$

$$\Sigma_{K,t}^{rig} \equiv 0,$$

Given that the distortion from firm's monopoly power is the only distortion which exists along the capital accumulation margin, this wedge is the only wedge which is eliminated. This distortion also ceases to exist along the job creation and job destruction margins, respectively. In contrast to the baseline rigid equilibrium, firing costs are the only distortion along the job creation margin. Similarly, inefficiency in job destruction is as a result of the distortions from firing costs and unemployment benefits.

2.5.2 A Sales Subsidy and inefficiency

As under the flexible perspective, a sales subsidy, τ_t, to firm sales implies the following optimal pricing equation: $\rho_{\omega t} = \dfrac{\mu}{(1+\tau_t)}\varphi$

The product creation equation is then given by:

$$(f_T + f_R) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T + f_R) + (1 - \tfrac{1+\tau_{t+1}}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$$

Eliminating the misalignment distortion in the product creation equation requires setting τ_t the same as in the flexible state of the world. That is, τ_t should obey the following rule:

$$1 + \tau_t^* = \frac{\mu_t(2\sigma N_t - 1)}{2\sigma N_t}$$

In contrast to the corresponding policy under the flexible scenario, all inefficiency wedges are present. Given that the same tax rate eliminates the misalignment distortion under the rigid and flexible perspectives, $\Upsilon_{\mu,t}$ is still given by the expression: $1 - [\dfrac{2\sigma N_t - 1}{2\sigma N_t}]$. The job creation, job destruction, and capital accumumation inefficiency wedges are as follows:

$$\Sigma_{JC,t}^{rig} \equiv \Sigma_{JC,t}$$

$$\Sigma_{JD,t}^{rig} \equiv \Sigma_{JD,t}$$

$$\Sigma_{K,t}^{rig} \equiv \Sigma_{K,t}$$

2.5.3 Entry and inefficiency

I assume that the entry subsidy to firms covers both f_R and f_T, i.e., the policy maker subsidizes the sum of these two entry costs. I also assume that fiscal policy does not seek to eliminate f_T in the decentralized economy given that it is present in the planner economy.

An entry subsidy to firms, ϕ_t, implies that the product creation equation is given by:

$$(1-\phi_t^*)(f_T + f_R) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(1-\phi_t)(f_T + f_R) + (1 - \tfrac{1}{\mu_{t+1}})\frac{Y_{t+1}}{N_{t+1}}\right]$$

As previously, the rate of the entry subsidy which eliminates the misalignment distortion is given by: $1 - \phi_t = (1 - \dfrac{1}{\mu_t})2\sigma N_t$. Substituting for the wedge minimizing value of $1 - \phi_t$, and simplifying implies:

$$f_T + f_R = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T + f_R) + \frac{1}{2\sigma N_{t+1}}\frac{Y_{t+1}}{N_{t+1}}\right],$$

which coincides with the product creation equation in the planner economy. Given that this policy does not affect firm pricing/profit rate, the distortionary effect of the profit rate still exists (as in the corresponding flexible scenario). The three other inefficiency wedges are as follows[6]:

$$\Sigma^{rig}_{JC,t} \equiv \Sigma_{JC,t}$$

$$\Sigma^{rig}_{JD,t} \equiv \Sigma_{JD,t}$$

$$\Sigma^{rig}_{K,t} \equiv \Sigma_{K,t}$$

As in the case of a sales tax, all inefficiency wedges are present under this policy. Also, the profit rate under this policy is the same as in the corresponding flexible scenario, given that optimal pricing is also not affected under this perspective.

2.5.4 Numerical exercise

The effect of eliminating non-regulation related distortions in the rigid model on the inefficiency wedges depends on model parameters. This section numerically evaluates the impact of the policies discussed above under the rigid perspective in a calibrated model of the Euro Area over the period 1995:Q1 to 2013:Q1. Model calibration follows CF. Periods are interpreted as quarters. As is standard in the business cycle literature, the discount factor, β, is set to 0.99, risk aversion, γ, to 1, the share parameter on capital in the Cobb-Douglas production function, α, to 0.33, and the capital depreciation rate, δ_k, to 0.025. The exogenous separation rate, λ^x, is chosen such that 71% of jobs which are destroyed in the previous year do not reappear in the current year. The price-elasticity of spending share on an individual good, σ, is set such that the markup, μ, is 10%. The implied elasticity of substitution is 11. The worker's bargaining power parameter, η, is set equal to the elasticity of matches to unemployment, ε, so that the Hosios condition is satisfied.

The vacancy posting cost, κ, is set equal to 0.13, which corresponds to 13% of the average wage. The average benefit replacement rate is set to 62%. Home production, h_p, the matching function, χ, and firing costs, F, are chosen by CF to match the total separation rate, λ^{tot}, the unemployment rate, U, and the probability of filling a vacancy, q. This requires that h_p and χ are equal to 0.38 and 0.43, respectively. F is equal to 7% of the average wage. q is set to

[6] The dividend tax which eliminates the misalignment distortion has the same effect on inefficiency wedges, given that pricing is also unaffected by this instrument. As in the flexible case, the tax rate which achieve this is given by $1-\tau_t^{D*} = (\frac{1}{2\sigma N_t})(\frac{\mu_t}{\mu_t - 1})$

0.6. The plant exit rate, δ is set such that 25% of the steady state gross job destruction rate is due to firm exit. The regulation-related entry cost, f_R is set such that the aggregate cost of product market deregulation is 1.98% of GDP. The technological cost of entry, F_T is set to 1.09% of GDP. The standard deviation of the technology shock, σ_Z, and the autoregressive parameter, ϕ_Z, are set to 0.009 and 0.98, respectively. The lognormnal scale, μ_{zi}, and the shape parameter, σ_{zi}, are set equal to zero and 0.15, respectively. The investment adjustment cost, ν, is equal to 1.5. The model calibration is summarized in Table 2.2.

Table 2.3 shows the results of the policy experiment comparing the inefficiency wedges which result under the four fiscal policies discussed under the rigid perspective. All policies raise the steady state product creation wedge relative to the baseline rigid equilibrium. On the other hand, the consumption output wedge is lower under all policies relative to the baseline rigid equilibrium. Efficiency outcomes along the job creation and job destruction margins vary by fiscal instrument. With marginal cost pricing and a sales subsidy, the steady state job creation inefficiency wedges are lower. The job destruction inefficiency wedge is lower only with marginal cost pricing. Capital accumulation is also efficient under marginal cost pricing as established previously.

The results show that, in the presence of regulation, marginal cost pricing does not lower all inefficiency wedges relative to the baseline rigid economy. In contrast to under the flexible perspective, marginal cost pricing is no longer a dominant policy given that it raises the product creation wedge, as in the case of the other policies. The results show that eliminating non-regulation related distortions in the rigid economy equilibrium cannot raise overall efficiency when regulation is present in the economy. There will be trade-offs associated with implementing the fiscal policies discussed.

Table 2.2: Calibration

Parameter	**Value**
Variety elasticity, σ	3.12
Risk aversion, γ	1
Discount factor, β	0.99
Technological entry cost, f_T	1.67
Regulation entry cost, f_R	1.77
Plant exit, δ	0.009
Investment adjustment cost, ν	1.5
Capital depreciation rate, δ_K	0.025
Capital share, α	0.33
Exogenous separation rate, λ^x	0.025
Matching function elasticity, ε	0.6
Workers' bargaining power, η	0.6
Home Production, h_p	0.38
Unemployment benefit, b,	1.06
Matching efficiency, χ	0.43
Vacancy cost, κ	0.13
Lognormal shape, σ_{z_i}	0.147
TFP, persistence ϕ_Z	0.983
Firing costs, F	0.11
TFP, standard deviation σ_Z	0.009

Table 2.3: Inefficiency wedges and fiscal policy

Wedge	**No policy**	**MC pricing**	**Sales subsidy**	**Entry subsidy**	**Dividend tax**
$\Sigma^{rig}_{PC,t}$	0.003	0.021	0.021	0.021	0.021
$\Sigma^{rig}_{JC,t}$	0.670	0.429	0.665	0.992	0.999
$\Sigma^{rig}_{JD,t}$	2.183	2.035	2.326	2.850	2.8663
$\Sigma^{rig}_{K,t}$	0.004	0	0.003	0.005	0.005
$\Sigma^{rig}_{Y,t}$	0.051	0.039	0.038	0.037	0.037

2.6 Conclusion

This chapter examined the effect of a range of fiscal policies on the distortions in the CF framework. This model embeds labour market frictions, endogenous job creation and job destruction into the BGM model which features endogenous firm entry. This was done under two perspectives - the flexible and rigid perspectives, respectively. The difference between the two perspectives is in the presence of regulation-related distortions in the decentralized economy. Under the flexible perspective, there are no distortions from regulation. There are two non-regulation related distortions. Under the rigid perspective, there are an additional three regulation-related distortions.

Under the flexible perspective, I consider the effect of fiscal policy instruments which Bilbiie et al. (2008) show can restore efficiency in the BGM framework on inefficiency in the CF framework. Both models feature a misalignment distortion which leads to inefficient firm entry. However, in the CF framework, the other distortion comes from the effect of monopoly power along the job creation, job destruction and capital accumulation margins. This is in contrast to the BGM framework where the other distortion is due to the non-synchronization of markups across time which also creates inefficiency in firm entry. This means that in the CF model the distortion created by monopoly power must be eliminated in order to restore efficiency in the market economy, in contrast to BGM.

Because firm's monopoly power does not create a distortion in BGM, marginal cost pricing is not required in order to restore efficiency. In contrast, this policy is necessary in order to restore efficiency in the flexible CF model. As in Bilbiie et al. (2008), I find that marginal cost pricing, implemented via a sales subsidy which ensures an equal split between households and firms in financing the subsidy, eliminates both distortions in the CF framework. Bilbiie et al. (2008) also show that this policy also eliminates the distortion created by the non-synchronization of markups. Therefore, this policy is optimal in both settings.

The product creation wedge is the only wedge which can possibly be eliminated by BGM-optimal fiscal policies, with the exception of marginal cost pricing. Under the flexible perspective, the distortionary effect of monopoly power will remain in job creation, job destruction and capital accumulation with all other instruments. This is because these instruments either do not affect firm pricing, in the case of a dividend tax and an entry subsidy, respectively, or are unable to eliminate the distortionary effect of firm's monopoly power, in the case of a sales subsidy.

Results from the calibrated model show that the effect of the fiscal policies on the job creation and job destruction inefficiency wedges under the rigid perspective varies by instrument. The steady state job destruction inefficiency wedge falls in the case of marginal cost pricing only. The job creation wedge is lower with marginal cost pricing and a sales subsidy, respectively. In contrast to under the flexible perspective, marginal cost pricing under the rigid perspective does not lower/eliminate all inefficiency wedges. The results for the calibrated model show that when regulation is present in the economy, eliminating non-regulation distortions cannot raise overall efficiency.

Chapter 3

Fiscal policy shocks: Endogenous entry and labour market frictions

3.1 Introduction

This chapter examines the implications of fiscal shocks in the context of a dynamic stochastic general equilibrium (DSGE) model with endogenous producer entry, labour market frictions and regulation in the goods and labour markets, developed by Cacciatore and Fiori (2016), here after CF. Studies have shown that entry dynamics matter for the propagation of technology and fiscal shocks. In this chapter, realistic aspects of fiscal policy are incorporated into the CF framework to investigate the extent to which the presence of labour market frictions matter for aggregate outcomes following fiscal shocks. This allows us to shed some light on the mechanisms which determine the aggregate effects of these shocks.

It also examine whether the mechanisms by which macroeconomic variables are affected may differ depending on the type of fiscal shock faced. Three fiscal policy shocks are considered, namely: i) a shock to government consumption; ii) a capital income tax shock; iii) a labour income tax shock. Finally, it investigates whether the effects of fiscal shocks depend on the level of market regulation. CF find that relative to an economy with high regulation, when overall market regulation is low, macroeconomic variables such as, consumption, investment and GDP show a less pronounced decline from steady state following a negative technology shock.

Bilbiie et al. (2012), hereafter, BGM show that endogenous firm entry and product creation have important implications for business cycle dynamics. Chugh and Ghironi (2011) incorporate fiscal policy into the BGM model and show that entry dynamics also matter for the aggregate effects of a positive labour income tax shock. The authors argue that, following the shock, output falls due to a decline in product creation.

However, little is known about the implications of labour market frictions, with endogenous job creation and job destruction, for the propagation of fiscal shocks. There is a vast theoretical literature on the effects of government spending shocks. This includes, Baxter and King (1993), Galí et al. (2007), Linnemann and Schabert (2003), among others. Some studies argue that private consumption reacts negatively to an expansion in government spending financed by lump sum taxation of households due to the negative wealth effect of higher future taxes. Others have shown, however, that with GHH preferences and rule-of-thumb consumers, respectively, it is possible to generate a positive response of consumption to an expansion in government spending.

Empirical studies based on vector autoregressions also make contrasting findings. Some studies, including Blanchard and Perotti (2002), Fatas and Mihov (2000), and Mountford and Uhlig (2009) find that government spending raises consumption. Others, such as, Ramey (2011) and Edelberg et al. (1999) find a negative effect on consumption. The empirical evidence on capital investment is also mixed. The widely accepted view that government spending and output are positively correlated has also been contested. For example, Linnemann and Schabert (2003) argue that an expansion in government spending leads to a fall in output. In addition, Alesina et al. (2018) find that fiscal austerity can be expansionary.

Studies examining the effects of government spending shocks generally assume that households face a labour supply decision and so in response to changes in government spending, the household can adjust its labour supply. In contrast, in the standard search and matching framework, the labor supply choice is not explicit, as employment is an outcome of a labour market matching process. The presence of endogenous producer entry may also have implications for the effect of a government spending shock. As explained by Lewis and Winkler (2017), the response of consumption to a positive government spending shock depends on the response of firm entry. An increase in the number of firms entering the market could stimulate consumption through increased labour demand. This makes the response of aggregate variables to an expansion in government consumption a priori ambiguous in the CF framework.

I find that private consumption reacts negatively following a positive shock to government spending which is financed by lump sum taxes, as in Chugh and Ghironi (2011), and consistent with standard RBC theory. An expansion in government spending also leads to a decline in investment in capital and new products, respectively. The results show that a rise in government spending can lead to a persistent decline in wages due to entry and capital investment dynamics. In addition, the positive fiscal shocks considered have recessionary effects due to the dynamics of entry, investment and labour market conditions. Results also show that, following fiscal shocks, unemployment volatility is greater when regulation is high. The chapter is organized as follows. Section 3.2 presents the model which introduces fiscal policy into the CF framework. Section 3.3 describes the calibration. Section 3.4 presents the results. Section 3.5 concludes.

3.2 Model

The general model framework follows Chapter 2 with a few exceptions detailed below. Household preferences and production follow sections 2.1 and 2.2 of Chapter 2, respectively, with important exceptions detailed below. In the model presented in this chapter, in addition to lump sum taxes, the government also has access to distortionary taxes to finance its spending.

3.2.1 Wage setting

Workers and firms bargain over the match surplus. The exogenous bargaining weight $\eta \in (0,1)$ determines the workers' bargaining power. Labour income is taxed at a rate τ_t^n which means that the surplus-splitting rule is given by:

$$\tilde{\Delta}_{\omega t}^{W} = (1-\tau_t^n)\frac{\eta}{1-\eta}\tilde{\Delta}_{\omega t}^{F}$$

τ_t^n creates a wedge in the Nash sharing rule such that the worker receives a smaller share of the surplus net-of-taxes than would have occured absent the tax (see, for instance, Arseneau and Chugh (2006)). The derivation of the wage equation is contained in the Appendix. The wage paid to each worker is given by:

$$w_{\omega t}(z) = \eta(\Pi_{\omega t}(z) + \frac{\kappa}{q_t} + F) + \frac{1-\eta}{1-\tau_t^n}\varpi_t - \frac{\eta(1-\tau_{t+1}^n)}{1-\tau_t^n}(\frac{\kappa}{q_t} + E_t\tilde{\beta}_{t,t+1}F) \tag{3.1}$$

It is a function of the firm surplus excluding the wage payment to the worker (given by the first term in brackets), the worker's outside option, ϖ_t, the marginal benefit of posting a vacancy, $\frac{\kappa}{q_t}$, and next period's firing costs, $\tilde{\beta}_{t,t+1}F$. The workers' outside option, ϖ_t, corresponding to the value of unemployment is given by the following expression:

$$\varpi_t \equiv h_p + ub + \int_{\omega \subset \Omega_t}^{\infty} s_t \frac{v_{\omega t}}{V_t} E_t[\tilde{\beta}_{t,t-1}(1 - G(z^c_{\omega t+1}))\tilde{\Delta}^W_{\omega t+1}] d\omega, \tag{3.2}$$

where ub represents unemployment benefits from the government and h_p is home production. The third term in the expression represents the expected discounted value of searching for other jobs.

The worker surplus is given by:

$$\Delta^W_{\omega t}(z) = (1 - \tau^n_t) w_{\omega t}(z) - \varpi_t + E_t \tilde{\beta}_{t,t+1}(1 - G(z^c_{\omega t+1}))\tilde{\Delta}^W_{\omega t+1} \tag{3.3}$$

The average worker surplus is given by the following expression:

$$\tilde{\Delta}^W_{\omega t} \equiv [(1 - G(z^c_{\omega t}))]^{-1} \int_{z^c_{\omega t}}^{\infty} \Delta^W_{\omega t}(z) dz \tag{3.4}$$

3.2.2 Household budget constraint and first-stage budgeting

Households hold shares in a mutual fund of firms and own the economy's stock of capital, K_t. x_t represents the share in the mutual fund held by the representative household entering period t, and x_{t+1} the amount of shares in a mutual fund of firms consisting of incumbent firms and new entrants $(N_t + N_{Et})$ purchased by the representative household in $t + 1$. The date-t price of a share in the mutual fund is equal to the price of claims to future firm real profits, e_t. Physical capital, K_t obeys a standard law of motion:

$$K_{t+1} = (1 - \delta_K) K_t + I_{Kt}[1 - (\nu/2)(I_{Kt}/I_{Kt-1} - 1)^2], \tag{3.5}$$

where $\nu > 0$ is a scale parameter. The per-period household's budget constraint is given by:

$$C_t + e_t(N_t + N_{Et}) x_{t+1} + I_{Kt} = (d_t + e_t) N_t x_t + (1 - \tau^n_t) \tilde{w}_t L_t + (1 - \tau^k_t) r_t K_t + (h_p + ub)(1 - L_t) + T_t, \tag{3.6}$$

where T are lump-sum taxes, τ_t^n and τ_t^k are tax rates on labour income and capital income, respectively. The household maximizes its expected intertemporal utility subject to the above budget constraint and law of motion for physical capital. The Euler equation for share holdings is given by: $e_t = E_t[\beta_{t,t+1}(d_{t+1} + e_{t+1})]$; the Euler equation for capital accumulation requires the following condition: $\zeta_{Kt} = E_t\beta_{t,t+1}[(1 - {\tau^k}_{t+1})r_{t+1} + (1 - \delta_K)\zeta_{Kt+1}]$, where ζ_{Kt} represents the shadow value of capital in units of consumption. The first-order condition for investment, I_{Kt} is given by:

$$1 = \zeta_{Kt}[1 - \frac{\nu}{2}(\frac{I_{Kt}}{I_{Kt-1}})^2 - \nu(\frac{I_{Kt}}{I_{Kt-1}} - 1)(\frac{I_{Kt}}{I_{Kt-1}})] + \nu\beta_{t,t+1}E_t[\zeta_{Kt+1}(\frac{I_{Kt}}{I_{Kt-1}} - 1)(\frac{I_{Kt}}{I_{Kt-1}})^2] \quad (3.7)$$

3.2.3 Government

The government finances an exogenous stream of government expenses $\{G_t\}_{t=0}^{\infty}$ through labour income taxes, capital income taxes, and lump sum taxes. [1] The period-t government budget constraint is:

$$G_t = \tau_t^k R_t K_t + \tau_t^n w_t N_t + T_t \quad (3.8)$$

3.2.4 Equilibrium

The elasticity of substitution across varieties in the symmetric equilibrium is given by: $\Theta_t = 1 + \sigma N_t$. Aggregate employment can be written as: $L_t = N_t L_t$. Aggregate vacancies is given by the sum of vacancy postings by existing firms and new entrants: $V_t = (N_t + N_{Et})v_t + N_{Et}l_t/q_t$. The law of motion of aggregate employment can be written as:

$$L_t = (1 - \delta)(1 - \lambda^x)[1 - G(z_t^c)][L_{t-1} + q_{t-1}V_{t-1}] \quad (3.9)$$

The aggregate resource constraint can be expressed as:

$$C_t^M + I_{Kt} + G_t + N_{Et}(f_R + f_T) = \tilde{w}_t L_t + r_t K_t + N_t d_t \quad (3.10)$$

[1] I follow Chugh and Ghironi (2011) in assuming that the government has access to lump sum taxes. This enhances the comparability of results and defines a useful benchmark.

where F_t denotes aggregate firing costs. The main model equations are summarized in Table 3.1. The model features 10 endogenous variables: C_t, ρ_t, N_{t+1}, L_t, V_t, M_t, z^c_t, K_{t+1}, I_{Kt}, ξ_{Kt}. In addition, the model features four exogenous variables, Z_t, G_t, τ^N and τ^k.

3.3 Calibration

The decision rules are solved for numerically given the non-linear nature of the equilibrium conditions. The model is calibrated following CF, where possible. The authors choose parameter values to match macroeconomic data for the Euro Area (EA) for the periods 1995Q1 to 2013Q1. Periods are interpreted as quarters. As is standard in the business cycle literature, the discount factor β is set to 0.99, risk aversion, γ to 1, the share parameter on capital in the Cobb-Douglas production function, α to 0.33, and the capital depreciation rate, δ_k, to 0.025. The exogenous separation rate, λ^x, is chosen such that 71% of jobs which are destroyed in the previous year do not reappear in the current year. The price-elasticity of spending share on an individual good, σ, is set such that the markup is 10%. The implied elasticity of substitution is 11. The model is calibrated so that the Hosios condition is satisfied, that is, the parameter governing worker bargaining power is set equal to the elasticity of matches to unemployment, $\eta = \varepsilon$.

The average benefit replacement rate is set to 62%. The cost of posting a vacancy is 13% of the average wage. Home production h_p, the matching function, χ, and firing costs, F, are chosen by the authors to match total separation rate, λ^{tot}, the unemployment rate, U and the probability of filling a vacancy, q. These are set to 0.38, 0.43, and 0.11 respectively. q is set to 0.6. U is set to 0.09. The technological cost of entry, F_T is set to match the producer level cost of R & D expenditure of 65% in Cacciatore and Fiori (2016). The regulation entry cost, f_R, is set equal to 69% of output per worker at the producer level.

Government consumption, capital income tax and labour income tax obey the following processes:

$$\text{In } G_t = (1 - \rho_g) \text{ In } \bar{G} + \rho_g \text{ In } G_{t-1} + \varepsilon_{g,t}$$

$$\tau^k_t = (1 - \rho_k)\tau^k + \rho_k \tau^k_{t-1} + \varepsilon_{k,t}$$

$$\tau^n_t = (1 - \rho_n)\tau^n + \rho_n \tau^n_{t-1} + \varepsilon_{n,t}$$

The steady state labour income tax rate, τ^n, and capital income tax rate, τ^k, are fixed

Table 3.1: Model Summary

Adjusted Discount Factor	$\beta_{t,t+1} = \beta(\frac{C_{t+1}}{C_t})^{-\gamma}$
Firm-level job separation	$\lambda_t = \lambda^x + (1-\lambda^x)G({z_t}^c)$
Law of motion of aggregate employment	$(1-\lambda_t)(1-\delta)(L_{t-1} + q(\theta_{t-1})V_{t-1})$
Law of motion of physical capital	$K_{t+1} = (1-\delta_K)K_t + I_{Kt}[1-(\nu/2)(I_{Kt}/I_{Kt-1}-1)^2]$
Aggregate Unemployment	$U_t = (1-L_t)$
Average wage	$\tilde{w}_{\omega t}(z) = \eta(\tilde{\Pi}_{\omega t}(z) + \frac{\kappa}{q_t} + F) + \frac{1-\eta}{1-\tau_t^n}\varpi_t - \frac{\eta(1-\tau_{t+1}^n)}{1-\tau_t^n}(\frac{\kappa}{q_t} + E_t\tilde{\beta}_{t,t+1}F)$
Vacancies by entrants	$v_t^e = (l_t + q_t v_t)/q_t$
Aggregate matching function	$M_t = \chi(1-L_t)^{\varepsilon}{V_t}^{-\varepsilon}$
Probability of filling a vacancy	$q_t = M_t/V_t$
Job finding probability	$s_t = M_t/U_t$
Job creation	$\frac{\kappa}{q_t} = (1-\delta)(1-\lambda^x)\mathbb{E}\left[\beta_{t,t+1}[(1-G(z^c_{\omega t}))(\tilde{\Pi}_{\omega t+1} - \tilde{w}_{\omega t+1} + \frac{\kappa}{q_{t+1}}) - G(z^c_{\omega t+1}F]\right]$
Job destruction	$\Pi(z^c_{\omega t}) - w(z^c_{\omega t}) + \frac{\kappa}{q_t} = -F$
Pricing	$\rho_t = \mu_t\varphi_t$
Markup	$\mu_t(N_t) = \mu_t = 1 + \frac{1}{\sigma N_t}$
Variety effect	$\rho_t = e^{-\frac{\tilde{N}-N_t}{2\sigma\tilde{N}N_t}}$
Profits	$d = (1-\frac{1}{\mu_t})\frac{Y_t}{N_t} + \psi_t l_t - \kappa(v_t + \frac{l_t}{q_t}) - [\frac{G({z_t}^c)}{1-G({z_t}^c)}]$
Free entry	$v_t = f_{E,t}$, where $f_{E,t} = f_R + f_T + \kappa {v^e}_t$
Number of firms	$N_t = (1-\delta)(N_{t-1} + N_{Et-1})$
Euler equation (shares)	$v_t = (1-\delta)E_t\beta_{t,t+1}(v_{t+1} + d_{t+1})$
Euler equation (physical capital)	$\zeta_{Kt} = E_t\beta_{t,t+1}[(1-{\tau^k}_{t+1})r_{t+1} + (1-\delta_K)\zeta_{Kt+1}]$
Aggregate Output	$Y_t = C_t^M + I_{Kt} + G_t + N_{Et}(f_R + f_T) + \kappa V_t + F_t$
Aggregate Accounting	$C_t^M + I_{Kt} + G_t + N_{Et}(f_R + f_T) = \tilde{w}_t L_t + r_t K_t + N_t d_t$

at 20% and 10%, respectively. The steady state level of government consumption, $\bar{G}$, is set to 22% of steady state GDP. The innovations $\varepsilon_{g,t}$, $\varepsilon_{k,t}$, and $\varepsilon_{n,t}$ are distributed $N(0,\sigma^2_{\varepsilon G})$, $N(0,\sigma^2_{\varepsilon K})$, and $N(0,\sigma^2_{\varepsilon N})$ respectively, and are independent. The persistence parameters are set as follows: ρ_g and ρ_k are set equal to 0.97, ρ_n is set equal to 0.90. These values are in the region of conventional values used in the literature. The standard deviation of innovations are as follows: $\sigma_G = 0.027$, $\sigma_K = 0.037$, and $\sigma_N = 0.037$. Table 3.2 summarizes the model calibration.

Table 3.2: Calibration

Parameter	**Value**
Variety elasticity, σ	3.13
Risk aversion, γ	1
Discount factor, β	0.989
Technological entry cost, f_T	1.59
Regulation entry cost, f_R	1.68
Plant exit, δ	0.009
Investment adjustment cost, ν	1.5
Capital depreciation rate, δ_K	0.025
Capital share, α	0.33
Exogenous separation rate, λ^x	0.025
Matching function elasticity, ε	0.6
Workers' bargaining power, η	0.6
Home Production, h_p	0.38
Matching efficiency, χ	0.43
Vacancy cost, κ	0.12
Lognormal shape, σ_{z_i}	0.147
TFP, persistence, ϕ_Z	0.983
Firing costs, F	0.11
Government consumption, persistence, ρ_g	0.97
Capital income tax, persistence, ρ_k	0.97
Labour income tax, persistence, ρ_n	0.90
TFP, standard deviation, σ_Z	0.009
Government consumption shock, standard deviation, σ_G	0.027
Capital income tax shock, standard deviation, σ_K	0.037
Labour income tax shock, standard deviation, σ_N	0.037

3.4 Fiscal policy shocks and business cycle dynamics

I examine the effects of three fiscal policy shocks, namely, positive shocks to i) government consumption; ii) the labour income tax rate; iii) the capital income tax rate. I also consider the mechanisms at play following the fiscal shocks considered. In addition, I consider whether the effects of fiscal shocks depend on the level of overall regulation in the economy.

For the low regulation economy, I follow the procedure outlined in CF to determine the values for regulation policy parameters. Policy parameters are lowered to their corresponding U.S. levels to determine the low regulation economy equilibrium. Product market regulation in the U.S. economy corresponds to a loss of steady state firm output of 0.54 months, as reported by Pissarides (2003). Firing costs are reduced to zero as in Veracierto (2008) and unemployment benefits are set equal to 57% of the average wage.

As shown by CF, business cycle dynamics following a temporary negative technology shock differs depending on the overall level of regulation in the economy. The authors argue that a highly regulated economy faces more macroeconomic volatility than one with low regulation following a technology shock. This suggests that the macroeconomic effect of exogenous shocks may depend on the overall level of regulation in the economy. It is also likely that the mechanisms by which macroeconomic variables are affected may differ depending on the kind of shock faced.

Figures 3.1 to 3.3 show the impulse responses from positive shocks to government spending, capital income, and labour income tax rates, respectively, under two different scenarios. The solid blue lines show the impulse response when regulation is high. Under this scenario, all three dimensions of regulation are at the Euro Area (EA) level. The dashed red lines show the impulse responses in the low regulation U.S. economy.

Figure 3.1 shows the responses of the two economies to a positive shock to government consumption. The average value of a match declines following the shock which increases firm-level job destruction. In addition, vacancies decline on impact as a result of a fall in firm entry. Ricardian equivalence dictates that households feel poorer following an expansion in government spending. The results show that this causes a decline in investment in product creation. As the return on shares rises, however, so does the entry of new firms as reflected in rising investment in new products. The fall in vacancies and rise in total separations raises unemployment in both economies but by a greater extent in the EA.

Households also reduce investment in capital due to feeling poorer. In addition, the shadow value of capital also falls which has a negative effect on capital investment. Labour market tightness declines steadily in both economies over the horizon shown due to rising unemployment. Declining labour market tightness and marginal productivity of labour have a negative effect on wages. The marginal productivity of labour declines due to a fall in capital accumulation and a decline in new entrants. The fall in firm entry leads to a rise in markups which reduces labour productivity.

The positive government consumption shock produces recessionary effects in both cases. This stands in contrast to results from standard RBC theory. Under the standard RBC setup, a rise in government consumption financed by lump sum taxes leads to a rise in GDP because higher government spending generates a negative wealth effect which causes households to increase their supply of labour and reduce consumption. In the search and matching framework, however, households do not explicitly choose labour supply. The results show that the shock increases job destruction and lowers vacancies which leads to a persistent rise in unemployment. In addition, the fall in wages, as well as, capital and product investment also negatively affect output.

Therefore, the contractions in household spending due to the crowding out effect of government spending on consumption and investment (which in turn negatively affects wages) leads to GDP declining in all economies for the period shown. This crowding out effect affects new product investment by the greatest extent on impact in terms of changes from the steady state. In the economy with high regulation, for example, investment in new products falls by approximately 5% on impact, compared with consumption and investment which fall by approximately 0.58% and 0.2%, respectively.

Figure 3.2 shows the responses to the shock to the capital income tax rate. Although capital investment has a similar response to Figure 3.1, consumption and investment in new products behave differently across the two shocks. Figure 3.2 shows that consumption rises before declining. This is due to a substitution effect. As in the standard RBC model, a higher capital income tax rate causes a decline in capital investment as households substitute towards consumption. The results show that households also substitute towards investment in new products.

Following the shock, investment in new products shows marginal deviation from its steady state value in both economies. Over time, it rises, reaching its peak at about 6 periods following the shock. Consumption falls as new product investment rises and investment in capital recovers. Households redirect resources to financing the entry of new producers. As following a government consumption shock, wages decline over the horizon shown following a shock to the capital income tax rate due to a fall in the job finding probability, labour market tightness and the marginal productivity of labour. The negative effect of the fall in investment and wages on GDP outweighs the positive effect of higher product investment and consumption leading to declining GDP over the horizon.

As in the case of a government spending shock, aggregate vacancies fall on impact following a capital income tax shock. The unemployment rate also shows the same pattern of adjustment as in Figure 3.1. However, the job productivity threshold rises by less compared with a government spending shock so that the rise in the unemployment rate is relatively lower after 20 periods (comparing corresponding economies) following a shock to the capital income tax rate. As in the case of a government consumption shock, the unemployment rate rises by a greater extent in the EA economy.

Figure 3.3 shows the responses to the shock to the labour income tax rate. A rise in the labour income tax rate leads to a decline in capital investment due to the negative effect it has on the marginal productivity of capital. Across the two economies, the marginal productivity of capital falls on impact before recovering after about 4 quarters following the shock. As the marginal productivity of capital rises, so does the shadow value of capital. This leads to a recovery in capital investment. Households initially increase new product investment as consumption and capital investment fall. Households find it initially more profitable to finance firm entry than to invest in capital. However, product investment falls following this initial rise, due to declining share returns, before recovering as the returns start to rise as profits increase.

In contrast to the other shocks, wages rise in both economies following a labour income tax shock. This is partly due to the rise in the marginal productivity of labour. Following the shock, labour market tightness falls. This lowers the cost of posting vacancies which causes firms to destroy more jobs. As the cost of posting vacancies rises, the separation rate falls which causes unemployment to decline. Again unemployment shows a greater rise in the EA economy. The dynamics of wages depend on the labour income tax rate both in the current and in the next period because the tax rate enters into the surplus sharing rule. The wage equation shows that, all else equal, a positive shock to the labour income tax rate in the current period leads to a rise in wages. Following the shock, wages increase and the cost of posting vacancies falls, which generates a rise in the endogenous separation rate, as the negative effect of these changes on the value of a worker to the firm outweighs the positive effect of the rise in the marginal productivity of labour.

In terms of variation in macroeconomic dynamics across economies, the most noticeable difference occurs in the adjustment of the unemployment rate. The results show that compared to an economy with low regulation, a highly regulated economy generates greater unemployment volatility following fiscal shocks. In addition, impulse responses show that the greatest variation across regulation scenarios occurs following a labour income tax shock.

In summary, a positive shock to government spending crowds out consumption and investment in both capital and product creation because households feel poorer leading to a contraction in spending. In the case of a capital income tax shock, there is a short run substitution away from capital investment towards investment in new product creation. Following a labour income tax shock, on the other hand, investment in capital falls in the short run due to a decline in the marginal productivity of capital.

3.5 Discussion and Conclusion

In this chapter, I introduced realistic aspects of fiscal policy into the CF framework to examine the macroeconomic effects of fiscal shocks in economies with low and high regulation, respectively. The CF setup embeds labour market frictions with endogenous job creation and destruction into a dynamic macroeconomic model with endogenous product creation. I consider the propagation mechanisms following shocks to government consumption, the capital income tax rate, and the labour income tax rate, respectively.

The results show that consumption and investment, in capital and new products, fall on impact following a positive shock to government spending. This is consistent with the standard RBC literature. Chugh and Ghironi (2011) also examine the effect of positive shocks to government spending and the labour income tax rate. The authors investigate the effects of these fiscal shocks in a model with endogenous product variety. In contrast to the results presented in this chapter, the authors argue, consistent with standard RBC theory, that GDP

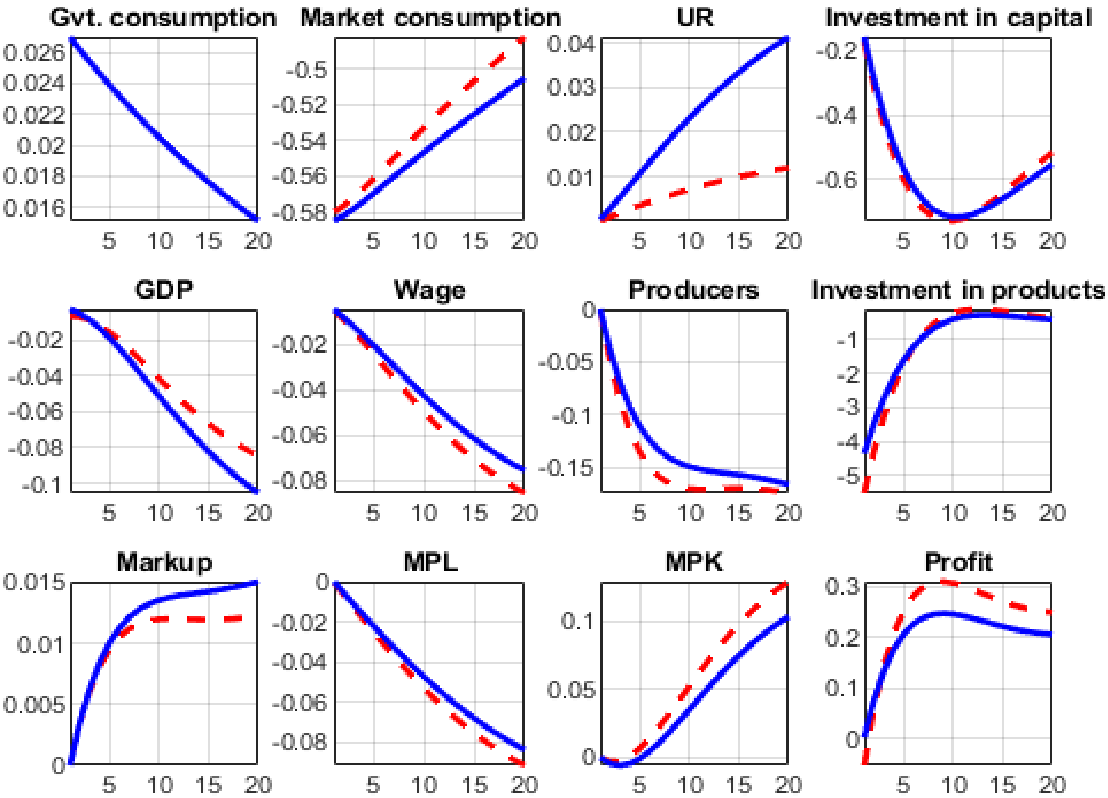


Figure 3.1: Impulse responses, Government consumption shock

Blue line: Rigid economy; *Dashed red line*: Flexible economy.

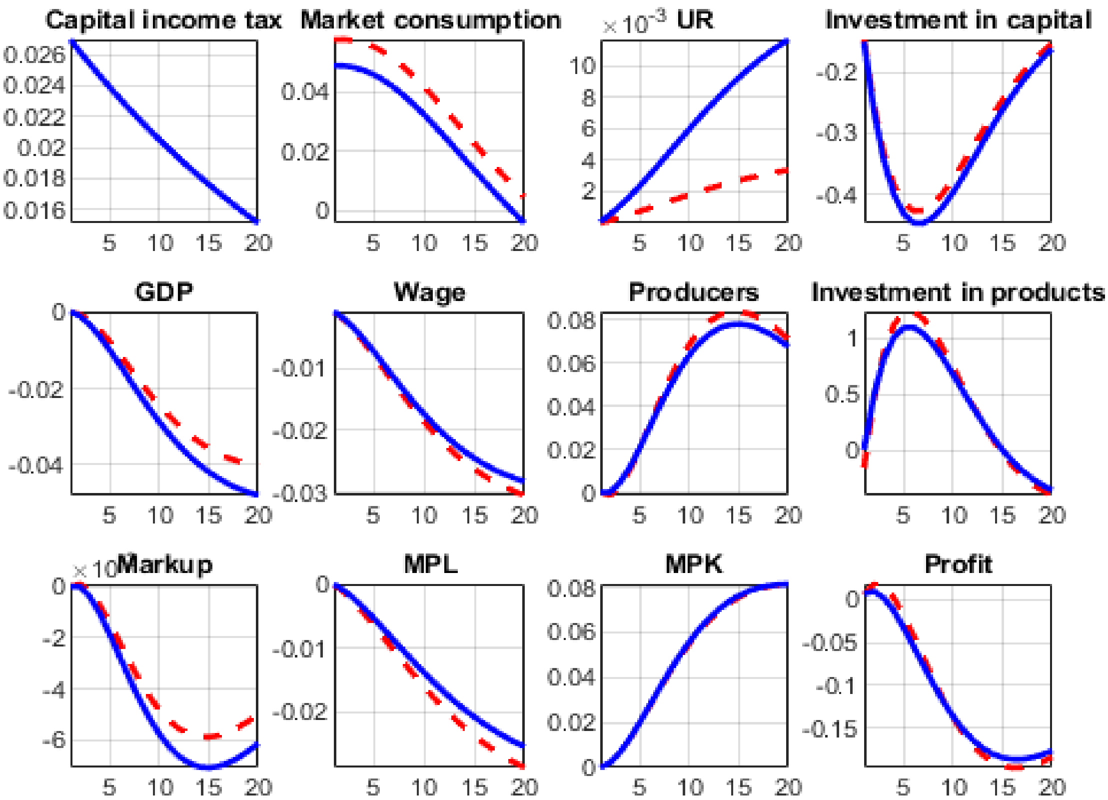


Figure 3.2: Impulse responses, Capital income tax shock

Blue line: Rigid economy; *Dashed red line*: Flexible economy.

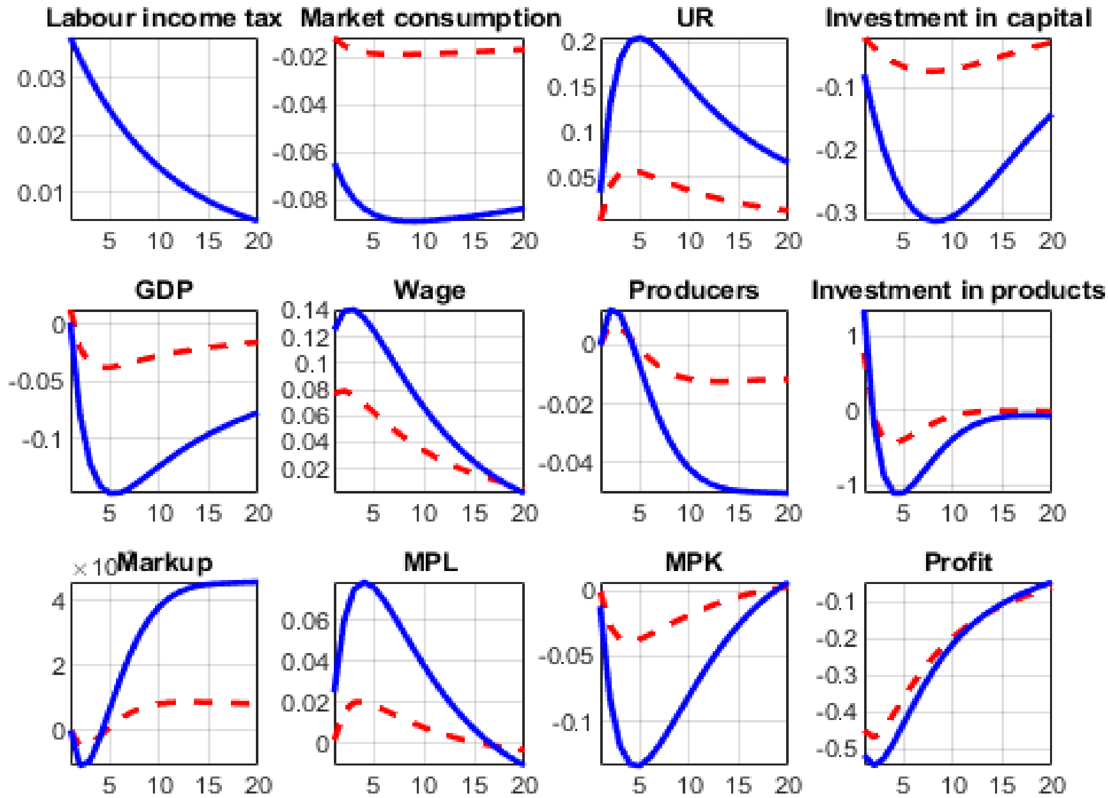


Figure 3.3: Impulse responses, Income tax shock

Blue line: Rigid economy; *Dashed red line*: Flexible economy.

rises following a shock to government spending.

In standard RBC theory and in Chugh and Ghironi (2011), this is due to the negative wealth effect which causes households to work more and consume less following an exogenous rise in government spending. In the CF framework, however, the measure of workers in the household is determined by a labour market matching process which means that the household cannot directly adjust labour supply. In addition, endogenous job creation and job destruction means that job flows are responsive to labour market conditions, which matter for aggregate outcomes.

In addition, in contrast to the results presented in Chugh and Ghironi (2011), product creation falls following an expansion in government spending. As explained by Lewis and Winkler (2017), a strong wealth effect generates positive firm entry and a negative consumption response following an expansion in government spending. The authors also argue that firm entry falls under conditions which reduce the wealth effect including GHH preferences and rule-of-thumb households. The finding in this chapter that entry falls following a positive shock to government spending suggests that when labour supply is determined by a labour market matching process, firm entry also reacts negatively to an expansion in government spending. However, this result deserves further attention.

In the CF framework, a rise in government spending leads to a persistent decline in wages due to entry and capital investment dynamics. In contrast to standard RBC theory, I find that an expansion in government spending has recessionary effects. Positive shocks to the labour and capital income tax rates, respectively, also have a persistently negative effect on output. Following a shock to the capital income tax rate, investment declines and consumption rises on impact. In addition, it has a positive effect on investment in new products. However, GDP declines due to the fall in capital investment and wages. Following a labour income tax shock, unemployment rises significantly in the short run due to a large increase in the wages. Similar to the findings of CF following a negative productivity shock, results show that, following fiscal shocks, unemployment volatility is higher when regulation is high compared with a low regulation economy.

Chapter 4

Optimized unemployment benefits and market deregulation

4.1 Introduction

This chapter examines the macroeconomic and welfare effects of deregulation under an optimized unemployment benefit policy. It also investigates the extent to which the welfare effects of deregulation and transitional adjustment depend on the path of unemployment benefits and whether there is scope for welfare improvements.

It has been argued that the benefit level following deregulation affects job creation and job destruction through the worker's outside option (see, for instance, Cacciatore et al. (2016a)). This is supported by empirical evidence (e.g. Feldstein and Poterba (1984)) which find that wages are responsive to the benefit level through the worker's outside option.

This indicates the assumption about the wage-setting mechanism is important when examining the effects of unemployment benefits. We adopt the real business cycle framework developed by Cacciatore and Fiori (2016), hereafter, CF. This model incorporates labour market frictions, with endogenous job creation and job destruction, à la Mortensen and Pissarides (1994), into the Bilbiie et al. (2012) framework, which features endogenous producer entry. In addition, wage setting follows surplus splitting which makes wages responsive to benefits through the worker's outside option.

Studies have shown that the welfare and macroeconomic effects of market reforms depend on the dimensions of regulation that are being lowered (e.g. Cacciatore et al. (2012), Cacciatore and Fiori (2016)). For example, CF, find that a reduction in barriers to market entry lowers short run welfare more significantly than a reduction in firing costs reflecting the more pronounced short run decline in consumption that follows a reduction in entry barriers.

The authors investigate the macroeconomic and welfare effects of lowering sunk entry costs and firing costs, respectively, in a calibrated model of the Euro Area. Following deregulation, the authors assume that unemployment benefits are immediately changed to their long run levels. In contrast, we examine the implications of optimizing unemployment benefits both in the final equilibrium following deregulation and in transition, respectively. Following Blanchard and Gali (2010), we introduce a disutility of labour term into the utility function to account for the role of employment dynamics on the welfare effects of deregulation.

In order to investigate the relative importance of the transition phases and final equilibria, respectively, for overall welfare following deregulation, we consider three scenarios under which optimization can occur following reform. In the first scenario, unemployment benefits are immediately changed to their optimized steady-state level following deregulation, similar to CF (however, here the final equilibrium is optimized). In the second scenario, unemployment benefits are optimized as the economy transitions to its new equilibrium, but not in the new equilibrium itself. In the final scenario, unemployment benefits are optimized both in transition and in the final steady state.

The key policy change we implement is the introduction of a novel unemployment benefit rule into the framework. Welfare optimization in transition involves implementing an unemployment benefit rule in which parameter values are chosen to maximize the overall welfare effect of deregulation. We consider two variants of the benefit rule which determines the path of unemployment benefits in transition. In the first variant of the rule, the unemployment benefit level depends solely on the pre- and post-deregulation benefit levels. The second variant, on the other hand, includes an additional term which responds to GDP growth. From this version of the rule, we can examine the welfare implications of relating the benefit path to changes in economic conditions. In addition, we can take a step towards answering the question of whether unemployment benefits should vary following deregulation.

Our work is related to the literature exploring the macroeconomic effects of deregulation in models with endogenous producer entry and labour market frictions, including, Cacciatore et al. (2012), Cacciatore and Fiori (2016) and Cacciatore et al. (2016a). It is also related to the literature on the macroeconomic theory of optimal unemployment insurance (UI). Studies in this vein have investigated the optimal cyclical behaviour of unemployment benefits following macroeconomic shocks in models which incorporate the effect of benefit policy on the labour market and firm hiring decisions (e.g. Landais et al. (2010), Mitman and Rabinovich (2011)). Kiley (2003), Andersen and Svarer (2011) and Sanchez (2008), among others, have also investigated whether UI policy should depend on economic conditions. We however depart from work in this area in abstracting from endogenous search intensity and assuming constant job search effort. This allows us to focus on firm behaviour as a key driving force for labour market outcomes and the implications of this mechanism for aggregate outcomes. In addition, we do not explore the insurance incentive trade-off which is often a main theme of the literature.

We find that, following product market deregulation, household consumption in the short run (first 12 periods following deregulation) is largely unresponsive to the level of unemployment benefits. Consumption always falls significantly due to the diversion of resources towards product creation. Unemployment benefit dynamics have a negligible effect on this process with the result that consumption always falls sharply following product market deregulation. Our results show that relating the benefit level to economic conditions improves the welfare effects of deregulation, but only marginally. However, the short run welfare effects of lowering firing costs become positive when the unemployment benefit path is optimized.

The chapter is organized as follows. Section 4.2 presents the model. Calibration of the model is described in Section 4.3. Section 4.4 discusses the results of deregulation with an optimized steady state. Section 4.5 and 4.6 discuss the results for the scenarios which implement the optimized unemployment benefit rule. In section 4.5, optimization occurs in transition. In section 4.6, both the path of unemployment benefits and its steady state level are optimized. Section 4.7 concludes.

4.2 The Model

The general model framework follows Chapter 2 with a few exceptions detailed below. Production follows section 2.2 of Chapter 2, respectively, except for wage determination.

As previously mentioned, the household utility function assumes disutility from working. In addition, depending on the scenario under consideration, unemployment benefits may either be fixed following deregulation or may vary according to the benefit rule discussed below. This will have implications for the dynamics of wages which depend on that of unemployment benefits.

4.2.1 Household preferences

The economy is populated by a unit mass of atomistic households, each composed of a [0,1] continuum of members. The measure of workers who work within the household is not determined by the household but by a labour market matching process. We assume full consumption insurance, so that consumption is the same for employed and unemployed members of the household. Each unemployed worker produces an amount h_p of home production. Following Andolfatto (1996) and Merz (1995), we assume that family members insure each other against variation in labour income that result from changes in employment status so that there is no expost-heterogeneity across individuals within the household. The representative household maximizes the expected intertemporal utility function:

$$\mathbb{E}\,[\Sigma]_{t=0}^{\infty}\,\beta^t(\frac{C_t^{1-\gamma}}{1-\gamma}-\chi\frac{L_t^{1+\phi}}{1+\phi}),\gamma,\chi>0,\phi\geq 0 \tag{4.1}$$

where $\beta \in (0,1)$ is the discount factor, C_t represents the consumption of market and home produced goods, and L_t is the measure of household members that are employed. Following Blanchard and Gali (2010), we introduce a disutility of labour term into the household utility function adopted in CF. This specification is consistent with business cycle models in the literature as it allows for the direct parametrization of the inverse of the Frisch elasticity of labour supply, ϕ. As explained by Blanchard and Gali (2010), the period utility function can also be "micro-founded" as the sum of household members' utilities by assuming that the disutility from working for each member is given by χi^{ϕ}.

The consumption of market goods, ${C_t}^M$ consists of a variety of goods defined over a continuum Ω. At any point in time, a subset of goods, $\Omega_t \in \Omega$ is available. The aggregator ${C_t}^M$ takes a translog form as proposed by Feenstra (2003). As a result, the elasticity of substitution across varieties is a function of the number of goods available. Translog preferences are represented by the unit expenditure function which is equal to the price index. The unit expenditure function of a basket of goods ${C_t}^M$ is given by:

$$\ln(P_t) = \frac{1}{2\sigma}(\frac{1}{N_t} - \frac{1}{\tilde{N}}) + \frac{1}{N_t}\int_{\omega\in\Omega_t} \ln(p_{\omega t})d\omega + \frac{\sigma}{2N_t}\int_{\omega\in\Omega_t}\int_{\omega'\in\Omega_t} \ln(p_{\omega t})(\ln(p_{\omega t}) - \ln(p_{\omega' t}))d\omega d\omega', \tag{4.2}$$

where σ represents the price-elasticity of the spending share on an individual good, and P_t is the welfare based price index. N_t is the measure of the set Ω_t. Household consumption C_t is given by $C_t = {C_t}^M + (1 - L_t)h_p$.

4.2.2 Wage setting

Wage setting follows Krause and Lubik (2007). Workers and firms bargain over the match surplus (the sum of the gains to the worker from employment and to the firm employing the worker). The exogenous bargaining weight $\eta \in (0, 1)$ determines the workers' bargaining power. The average wage is a weighted average of the average marginal revenue of labour (plus a firing cost term) and the worker's outside option. It is given by:

$$\tilde{w}_{\omega t} = \eta[\tilde{\pi}_{\omega t} + [1 - (1 - \delta)(1 - \lambda^x)E_t\beta_{t,t-1}]F] + (1 - \eta)\varpi_t \tag{4.3}$$

The worker's outside option, corresponding to the value of unemployment, is given by the following expression:

$$\varpi_t \equiv h_p + ub_t + \int_{\omega\subset\Omega_t}^{\infty} s_t \frac{v_{\omega t}}{V_t} E_t[\tilde{\beta}_{t,t-1}(1 - G(z^c_{\omega t+1}))\tilde{\Delta}^W_{\omega t+1}]d\omega, \tag{4.4}$$

where ub_t are lump-sum financed unemployment benefits from the government in units of the consumption basket. The worker's outside option also depends on home production, h_p, and the expected discounted value of searching for other jobs, the third term in the expression.

Under the scenarios where unemployment benefits are assumed to be constant following deregulation, wages are a function of a constant ub_t. However, when unemployment benefits are allowed to vary over time, it does so according to a rule. The unemployment benefit rule allows for a smooth transition in unemployment benefits between its initial and final steady state values. We consider two variants of the rule, where the second variant nests the first, as discussed further below. Time-varying ub_t evolves according to the following rule:

$$ub_t = (\alpha ub_t) * ub_f + (1 - \alpha ub_t) * ub_i + \phi_p ln(\frac{gdp_t}{gdp_{t-1}}) \tag{4.5}$$

where,

$$\alpha ub_t = \alpha ub_f - \alpha P * (\alpha ub_f - \alpha ub_{t-1}) \tag{4.6}$$

αub_t is a time varying coefficient determining the weight assigned to the initial (before deregulation) and final (after deregulation) steady state levels of unemployment benefits. The initial and final unemployment benefit steady state values are given by ub_i and ub_f, respectively. αub_t is initialized at αub_i and αub_f is its terminal value.

ϕ_p determines the direction and strength of the relationship between unemployment benefits and GDP growth, all else equal. It determines whether the level of unemployment benefits adjusts positively or negatively with changes in GDP in any given period and the degree of responsiveness. In the first variant of the rule, ϕ_p is set equal to zero, such that the third term in (4.5) disappears. This means that the sequence of unemployment benefits are determined solely by the time varying parameter αub_t and the steady state benefit levels. In the second variant of the rule, the third term in included as a determinant of the evolution of unemployment benefits. The choice of parameter values related to the rule follows an optimization process discussed further below. gdp_t and gdp_{t-1} are GDP at time t and t-1 respectively, which appear in the second variant of the benefit rule.

αP is the parameter which determines the evolution of αub_t from its initial to its final steady state value. We restrict its value to lie between 0 and 1 so that αub_t also lies within this range. The closer αP is to 1, the longer it takes for αub_t to reach its final steady state value. The values of αP and ϕ_p are chosen such that the overall welfare effect of deregulation is maximized.

The unemployment benefit rule also embeds the assumption about unemployment benefits adopted by CF, where the benefit level is fixed at its final equilibrium value following deregulation. If αP and ϕ_p are equal to zero, then αub_t is equal to αub_f and unemployment benefits are equal to their their final steady state value ub_f.

4.2.3 Equilibrium

The elasticity of substitution across varieties in the symmetric equilibrium is given by: $\Theta_t = 1+\sigma N_t$. Aggregate employment can be written as: $L_t = N_t L_t$. Aggregate vacancies is given by the sum of vacancy postings by existing firms and new entrants: $V_t = (N_t + N_{Et})v_t + N_{Et}l_t/q_t$. The law of motion of aggregate employment can be written as:

$$L_t = (1-\delta)(1-\lambda^x)[1-G(z_t^c)][L_{t-1} + q_{t-1}V_{t-1}] \tag{4.7}$$

The aggregate resource constraint can be expressed as:

$$Y_t = C_t^M + I_{Kt} + N_{Et}(f_R + f_E) + \kappa V_t + F_t, \tag{4.8}$$

where F_t denotes aggregate firing costs. The main model equations are summarized in Table 4.1. The model scenario with non-varying unemployment benefits features 10 endogenous variables: C_t, ρ_t, N_{t+1}, L_t, V_t, M_t, z_t^c, K_{t+1}, I_{Kt}, ξ_{Kt}. ub_t is also an endogenous variable under the scenarios of the model where benefits are optimized in transition. In the non-optimized scenario, where unemployment benefits are determined following CF, ub is treated as a policy variable along with barriers to market entry, f_R and firing restrictions, F, respectively. This is discussed further below. Aggregate productivity Z_t is exogenously determined. In model scenarios where the unemployment benefit rule (4.5) is in effect, αub_t is also exogenously determined.

4.3 Calibration

The decision rules which determine the present and future values of model variables are solved for numerically given the non-linear nature of the equilibrium conditions. Periods are interpreted as quarters. Parameter values are taken from CF, where appropriate. The authors parameterize their model to match the Euro Area economy over the period 1995:Q1 to 2013:Q1. As is standard in the business cycle literature, the discount factor, β, is set to 0.99, risk aversion, γ to 1, the share parameter on capital in the Cobb-Douglas production function, α, to 0.33, and the capital depreciation rate, δ_k, to 0.025. The value for the preference weight for leisure in the utility function, χ, is a new parameter introduced into the CF utility function. χ and the exogenous separation rate, λ^x, are chosen to match the total separation rate, λ^{tot}, of 0.036 and the unemployment rate of 0.095. The values for these variables are set to 0.878 and 0.025, respectively. The inverse of the Frisch elasticity of labour supply, ϕ, a feature of the disutility of labour term in the utility function, is set to 1 following Blanchard and Gali (2010).

Table 4.1: Model Summary

Adjusted Discount Factor	$\beta_{t,t+1} = \beta(\frac{C_{t+1}}{C_t})^{-\gamma}$
Firm-level job separation	$\lambda_t = \lambda^x + (1-\lambda^x)G({z_t}^c)$
Law of motion of aggregate employment	$(1-\lambda_t)(1-\delta)(L_{t-1} + q(\theta_{t-1})V_{t-1})$
Aggregate Unemployment	$U_t = (1 - L_t)$
Vacancies by entrants	$v_t^e = (l_t + q_t v_t)/q_t$
Aggregate matching function	$M_t = \chi(1-L_t)^{\varepsilon} V_t^{-\varepsilon}$
Probability of filling a vacancy	$q_t = M_t/V_t$
Market tightness	$\theta_t = V_t/U_t$
Job finding probability	$s_t = M_t/U_t$
Pricing	$\rho_t = \mu_t \varphi_t$
Markup	$\mu_t(N_t) = \mu_t = 1 + \frac{1}{\sigma N_t}$
Variety effect	$\rho_t = e^{-\frac{\tilde{N} - N_t}{2\sigma \tilde{N} N_t}}$
Profits	$d = (1 - \frac{1}{\mu_t})\frac{Y_t}{N_t} + \psi_t l_t - \kappa(v_t + \frac{l_t}{q_t}) - [\frac{G({z_t}^c)}{1-G({z_t}^c)}]$
Free entry	$v_t = f_{E,t}$, where $f_{E,t} = f_R + f_T + \kappa {v^e}_t$
Number of firms	$N_t = (1-\delta)(N_{t-1} + N_{Et-1})$
Euler equation (shares)	$v_t = (1-\delta)E_t\beta_{t,t+1}(v_{t+1} + d_{t+1})$
Aggregate Output	$Y_t = C_t^M + I_{Kt} + N_{Et}(f_R + f_T) + \kappa V_t + F_t$
Aggregate Accounting	$C_t^M + I_{Kt} + N_{Et}(f_R + f_T) = \tilde{w}_t L_t + r_t K_t + N_t d_t$

The firm exit rate, δ, is set equal to 0.25. In calibrating the regulation-related entry cost, f_R, the authors convert the index for entry delay into months of lost output. Following this procedure, the aggregate cost of entry is 1.98% of GDP. The technological entry cost, F_T, is calibrated such that the aggregate cost of this entry cost component is 1.87% of GDP. We set the price-elasticity of spending share on an individual good, σ, such that the markup is 10%. The implied elasticity of substitution is 11. The elasticity of matches to unemployment, ε, is set to 0.6. The model is calibrated so that the Hosios condition is satisfied, that is, the parameter governing worker bargaining power is set equal to the elasticity of matches to unemployment, $\eta = \varepsilon$. Home production, h_p, is set to 0.38 and the vacancy cost, κ, is set to 0.13. Firing costs, F, are set to 0.11. These values are taken from CF. The probability of filling a vacancy, q, is set to 0.6.

As is standard in the literature, the standard deviation of the technology shock, σ_Z, and the autoregressive parameter, ϕ_Z, are set to 0.009 and 0.98, respectively. The remaining model parameters are calibrated to match CF. The lognormnal scale, μ_{zi}, and the shape parameter, σ_{zi}, are set equal to zero and 0.14, respectively. The investment adjustment cost, ν, is equal to 1.5. αub_i is set to 0, while αub_f is set equal to 1 consistent with the final steady state value of unemployment benefits, ub_f, being reached. Table 4.2 summarizes the model calibration.

4.4 Market deregulation: transition dynamics and welfare

We examine the effects of a permanent decline in the sunk costs of market entry and firing costs, respectively, to the levels that obtain in the U.S, under perfect foresight. As in CF, transitional dynamics following reform are found using the Newton-Rhapson method, as described in Laffargue (1990) [1]. Product market regulation in the U.S. involves a loss of steady state firm output of 0.54 months, as reported by Pissarides (2003). Following labour market deregulation, firing costs are reduced to zero as in Veracierto (2008).

Before examining the impact of deregulation, we detail the different scenarios considered with respect to the optimization of the final post-deregulation steady state and of unemployment benefits in transition, respectively. In the model, optimization of unemployment benefits can occur along two dimensions. Firstly, it can occur in the final steady state, the new equilibrium of the economy following deregulation. In this case, the unemployment rate in the

[1]We would like to thank the authors for making available the codes to execute this routine.

Table 4.2: Calibration

Parameter	**Value**
Variety elasticity, σ	3.13
Risk aversion, γ	1
Inverse Frisch ϕ	1
Discount factor, β	0.989
Technological entry cost, f_T	1.67
Regulation entry cost, f_R	1.77
Plant exit, δ	0.009
Investment adjustment cost, ν	1.5
Capital depreciation rate, δ_K	0.025
Capital share, α	0.33
Exogenous separation rate, λ^x	0.025
Matching function elasticity, ε	0.6
Workers' bargaining power, η	0.6
Home Production, h_p	0.38
Matching efficiency, χ	0.43
Vacancy cost, κ	0.13
Lognormal shape, σ_{z_i}	0.147
TFP, persistence ϕ_Z	0.983
Firing costs, F	0.11
TFP, standard deviation σ_Z	0.009
chi, χ	0.88

final equilibrium is chosen so as to maximize steady state welfare, given the constraints of the model and the level of regulation parameters post-deregulation. We refer to the final steady state level of unemployment benefits derived from this optimization process as the optimized benefit level. Secondly, optimization can also occur during transition, as the economy adjusts to its new post-deregulation steady state. This creates four scenarios of interest for which transition dynamics and welfare can be considered: (i) optimization does not occur along either dimension; (ii) optimization occurs in the final steady state only; (iii) optimization occurs in transition only; (iv) optimization occurs along both dimensions, that is, both in the final steady state and in transition.

Both the final steady state and the transition dynamics of unemployment benefits affect the transitional adjustment of model variables following deregulation as will be further discussed below. We examine two scenarios for the final steady state level of unemployment benefits which depend on whether or not final steady state welfare is maximized. In (i), optimization does not occur along any dimension. Unemployment benefits in transition are equal to their final steady state level which is determined by a fixed benefit replacement rate of 62% à la CF. In (ii) and (iv), respectively, the post-deregulation benefit level is fixed at its optimized value.

Under (iii) and (iv), unemployment benefits are optimized in transition (in contrast to (i) and (ii)). In the optimized transition scenario, unemployment benefits vary in transition in an optimized way. This is achieved by calibrating the value of αP and ϕ_p (in the second variant of the benefit rule) in (4.6) and (4.5), respectively, to maximize household welfare following deregulation. Welfare is defined as the percentage increase in steady state consumption Δ which would make the household indifferent between adopting a particular reform and not adopting it, keeping the level of regulation at the initial steady state level.

4.4.1 Optimized steady state: transitional adjustment and welfare following deregulation

In this section, we examine the transitional adjustment and welfare outcomes following deregulation associated with an optimized final steady state, and the corresponding benefit replacement rates and unemployment benefit levels (scenario (ii) above). Following deregulation, unemployment benefits in transition are fixed at their optimized final steady state level. However, as mentioned above, the final steady state is determined by choosing the steady state unemployment rate which maximizes welfare subject to the model constraints and the corresponding U.S. level of regulation. We compare transition dynamics and welfare under this scenario with (i) where unemployment benefits are fixed in transition at their non-optimized final steady state level.

Using the above methodology to determine the optimized steady state, we find that the final steady state welfare maximizing benefit replacement rates following product and labour market deregulation are 0.58 and 0.60, respectively. These values correspond to unemployment benefit levels of 1.071 and 1.041, respectively. The pre-deregulation benefit level and replacement rate are 1.066 and 0.62, respectively. Both values of the replacement rate following deregulation are below the initial steady state benefit replacement rate (which coincides with the post-deregulation steady state in the non-optimized steady state). Therefore, final steady state optimization prescribes a decline in the long run benefit replacement rates. In the case of product market deregulation, there is a marginal rise in the unemployment benefit level from its pre-deregulation value. In contrast, the decline in the replacement rate following labour market deregulation implies a fall in the benefit level. These differences are due to differences in the dynamics of the long run real wage. Following product market deregulation, long run real wages rise which generate higher unemployment benefits in contrast to labour market deregulation where there is a decline in real wages.

The optimized steady state scenarios discussed above share some similarity with the joint deregulation exercise considered by CF which involved lowering all three dimensions of regulation simultaneously. The main difference here is that the replacement rate in the final equilibrium is fixed at a level consistent with welfare maximization in the post-deregulation steady state. In contrast, the replacement rate in the final equilibrium following joint deregulation is not optimized in CF. In addition, here, we consider a reduction in two policy variables to focus on the effects of the sequence of unemployment benefits on individual reforms. We consider joint deregulation in the form of: 1) a reduction in sunk entry costs to its corresponding U.S. level and the replacement rate to its optimized value of 58% in the final equilibrium; 2) a reduction in firing costs to its corresponding U.S. level and the replacement rate to its optimized value of 60% in the final equilibrium. We examine transition dynamics following 1) and 2), respectively. We compare this with the corresponding non-optimized scenario where the replacement rate in the final equilibrium remains at 62%.

Figure 4.1 plots the dynamic adjustment following product market deregulation under the optimized steady state scenario (red dash-dotted line). It also shows transition dynamics for the non-optimized CF scenario (solid blue line). Compared with the optimized steady state scenario, unemployment benefits rise considerably higher in the non-optimized scenario following deregulation (3.8% versus 0.5% from its pre-deregulation level). Differences in the dynamic adjustment to market deregulation across the two scenarios are most noticeable in the adjustment of labour market variables. Lower unemployment benefits generate lower wages by lowering workers' outside option following product market deregulation. Unemployment is also lower because firms destroy fewer jobs.

CF examine the effects of market deregulation under the same assumptions adopted for the non-optimized steady state scenario. The authors explain that slow job creation by new firms and the destruction of unproductive matches by incumbent firms leads to a rise in unemployment in the short-run. The authors also find that there is a short run decline in consumption and investment in physical capital by households due to the reallocation of resources to finance the creation of new products.

We find a similar short run decline in the optimized steady state case. There is only a marginal difference in the dynamics of consumption and investment, particularly in the short run. This occurs because the return from product creation, and therefore entry dynamics, are largely unaffected by the dynamics of labour market variables. This can be seen from the similar adjustment patterns in product investment. Higher employment under the optimized steady state scenario generates slightly greater marginal productivity of capital, and in turn capital investment, relative to the non-optimized steady state scenario, for the period shown. Wage income is also marginally higher under the optimized scenario. However, this has only a negligible effect on household income, and therefore consumption. The results show that for consumption, lower unemployment benefits matter more for dynamics in the medium to long run, albeit, marginally. In contrast, it matters more significantly for GDP and unemployment both in the short and long run.

By conducting policy experiments which involve a comparison across the three scenarios mentioned: the joint deregulation (optimized steady state) case, the joint deregulation case presented in CF, and the non-optimized steady state case, respectively, some noteworthy observations can be made. Firstly, a lower unemployment benefit level following product market deregulation is associated with a lower unemployment rate and higher GDP, both in the short and long run. We make similar findings for investment in physical capital. Capital investment is positively related to the level of employment, both in the short and long run. Secondly, the similarity in transition dynamics across the two scenarios for short run consumption and investment in new products, on the other hand, show that the dynamics of these variables are largely driven by changes in the competitive environment, and to a much lesser extent by the benefit level or firing costs. In addition, higher wages from higher unemployment benefits are associated with lower consumption levels because unemployment also rises, leading to a decline in household income.

Table 4.3 shows the welfare gains/losses that ensue from product market deregulation under the two scenarios. Although medium to long run (the 13th quarter onwards) welfare is slightly higher under the optimized scenario, overall welfare is lower (1.34% versus 1.42%). This is because the short run welfare loss is greater under the optimized scenario. The reason for this is that, in the short run, the disutility from working outweighs the positive welfare effect of the marginally higher consumption levels in the optimized scenario. This result implies that short run consumption needs to be higher than it is under the optimized scenario, all else equal, for overall welfare gains to materialize relative to the non-optimized steady state.

Figure 4.2 shows the impulse responses from labour market deregulation under the optimized (red dash-dotted line) and non-optimized (solid blue line) scenarios. Under the non-optimized scenario, unemployment benefits rise by 0.03%. It falls by 2.33% under the optimized scenario. Investment in capital is much higher under the optimized steady state scenario, particularly in the long run. This can be explained by the higher marginal productivity of capital under the optimized scenario owing to higher employment following deregulation. New product investment also falls by a larger extent on impact relative to its steady state level in the optimized model because the differential return between investing in capital and shares is higher under the optimized scenario. However, by the third period, new product investment is higher in the non-optimized case as the return on shares rises.

In contrast to Figure 4.1, consumption is noticeably higher in the optimized model compared with the non-optimized model. There is an initial decline in consumption in the non-optimized model. In contrast, consumption is positive following deregulation in the optimized model. This is because a lower wage rate from lower unemployment benefits reduces the measure of jobs which are destroyed due to the fall in firing costs such that although there is an initial rise in unemployment in the optimized model, unemployment rises by a lesser extent than in the non-optimized model. The unemployment rate in the optimized steady state model is significantly lower both in the short and long run. There is only a short lived decline in GDP in the optimized steady state model, which is much higher due to higher aggregate demand.

Following policy experiments similar to those carried out in case of product market deregulation, some important observations can also be made about how the benefit level affects macroeconomic outcomes following labour market deregulation. Similar to findings following product market deregulation, unemployment in the short and long run is decreasing in the benefit level, which is also reflected in the adjustment of GDP. In addition, capital investment is rising in the employment rate due to increasing returns from investment.

Welfare results are similar to findings following product market deregulation in that labour market deregulation entails a short run welfare loss and overall welfare is lower under the optimized scenario. However, the overall welfare effect of labour market deregulation is negative under the optimized steady state scenario in contrast to the corresponding case under product market deregulation. We find that short run welfare loses are greater under the optimized steady state scenario compared with the non-optimized steady state (0.45% versus 0.013% loss, respectively), although consumption is higher throughout in the optimized model. Short run employment rises too rapidly relative to consumption in the optimized model which generates a short run welfare loss.

Only in the medium to long run does the welfare gain from consumption outweigh the loss from employment. Medium to long run welfare is greater in the optimized steady state model (0.33% versus 0.06%). However, overall welfare is lower because the medium to long run welfare gain is outweighed by lower short run welfare. The results presented in this section imply that higher short run consumption, lower short run employment, or both, all else equal, are required for deregulation under the optimized scenario to generate better overall welfare outcomes relative to the non-optimized scenario.

4.5 Optimized transition: transitional adjustment and welfare following deregulation

In sections 4.5 and 4.6, we examine the macroeconomic effects of deregulation when the sequence of unemployment benefits in transition are determined by an optimized rule. We consider two scenarios. In the first scenario, discussed in this section, unemployment benefits

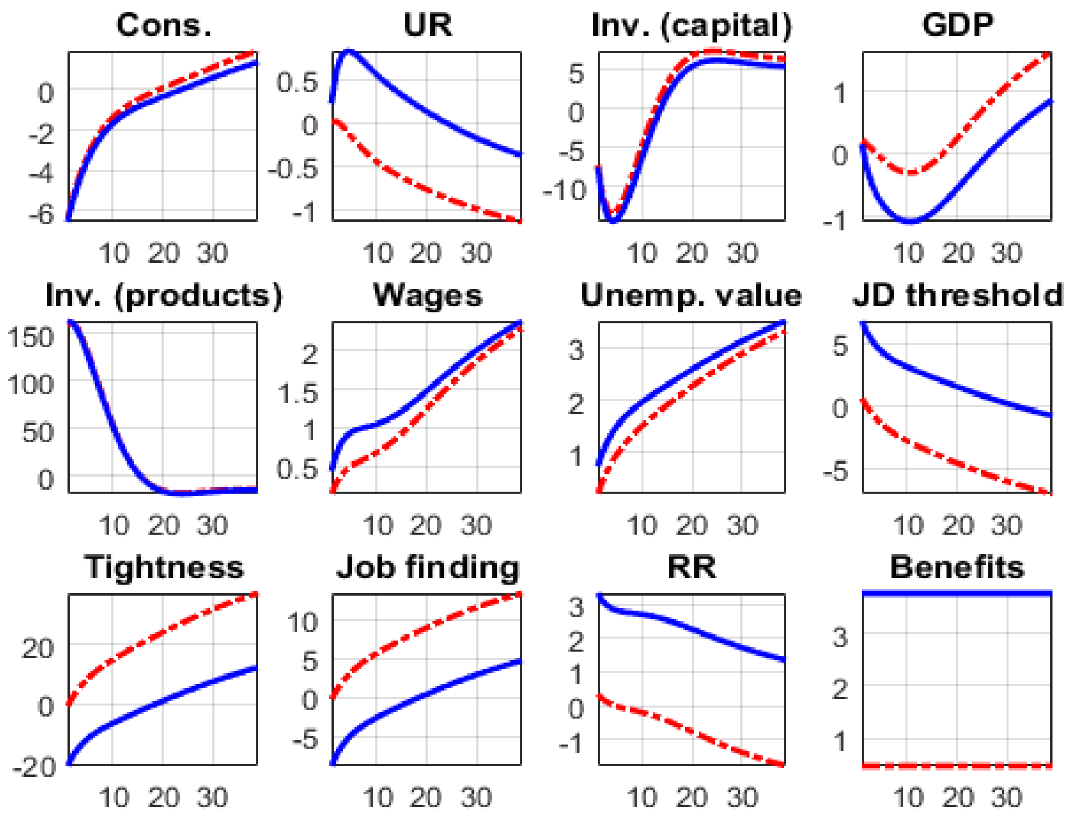


Figure 4.1: Impulse responses, sunk entry cost reduction

Solid blue line: Unemployment benefit level following product market deregulation not optimized; *Dash-dotted red line*: Unemployment benefits following product market deregulation fixed at optimized level.

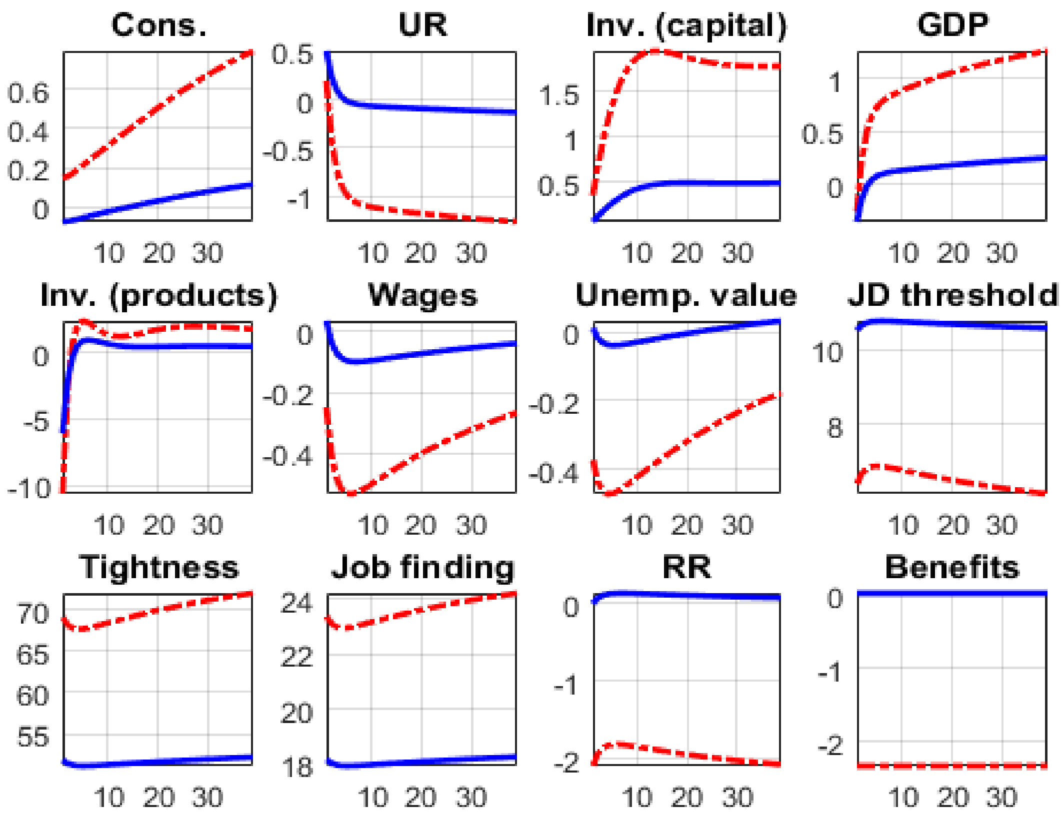


Figure 4.2: Impulse responses, firing cost reduction

Solid blue line: Unemployment benefit level following labour market deregulation not optimized; *Dash-dotted red line*: Unemployment benefits following labour market deregulation fixed at optimized level.

are optimized in transition alone. That is, as in the non-optimized model, the final steady state following deregulation is not optimized. In the second scenario, optimization occurs both in transition and in the final steady state - this is discussed in the next section.

4.5.1 Product market deregulation

We find that overall welfare cannot be improved following product market deregulation by allowing unemployment benefits to vary using the first variant of the rule. That is, under the fist variant of the rule, welfare is optimized when unemployment benefits are fixed at the (non-optimized) final steady state level following deregulation - αP equal to zero.

The blue line in Figure 4.3 shows transition dynamics following product market deregulation for the non-optimized case which coincides with the optimized transition scenario under the first variant of the benefit rule. The dash-dotted red line shows the impulse responses following product market deregulation for αP equal to 0.95 in the first variant of the rule. We compare transition dynamics under these two policies to more closely examine the mechanisms behind the effect of the unemployment benefit sequence on aggregate dynamics and welfare following product market deregulation. Figure 4.3 shows that a rising benefit sequence can be associated with a declining unemployment rate. Endogenous job destruction is lower than in the non-optimized scenario for the period shown (as in Figure 4.1) following deregulation when αP is equal to 0.95 because wages are lower relative to the non-optimized steady state for most of the periods shown.

As unemployment benefits rise, however, unemployment declines less steeply compared with the optimized steady state scenario shown in Figure 4.1. Figure 4.3 suggests that an initial large rise in unemployment benefits following deregulation leads to a large rise in unemployment via its effect on wages compared with when that rise is gradual. Figures 4.1 and 4.3 show that the magnitude of the rise in unemployment benefits following deregulation matters for the dynamics of unemployment both in the short and long run. Figure 4.3 also confirms that the path of unemployment benefits in the short run has a very negligible effect on the dynamics of short run consumption. In the long run however, a lower unemployment benefit level is associated with higher consumption. Comparing the optimized scenario shown in Figure 4.1 with the rising unemployment benefit scenario shown in Figure 4.3, we find that the lower medium to long run unemployment benefits are, the higher consumption is over this period due to the positive effect of higher employment over this period on household income. However, for the sequences of unemployment benefits considered, consumption varies only marginally across scenarios. This is because the difference in the adjustment of household income is marginal. In addition, the adjustment of new product investment is also largely similar across scenarios such that the amount of resources being diverted to product creation is almost identical in both cases.

We find that the short run welfare loss is increasing in the value of αP where as the medium to long run welfare gain is increasing. Short run welfare loss is rising because the average unemployment rate is lower the higher is αP as this prescribes a greater weight on the (lower) final steady unemployment benefit level. In addition, short run consumption does not increase sufficiently to increase short run welfare. When αP is equal to 0.95, the short run welfare loss from deregulation is 3.05% compared with 2.68% in the non-optimized scenario. The medium to long run welfare gain when αP is 0.95, on the other hand, is 4.45%. In the non-optimized scenario, this value is 4.11%. Because the short run welfare losses outweigh the medium to long run welfare gains when αP is greater than zero, overall welfare is lower.

The next part of the analysis incorporates the last term in the unemployment benefit rule (4.5), i.e., the second variant of the rule. We determine the values for αP and ϕ_p for which overall welfare is optimized. As under the first variant of the rule, the optimized value of αP is found to be zero. The optimized value of ϕ_p, the parameter governing the cyclicality of unemployment benefits, is equal to 117. These values mean that the optimized sequence of unemployment benefits are related only to the final steady state benefit level (which is higher than the initial value) and have a procyclical component. The impulse responses under the second variant of the rule are shown in Figure 4.4 (solid green line). The dash-dotted red lines show the impulse responses for the optimized transition/non-optimized steady state scenario. First we discuss the effect of introducing the GDP term into the rule on transitional adjustment before examining the welfare implications.

Incorporating the third term into the benefit rule generates a much larger rise in the unemployment benefit level relative to the steady state following a reduction in sunk entry costs. This occurs because the responsiveness of the unemployment benefit level to GDP growth is fairly high - the value of ϕ_p implies that the third term in (4.5) is 117 times larger than the log deviation of GDP. This is reflected in a higher unemployment rate on impact compared with the non-optimized transition scenario. However as GDP declines, benefits also decline sharply before steadily recovering. The benefit level under the second variant of the benefit rule rises above its value in the non-optimized scenario after 13 periods. The unemployment rate also reacts contemporaneously, rising above its rate in the non-optimized scenario in the same period. The higher medium to long run unemployment rate has a negative effect on GDP which falls below that in the non-optimized scenario in the next period.

As shown in Table 4.3, including a GDP growth term into the benefit rule improves overall welfare, albeit marginally. Household welfare is lower in the short run because the employment rate is higher over this period, where as consumption is marginally lower relative to the non-optimized scenario. In the medium to long run, however, household welfare is marginally higher as the welfare loss from lower consumption is outweighed by the gain from lower employment - which coincides with a higher consumption of leisure in the model. This leads to an overall welfare gain relative to the non-optimized steady state scenario.

4.5.2 Labour market deregulation

As in the case of product market deregulation, unemployment benefit optimization following labour market deregulation, prescribes an αP value of zero. That is, fixing the unemployment benefit level in transition at the post-labour market deregulation unemployment benefit level, which is only 0.02% higher than its pre-deregulation level. Because these values are very close to each another, the adjustment of labour market and aggregate variables show a negligible dependence on the dynamics of unemployment benefits. This is shown in Figure C.1 in the appendix which corresponds to Figure 4.3 for the case of labour market deregulation.

Figure 4.5 shows the impulse responses with the second variant of the benefit rule. The results shown are for αP equal to zero and a value of ϕ_p of 69. These are the values at which overall welfare effect of a reduction in firing costs is maximized. As in the case of product market deregulation, the second variant of the rule prescribes an unemployment benefit path which is unrelated to the initial steady state value of unemployment benefits. In addition, the rule prescribes a strongly procyclical component to the benefit level in each period.

The second variant of the optimized rule generates a decline in unemployment benefits on impact, following the decline in GDP. It then rises above its final steady state value as GDP recovers. Wages also fall on impact given the decline in unemployment benefits, and therefore, workers' outside option. The initial decline in unemployment benefits generates a

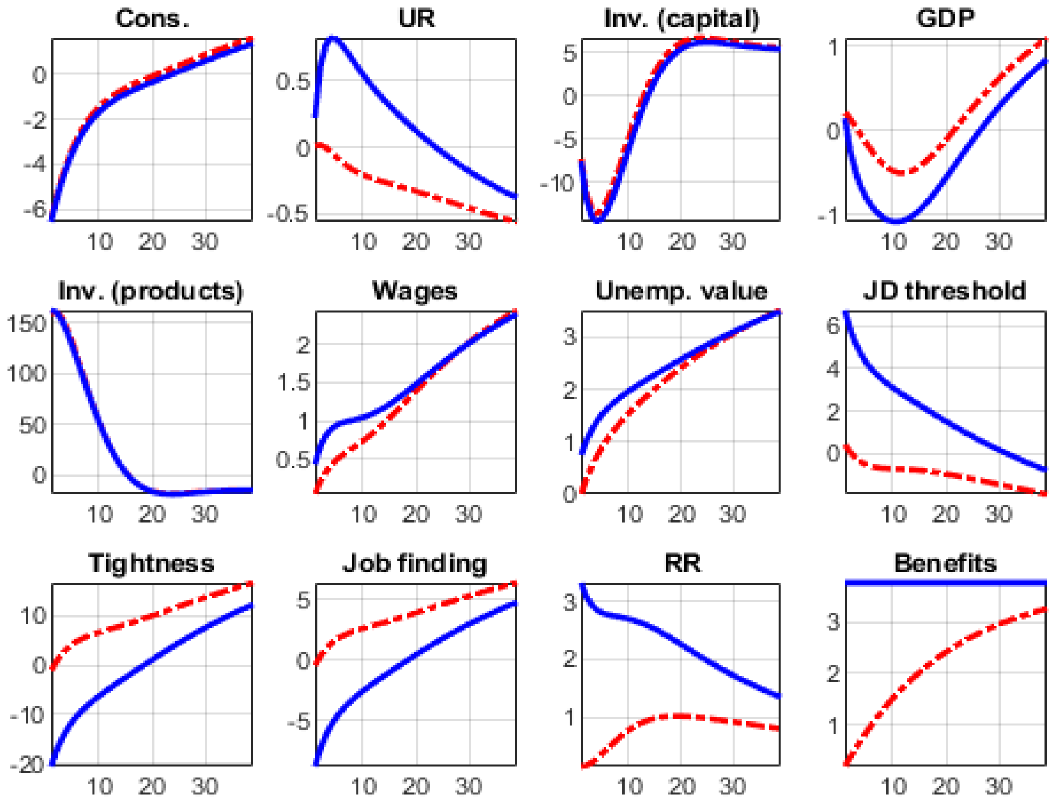


Figure 4.3: Impulse responses, sunk entry cost reduction

Steady state not optimized. *Red dash-dotted line*: αP in first variant of unemployment benefit rule equal to 0.95; *Blue line*: non-time varying unemployment benefit sequence as prescribed by first variant of unemployment benefit rule.

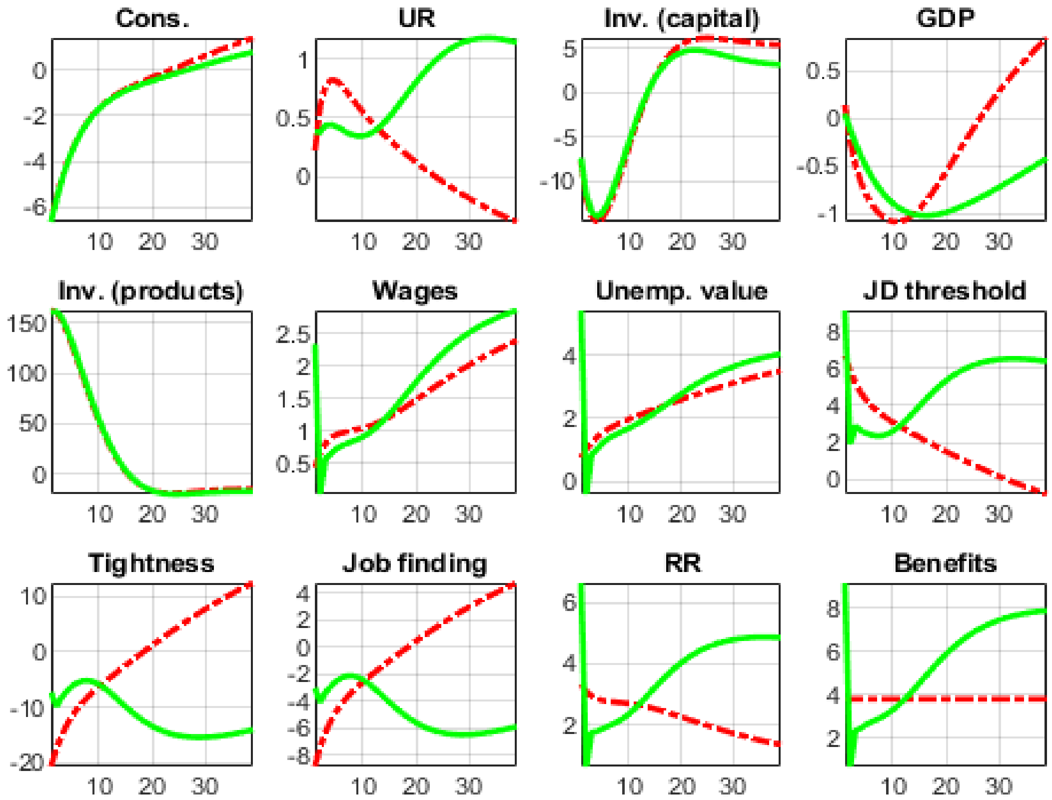


Figure 4.4: Impulse responses, sunk entry cost reduction

Steady state not optimized. *Red dash-dotted line*: Optimized transition (coincides with the non-optimized steady state scenario); *Green line*: optimized unemployment benefit rule with a GDP growth component.

lower rise in the unemployment rate from steady state on impact. However, the employment rate under the second variant of the rule remains below that in the non-optimized steady state scenario thereafter for the time period shown, as does GDP. Consumption and investment are also lower for the duration shown. Although unemployment is initially lower under the second variant of the rule, this does not translate into higher consumption. This is because wage income actually falls on impact because of the fall in wages. Higher income from share holdings and dividends in the non-optimized steady state also lead to higher household income which stimulates consumption.

The optimized parameters under the second variant of the rule generate higher overall welfare. This comes from short run welfare gains outweighing the medium to long run welfare loss relative to the non-optimized steady state scenario. The overall welfare gain from deregulation is 0.07% under the second variant of the rule, whereas in the non-optimized steady state, the welfare gain is 0.05%.

4.6 Optimized transition and steady state: transitional adjustment and welfare following deregulation

In the previous sections, optimization was considered along only one dimension, in the steady state or in transition respectively. In the case of optimization in transition, we examined the effect of implementing two variants of the unemployment benefit rule - with and without the third term in (4.5). In this section, we examine the effects of deregulation when optimization occurs along both dimensions, that is, both in transition and in the final equilibrium, under both variants of the benefit rule. By this we are able to investigate the extent to which optimization along both dimensions matters for welfare outcomes.

4.6.1 Product market deregulation

We find that welfare optimization along both dimensions following a reduction in sunk entry costs occurs when unemployment benefits are fixed at their post-deregulation optimized steady state value (αP equal to zero). As with the non-optimized post-deregulation steady state following labour market deregulation, the unemployment benefit level in the optimized steady state following product market deregulation is close to its pre-deregulation level (approximately

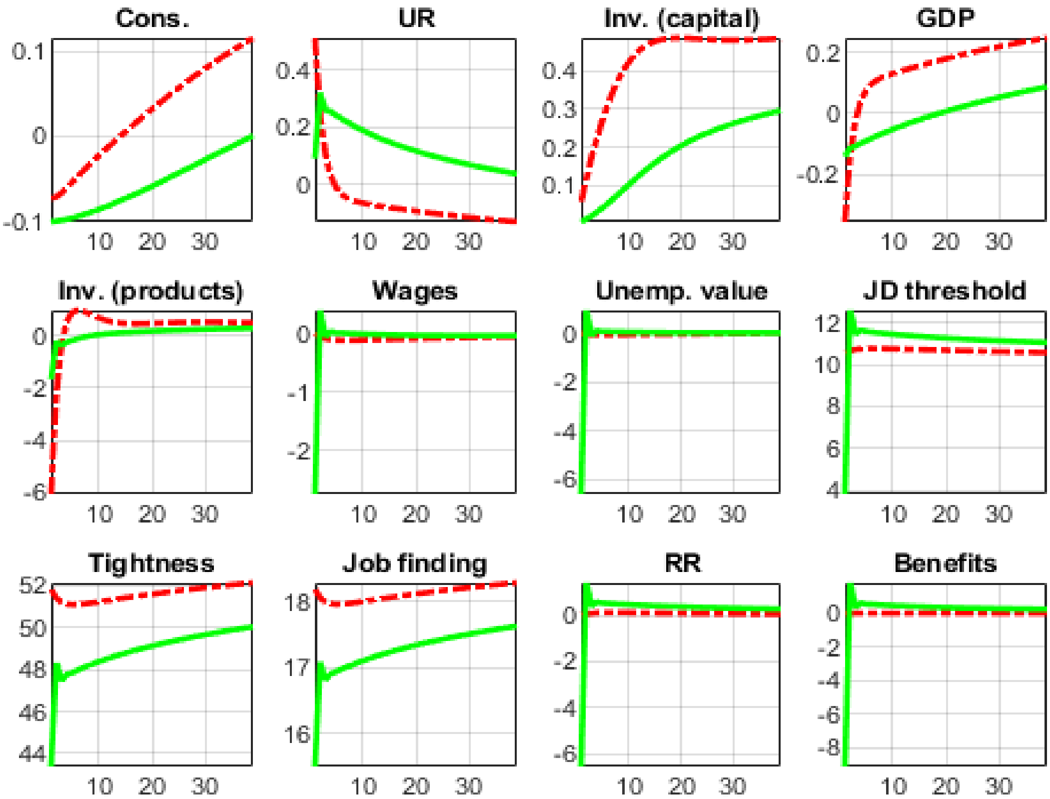


Figure 4.5: Impulse responses, firing cost reduction

Steady state not optimized. *Red dash-dotted line*: Optimized transition (coincides with the non-optimized steady state scenario); *Green line*: optimized unemployment benefit rule with a GDP growth component.

0.5% higher). The two scenarios shown in Figure C.2 in the appendix (for αP equal to zero and 0.95 respectively) show that the dynamics of unemployment benefits have a minimal effect on transitional adjustment following deregulation under these circumstances.

Figure 4.6 plots the impulse responses for the dual optimization scenario with the second variant of the benefit rule (solid green line). This is compared with the optimization in steady state alone scenario (red dash-dotted line), which coincides with optimization (in steady state and transition) using the first variant of the benefit rule. Under the second variant of the rule, the optimized values of αP and ϕ_P are 0 and 37, respectively. As in the previous cases, the optimized rule prescribes a procyclical component to unemployment benefits. The effect of this can be seen in the impulse responses. Unemployment benefits rise following deregulation mirroring the rise in GDP.

The results show that unemployment benefits under the second variant of the rule are always greater than in the optimized steady state alone scenario over the period shown. This means that the dynamics of employment under the second variant of the rule makes a positive contribution to welfare differences relative to the optimized steady state scenario for the duration of time shown. Welfare results in Table 4.3 show that welfare does not vary much across the two scenarios. A higher medium to long run consumption level under the optimized steady state scenario offsets most of the short run welfare gain under the second variant of the rule such that overall welfare is only marginally higher. The short run welfare loss from deregulation is lower under the second variant of the rule. However, this welfare gain is reversed in the medium to long run as consumption falls below the level under the optimized steady state scenario.

4.6.2 Labour market deregulation

In contrast to optimization under the first variant of the rule in the previous scenarios, unemployment benefit optimization prescribes that the transition of unemployment benefits is related to both of its steady state values. Under the previous scenarios, allowing variation in unemployment benefits following deregulation led to a trade-off between short and medium to long run welfare which lowered welfare. Although such a trade-off also exists here, in contrast to the previous cases, welfare rises. We find that welfare is optimized for an αP value of 0.98. Figure 4.7 shows the impulse responses (blue line). The impulse responses from the

Table 4.3: Welfare and market deregulation

Non-optimized steady state and transition	Entry cost	Firing cost
Δ_{SR}	-2.68%	- 0.013%
Δ_{LR}	4.11%	0.06%
$\Delta_{SR} + \Delta_{LR}$	1.42%	0.05%
Optimized steady state		
Δ_{SR}	-3.10%	-0.45%
Δ_{LR}	4.44%	0.33%
$\Delta_{SR} + \Delta_{LR}$	1.34%	-0.12%
Optimized transition (no growth)		
Δ_{SR}	-2.68%	- 0.013%
Δ_{LR}	4.11%	0.06%
$\Delta_{SR} + \Delta_{LR}$	1.42%	0.05%
Optimized transition (with growth)		
Δ_{SR}	-2.89%	0.08%
Δ_{LR}	4.38%	-0.01%
$\Delta_{SR} + \Delta_{LR}$	1.49%	0.07%
Optimized transition and steady state (no growth)		
Δ_{SR}	-3.10%	-0.05%
Δ_{LR}	4.44%	-0.01%
$\Delta_{SR} + \Delta_{LR}$	1.34%	-0.07%
Optimized transition and steady state (with growth)		
Δ_{SR}	-3.01%	0.08%
Δ_{LR}	4.37%	-0.1%
$\Delta_{SR} + \Delta_{LR}$	1.36%	-0.015%

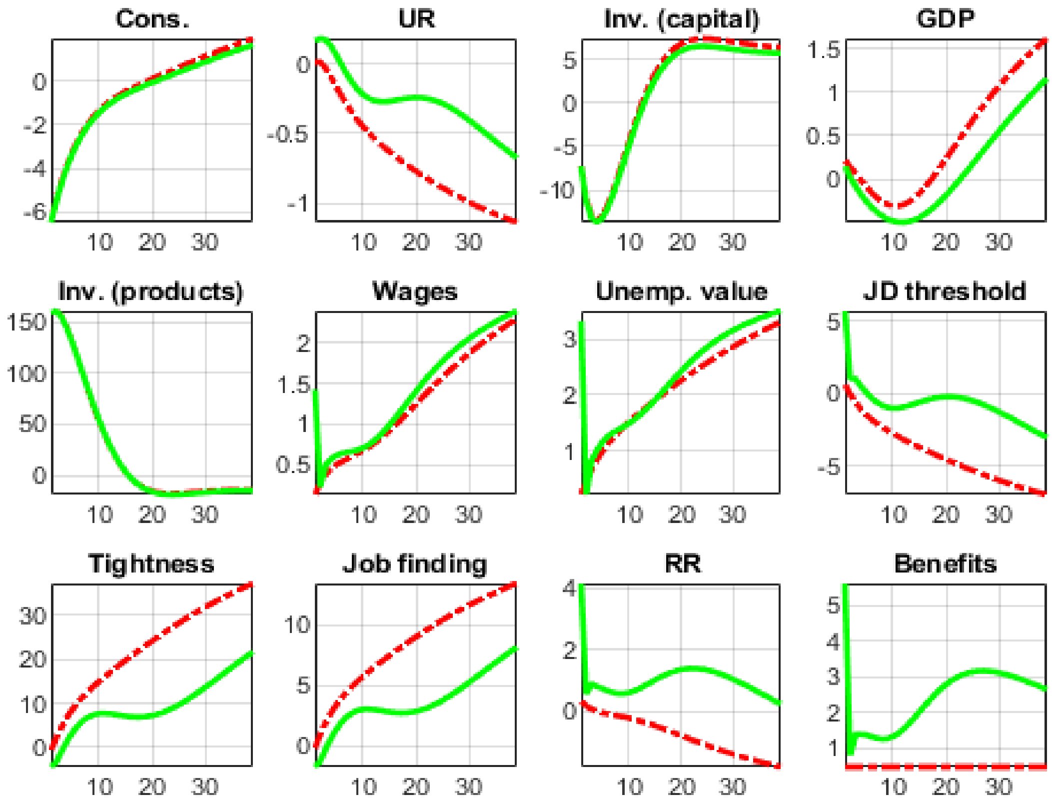


Figure 4.6: Impulse responses, sunk entry cost reduction

Red dash-dotted line: optimization occurs both in transition and in the final steady state with the first variant of the optimized benefit rule - this coincides with the optimized steady state scenario; *Green line*: optimization occurs both in transition and in the final steady state. Unemployment benefits in transition determined by an optimized benefit rule with a GDP growth component.

corresponding optimized steady state case (red dash-dotted line) are also plotted. The unemployment rate under the dual optimization scenario lies above that of the optimized steady state scenario following the shock. Greater job destruction under this scenario exacerbates the negative effect of lower firing costs on employment.

As shown in Table 4.3, an optimized steady state, both without and with an optimized transition in benefits (under the first variant of the rule), is associated with an overall welfare loss from deregulation. This is a result of either welfare loss in the short run or in both periods. Although deregulation is associated with welfare loss in both sub-periods under the first variant of the benefit rule, it is still lower than in the optimized steady state scenario where welfare loss is confined to the short run. Rising consumption in the medium to long run under the optimized steady state scenario generates a welfare gain from deregulation in contrast to under the first variant of the rule where consumption does not rise sufficiently enough from its initial level to generate a welfare gain. However, the slower short run decline in the unemployment rate with the benefit rule result in higher short run welfare under this scenario. Households experience a welfare loss of 0.07% with the rule where as under the optimized steady state scenario, welfare loss is 0.12%.

In Figure 4.8, we compare the impulse responses under the second variant of the optimized unemployment benefit rule (solid green line) with the optimized steady state (red dash-dotted line). Benefit optimization under the dual optimization scenario implies an αP value of 0.98 and ϕ_P equal to 84. As in the previous cases, the optimized rule introduces a procyclical component. GDP falls following a reduction in firing costs which leads to a decline in unemployment benefits on impact. This is followed by a sharp rise as GDP rises in the following period. Unemployment benefits under the second variant of the rule remain above its level under the optimized steady state scenario thereafter, which causes a large and persistent divergence in the unemployment rates for the time period shown. Consumption is also lower over the whole time period with the second variant of the rule due to lower household income. Wage income falls by a larger magnitude following deregulation under the second variant of the rule. The initial decline in wage income from lower wages under the second variant of the rule has a negative effect on household income. As wages rise above the wage level in the optimized steady state scenario, the negative effect of higher unemployment on wage income means that wage income remains higher under the optimized steady state scenario. In addition, as entry rises in the short run under the optimized steady state scenario, so does dividend income which contributes towards higher household income.

As shown in Table 4.3, welfare loss is lower under the second variant of the rule compared with the optimized steady state scenario. Under the former scenario, welfare loss from deregulation occurs in the medium to long run in contrast to the latter scenario where the welfare loss occurs in the short run. Both the short run gain from deregulation and the medium to long run loss are very small, with the outcome that the welfare loss from deregulation is close to zero. Under the optimized steady state scenario on the other hand, the short run welfare loss and medium to long run welfare gain from deregulation are larger and farther apart numerically, generating a larger welfare loss.

In Figure C.3 (Appendix) the red dash-dotted line shows the impulse response under the first variant of the benefit rule. The green line shows the impulse response under the second variant. Dynamics are largely similar to those in Figure 4.8. As in the case of product market deregulation, welfare outcomes are better under the second variant of the rule relative to the first.

4.7 Conclusion

In this chapter, we examined the implications of optimized unemployment benefits following deregulation for transition dynamics and welfare. The dimensions of deregulation considered were a reduction in the sunk costs of market entry and a reduction in firing costs, respectively. We considered four post-deregulation scenarios. Each scenario is associated with the presence or absence of unemployment benefit optimization either in the final steady state and/or in transition. Three of the four scenarios involve some form of welfare optimization, which is where the novelty of our analyses lie.

When welfare optimization is absent, the final post-deregulation equilibrium is not constrained by welfare maximization. In addition, under this scenario, unemployment benefits following deregulation are immediately changed to their long run level based on the pre-deregulation benefit replacement rate. When welfare optimization occurs, it takes place either: i) in the post-deregulation steady state; ii) in transition following deregulation; iii) in both the post-deregulation steady state and in transition.

In i) and iii) unemployment benefits in the final steady state are determined by choosing

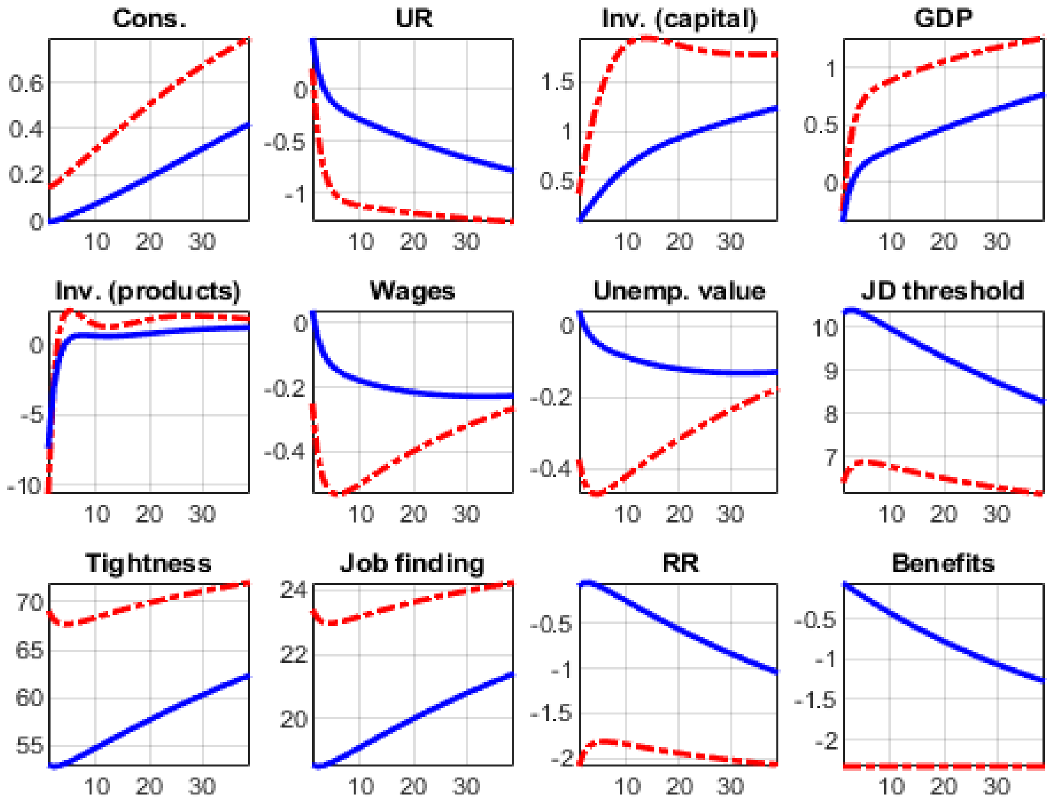


Figure 4.7: Impulse responses, firing cost reduction

Red dash-dotted line: unemployment benefits following labour market deregulation optimized in steady state but not in transition; *Blue line*: unemployment benefits following labour market deregulation optimized in transition and in the final steady state.

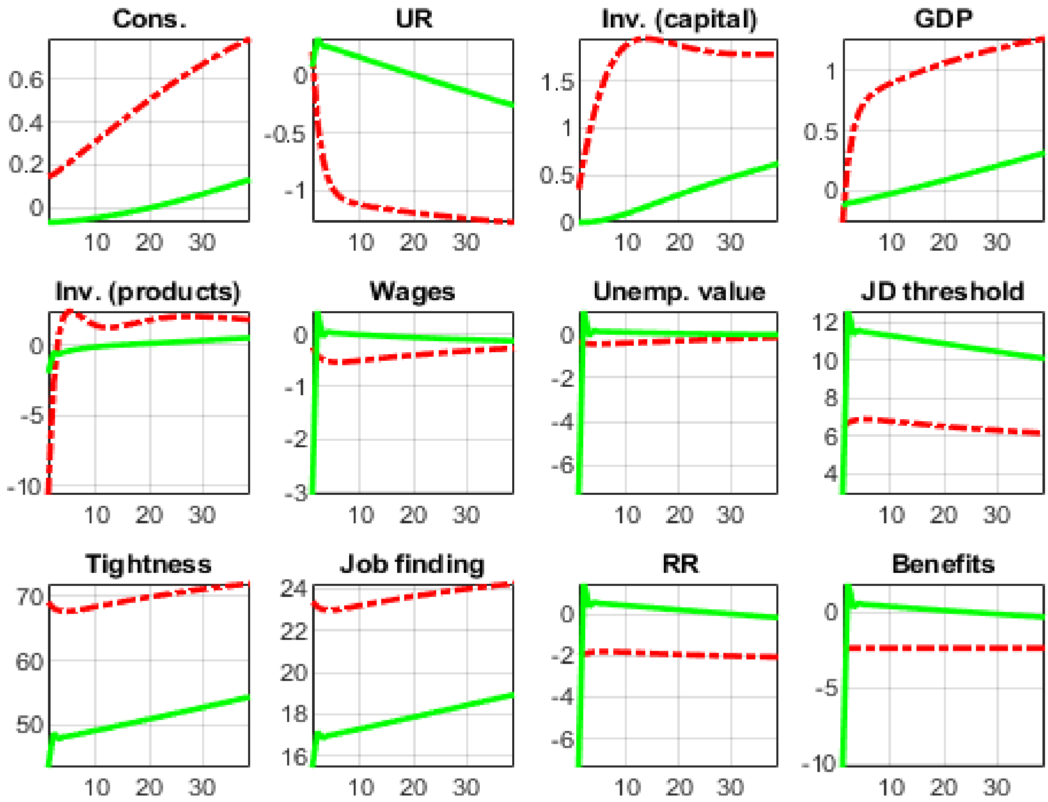


Figure 4.8: Impulse responses, firing cost reduction

Red dash-dotted line: optimization occurs both in transition and in the final steady state with the first variant of the optimized benefit rule - this coincides with the optimized steady state scenario; *Green line*: optimization occurs both in transition and in the final steady state. Unemployment benefits in transition determined by an optimized benefit rule with a GDP growth component.

the unemployment level which maximizes final steady state welfare subject to the targeted (U.S.) level of regulation. In ii) and iii), we also define an optimized unemployment benefit rule which determines the evolution of unemployment benefits as the economy adjusts to its new equilibrium following deregulation. We consider two variants of the rule. In the first variant, the benefit sequence depends only on a weighted average of the pre and post-deregulation benefit levels. In the second, which nests the first, the benefit rule is allowed to respond to GDP growth.

We find that final steady state welfare maximization generates a lower benefit level than in the non-optimized steady state scenario. However, the lower benefit level negatively affects short run and overall welfare. This is because employment rises too sharply in the short run relative to the increase in consumption associated with higher employment. We also find that the dynamics of unemployment following deregulation are significantly affected by the unemployment benefit sequence. The dynamics of unemployment in turn matter for capital investment, particularly following labour market deregulation, where entry dynamics are significantly more muted. We find that the short run adjustment of consumption and capital investment are largely driven by the entry of new firms following product market deregulation and show almost no response to the adjustment of unemployment benefits. Consumption and capital investment always decline in the short run due to the redirection of resources towards financing investment in new products. For this reason, the behaviour of consumption following product market deregulation contributes to welfare loss, particularly in the short run.

Given our specification of the utility function which includes a disutility of labour term, the adjustment of unemployment also has important implications for welfare outcomes. We find that overall welfare is lower following both product and labour market deregulation respectively when the new equilibrium alone is optimized compared with when this is not the case. As suggested above, this occurs because higher short run welfare losses with an optimized equilibrium outweigh the medium to long run welfare gains. In the case of product market deregulation, the greater short run loss is the result of rising employment which is not compensated for by sufficiently higher short run consumption. A similar result is found following labour market deregulation. Although short run consumption is higher in this case, it does not compensate for the more significant short run rise in employment which leads to lower short run welfare.

When optimization occurs in transition alone (but not in the final steady state), welfare can only be improved relative to the non-optimized steady state scenario under the second variant of the benefit rule. However, the welfare gain is minimal mostly because consumption under the rule is lower following both product and labour market deregulation. Optimization along both dimensions, under the second variant of the benefit rule, is associated with lower overall welfare compared with the non-optimized scenario. In the case of product market deregulation, this is due to the steeper decline in the unemployment rate associated with having an optimized steady state under the dual optimization scenario which is not sufficiently compensated for by higher consumption. Adding the GDP growth term to the benefit rule following a reduction in firing costs turns short run welfare outcomes positive, on one hand, but generates medium to long run welfare losses on the other which also lead to lower overall welfare relative to the non-optimized steady state scenario.

We find that product market deregulation always leads to short run welfare losses irrespective of the dynamics of unemployment benefits due to the negative adjustment of consumption in the short run. Following both product and labour market deregulation, respectively, overall welfare is highest when optimization occurs in transition, under the second variant of the benefit rule. However, the welfare gains are relatively small. The results suggest that the response of labour market variables and product creation to deregulation make it difficult to improve welfare outcomes relative to the status quo. However, the short run welfare effects of lowering firing costs become positive when the unemployment benefit path is optimized. This could reduce political aversion to its implementation.

Chapter 5

The macroeconomic effects of deregulation: Evidence from panel VAR

5.1 Introduction

This chapter examines the macroeconomic effects of market deregulation using a panel vector autoregression (VAR) model estimated for a sample of 21 OECD countries. I consider three dimensions of regulation, namely, barriers to market entry, employment protection legislation and the benefit replacement rate. The main focus of the chapter is on potential interactions between regulation and reform. The first part of the analysis examines the macroeconomic effects of market deregulation, with a focus on private consumption.

Secondly, I consider whether the level of labour market regulation (firing restrictions and unemployment benefits, respectively) has implications for the macroeconomic effects of lowering regulation along another dimension. More specifically, I examine whether the macroeconomic effects of reducing regulatory impediments to product market competition and employment protection, respectively, varies with the long run level of the unemployment benefit replacement rate. A similar exercise is performed with the long run level of employment protection. In contrast to the level of product market regulation, the level of the benefit replacement rate and of employment protection in most OECD countries has been fairly stable over time such that the average values of these regulatory variables across time for each country are largely representative of their values at any given point in time. This makes it possible to categorize countries in a credible manner.

I find that product market deregulation and a reduction in the stringency of employment protection, respectively, negatively affect consumption in the short run. In terms of interaction effects, the results show that there is no statistically significant difference in the impact of product market deregulation on consumption across high and low unemployment benefit countries. In addition, I find that product market deregulation leads to a larger rise in unemployment in the short run in a high replacement rate setting, as well as when employment protection is high. The rest of the chapter is organized as follows. Sections 5.2 reviews the empirical literature. A review of theoretical work and the main hypotheses of the chapter are presented in Section 5.3. Section 5.4 presents the empirical methodology. Baseline results are detailed in Section 5.5. Robustness results are presented in Section 5.6. Section 5.7 concludes.

5.2 Literature review

Empirical studies on the effect of market deregulation, particularly those examining interactions between regulation policies, have largely focused on the effect of regulation/deregulation on labour market variables. Fiori et al. (2012), for example, examine the effect of market regulation on unemployment by estimating a panel fixed effects model using data on OECD countries. The authors find that more stringent product market regulation lowers employment. Similar results are found for labour market regulation. Griffith et al. (2007) find supporting evidence for the effect of product market deregulation on unemployment.

Few studies, including, Nicoletti and Scarpetta (2003), Griffith and Harrison (2004), and Cacciatore and Fiori (2016) have considered the effect of market deregulation on aggregate outcomes.Griffith and Harrison (2004) in a panel of 12 European Union countries over the 1980s and 1990s find that labour market reform lowers the average level of economic rents and is associated with higher employment and investment. Nicoletti and Scarpetta (2003), using panel regression methods, show that entry liberalization in the service sector has a statistically significant positive effect on economy-wide total factor productivity growth.

Few studies, such as, Bassanini and Cingano (2017) and Cacciatore and Fiori (2016) have also examined the short run effects of deregulation. Bassanini and Cingano (2019) find that increasing competition and easing employment protection can entail sizeable short run employment losses. Using a local projection method, the authors find that a decrease in the stringency of entry barriers in network industries leads to a 0.66% reduction in employment. The authors also find that lowering dismissal costs on regular contracts decreases employment. Cacciatore and Fiori (2016) provide evidence which supports this finding. The authors examine the macroeconomic effects of product and labour market deregulation using a panel VAR on a sample of nineteen OECD countries for the period 1982-2005. The panel VAR in their baseline specification includes three macroeconomic variables including real investment, unemployment and real GDP, in addition to, an indicator for regulatory impediments, employment protection, or gross benefit replacement rates, respectively.

The authors find that unemployment rises and GDP falls in the short run, following a reduction in entry barriers and employment protection, respectively. Following both shocks, GDP falls on impact before recovering after approximately three years. On the other hand, there are no recessionary effects from a reduction in unemployment benefits. In terms of interactions, Bassanini and Cingano (2019) find that product market deregulation has a statistically significant negative effect on employment in the short run only in a group of countries with low employment protection. Similarly, Fiori et al. (2012) find that the employment enhancing effect of product market deregulation is larger when employment protection is high.

5.3 Hypotheses

As in the empirical literature, most theoretical work on the effects of deregulation have focused on labour market outcomes. Ebell and Haefke (2003) in a two-period model find that product market deregulation increases employment in the short run. This is supported by Fiori et al. (2012). Blanchard and Giavazzi (2003) in a similar model setup to both studies find positive employment gains from deregulation in the long run. These studies assume that the number of firms in the market is given in the short run. On the other hand, studies such as Cacciatore et al. (2012), Cacciatore and Fiori (2016) and Cacciatore et al. (2016), examine the dynamic adjustment of macroeconomic variables following deregulation in macroeconomic models which allow for endogenous producer entry in the short run.

Cacciatore and Fiori (2016) find that a reduction in sunk entry costs and firing costs, respectively, negatively affect market consumption in the short run. Following product market reform, resources are diverted towards the creation of new goods which requires a contraction in consumption. Following both reforms, job destruction also rises which negatively affects unemployment and GDP in the short run. In contrast to the other reforms, consumption rises following a reduction in the benefit replacement rate which raises job creation.

Studies have also examined interactions between reform and regulation. Work in this area suggests that the effect of deregulation along a particular dimension depends on the type of reform and the regulatory variable under consideration. Ebell and Haefke (2003) examine the effect of lowering product market regulation at high and low unemployment benefit replacement rates in a dynamic matching model with monopolistic competition in the goods market. The authors argue that the reduction in unemployment that occurs following product market deregulation (a reduction in entry costs) is greater when the replacement rate is high. This arises because at a higher replacement rate, labour market tightness is lower making unemployment more responsive to a given differential in tightness brought about by a differential in entry costs. Coe and Snower (1997) find complementarity effects between labour market policies in that a restrictive labour market policy reduces the effectiveness of another in reducing unemployment. For example, the authors show that when the benefit replacement ratio is high, a policy which reduces barriers to job creation can have almost no effect.

Based on predictions from their theoretical model, Cacciatore and Fiori (2016) argue that a reduction in barriers to entry and firing restrictions, respectively, lowers consumption in the short run, where as consumption reacts positively following a reduction in the benefit replacement rate.

Findings from Chapter 4, which are based on the model developed by the authors, show that following product market deregulation, the decline in consumption in the short run varies marginally across different levels of unemployment benefits. The results also show that unemployment dynamics vary with the benefit level following product and labour market deregulation (a reduction in firing costs), respectively. Investment dynamics also vary considerably across benefit levels following a reduction in firing costs.

5.4 Empirical methodology

I adopt a panel VAR approach to examine the macroeconomic effects of reform in a sample of 21 OECD countries. Four macroeconomic variables are included in the baseline panel VAR. These include private consumption, the unemployment rate, real investment and real GDP. I augment the panel VAR estimated by Cacciatore and Fiori (2016) with a measure of private consumption to empirically investigate the findings of their theoretical model with regards to this variable. I also consider the effect of the level of individual labour market policies on the macroeconomic effect of reform along another dimension. The standard deviation of the labour market regulation indicators, presented in Table 5.1, show low variation for most countries which allows for a credible categorization of countries into high and low groups by the respective labour market indices, discussed further below. Following Cacciatore and Fiori (2016), I impose a recursive ordering of the structural shocks based on the assumption that the regulation variables are more exogenous in the panel VARs. A second-order VAR model is specified as follows:

$$z_{it} = \Gamma_0 + \Gamma_1 z_{it-1} + \Gamma_2 z_{it-2} + f_t + d_i + e_{it},$$

where z_t is a five-variable vector of the four macroeconomic variables and a reform indicator. d_i and f_t are country and time fixed effects, respectively. e_t is the vector of error terms.

5.4.1 Data

I include 21 OECD countries in the panel VAR, using data between the years 1982 and 2005.[1] Data for most variables are taken from the OECD, with the exception of the measure of aggregate private consumption which comes from the World Bank's database of economic indicators. The details of the data included in the VAR are described as follows. For private consumption, I use the World Bank's measure of households and non-profit institutions serving households (NPISH) final consumption expenditure in constant 2010 prices. GDP and aggregate investment data are in constant 2010 prices. Data on the unemployment rate is from the OECD annual labour force statistics. The unemployment rate used is the harmonized unemployment rate which represents the unemployment rate (unemployed population as a percentage of the working age population) for the 15-64 age range.

Three measures of regulation are considered. For product market regulation, I use the OECD summary measure of regulatory impediments to product market competition in seven

[1] These include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

network sectors, including gas, electricity, telecoms, post, passenger air transport, ralways, and road freight. Labour market regulation is considered along two dimensions. The first is employment protection legislation. I use the OECD summary indicator for the stringency of employment protection for indefinite contract workers, fixed-term contract workers, and all contracts (an average of indefinite and fixed-term contracts). The value of the index varies from 0, which represents extreme flexibility, to 6, representing extreme rigidity. The other dimension of labour market regulation considered is the benefit replacement rate. I use the average unemployment benefit replacement rate across two income situations, three family situations, and three different unemployment durations.

5.5 Results

First, I report the results of the panel VAR estimated for the full sample with aggregate consumption introduced as a macroeconomic variable in the panel VAR estimated by Cacciatore and Fiori (2016). I then consider whether there are interaction effects between regulation and reform.

5.5.1 Individual deregulation

Figure 5.1 shows the impulse responses to a one standard deviation reduction in the regulation variables. Panel 1 reports the results folowing a shock to product market regulation (PMR). Panels 2 and 3 show the results for shocks to employment protection legislation (EPL) and unemployment benefits (UB), respectively. The continuous lines denote the median responses to the reform shock. The dash-dotted lines represent 68% confidence bands.

The results are quantitatively similar to the empirical results of Cacciatore and Fiori (2016), with a few exceptions. I find that following an EPL shock, there is a slight increase in investment on impact before it declines. In contrast, the authors find that investment falls on impact. However, both results are not statistically significant. Also, the response of investment has a pronounced U shape in contrast to the results of the authors where the impulse response function is largely upward sloping. In addition, following a UB shock, the response of GDP has a more pronounced hump-shape in the medium run than found by the authors. However, the results are still quantitatively very similar.

Table 5.1: Mean of reform variables

Country	**PMR**	**EPL**	**UBARR**
Australia	3.06 (0.99)	1.04 (0.13)	24.71 (1.69)
Austria	3.93 (0.95)	2.18 (0.09)	30.15 (2.19)
Belgium	4.18 (1.19)	2.78 (0.48)	41.11 (1.73)
Canada	2.86 (0.84)	0.75 (0.00)	17.41 (2.32)
Denmark	3.85 (1.54)	1.99 (0.46)	54.47 (4.95)
Finland	3.77 (1.18)	2.18 (0.13)	34.37 (3.48)
France	4.74 (1.07)	2.92 (0.13)	37.18 (2.94)
Germany	3.78 (1.46)	2.81 (0.46)	27.24 (1.47)
Greece	5.27 (0.63)	3.42 (0.27)	11.61 (3.66)
Ireland	4.57 (0.86)	0.95 (0.06)	31.07 (3.96)
Italy	4.82 (1.20)	3.09 (0.70)	15.61 (14.10)
Japan	3.67 (0.96)	1.75 (0.28)	9.77 (1.10)
Netherlands	3.92 (1.44)	2.55 (0.28)	51.50 (4.55)
New Zealand	3.14 (1.09)	1.01 (0.27)	29.47 (2.02)
Norway	3.83 (1.05)	2.77 (0.15)	38.89 (3.70)
Portugal	4.65 (1.12)	3.87 (0.24)	32.52 (10.29)
Spain	3.96 (1.15)	3.40 (0.43)	34.52 (3.00)
Sweden	3.49 (1.10)	2.85 (0.61)	26.82 (2.15)
Switzerland	3.86 (0.53)	1.14 (0.00)	27.41 (7.66)
United Kingdom	2.49 (1.32)	0.63 (0.06)	18.24 (1.81)
United States	2.29 (0.37)	0.21 (0.00)	12.89 (1.17)

standard deviations in brackets

The finding that unemployment rises following product and labour market deregulation, respectively, is supported by Bassanini and Cingano (2019), one of the very few studies examining short run outcomes. The results support model predictions from Cacciatore and Fiori (2016) on the effect of deregulation on consumption. Following a reduction in product market regulation, consumption falls in the short run before recovering and turning positive in the medium run.

Consistent with the theoretical prediction of the model following a reduction in firing costs, consumption also falls when employment protection legislation is relaxed. However, the empirical results show that consumption falls by a greater extent and takes a much longer time to recover. The authors show that consumption falls by approximately 0.07% from its steady state level on impact. In contrast, the results of the panel VAR show a 2.5% decline in consumption following a reduction in employment protection. I also find a similar adjustment pattern in consumption to that found by the authors following a UB shock. Although there is an initial decline in consumption, in contrast to the findings of the authors, consumption shows an upward trajectory, a finding also made by the authors. The results of the baseline panel VAR are confirmed by the robustness analysis presented in Figure 5.6.

5.5.2 Interactions

In this section, I examine the effect of the average level of the dimensions of labour market regulation considered on the macroeconomic effect of deregulation along another dimension. This allows for an examination of whether the macroeconomic effect of product market deregulation depends on the stringency of labour market policies. In addition, it is also possible to investigate whether there are interaction effects between labour market policies. I categorise countries into "low" and "high" labour market regulation for each of the two measures of labour market regulation and estimate a panel VAR for each group. Low regulation countries are those which fall below the average of the regulation index average across countries[2]. High regulation countries are those which fall above the average.[3] Figures 5.2 and 5.3 show the

[2]Countries in the low benefit replacement rate category include Australia, Canada, Germany, Greece, Italy, Japan, Sweden, Switzerland, UK, US. Low EPL countries include Australia, Canada, Denmark, Ireland, Japan, New Zealand, Switzerland, United Kingdom, United States.

[3]Countries in the high benefit replacement rate category include Austria, Belgium, Denmark, Finland, France, Ireland, Netherlands, New Zealand, Norway, Portugal, Spain. High EPL countries include Austria, Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain, Sweden.

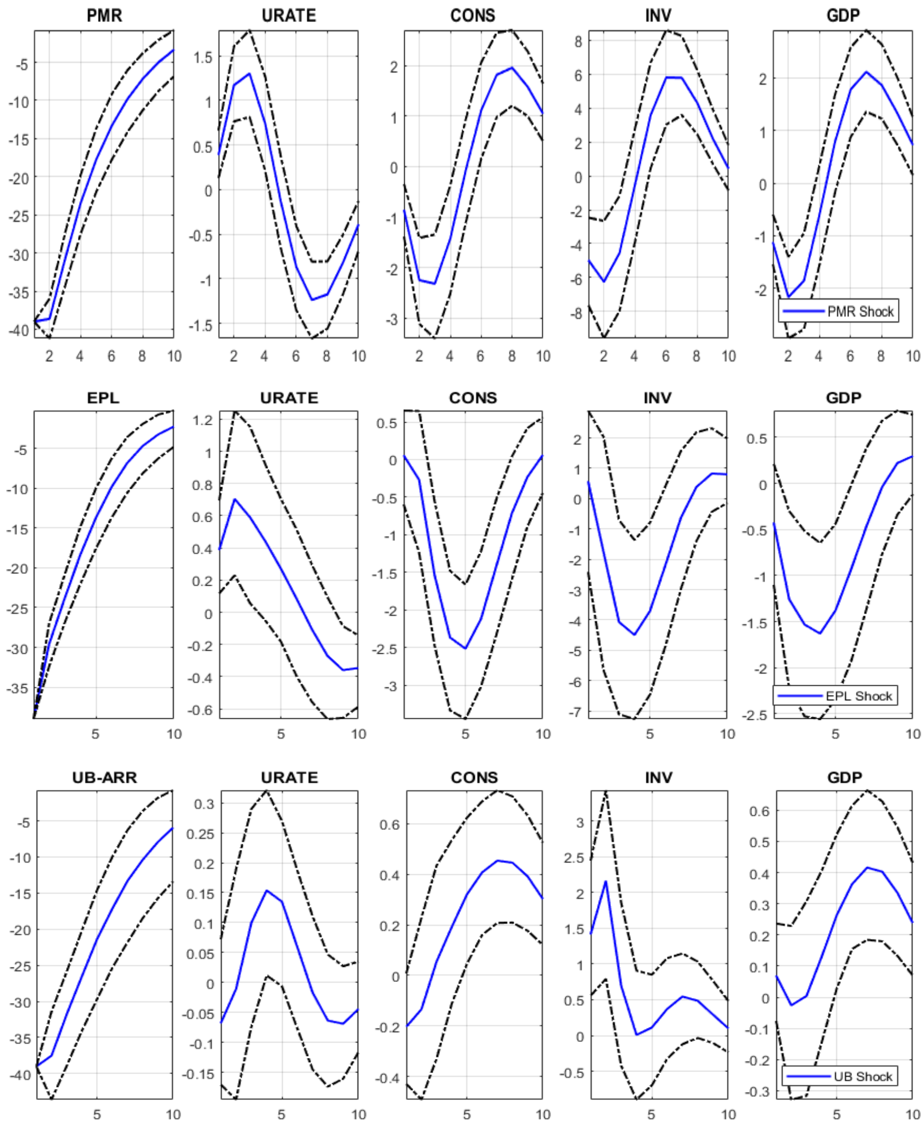


Figure 5.1: Panel VAR, impulse responses to regulation shocks

GDP, Investment and consumption are in percent from baseline; The unemployment rate is in deviations from baseline. *URATE*: Unemployment rate; *CONS*: Consumption; *INV*: Investment.

results for a PMR shock and EPL shock, respectively, for low and high UB countries. Figures 5.4 and 5.5 show the results for a PMR shock and UB shock, respectively, in low and high EPL countries.

5.5.2.1 Unemployment benefits and a PMR shock

Figure 5.2 plots the impulse responses to a PMR shock in countries with low average unemployment benefits (panel A) and countries with high average unemployment benefits (panel B). In low UB countries, a PMR shock leads to a peak rise in unemployment of approximately 0.5 percentage points from baseline. In high UB countries, unemployment has a peak response of over 2 percentage points. In contrast to findings, Ebell and Haefke (2003) argue that product market deregulation lowers unemployment more significantly when unemployment benefits are high.

The adjustments of investment and GDP also differ between the two groups. In high UB countries, investment has a greater decline from baseline following the shock and falls further in the short run. In contrast to the high UB group, investment rises after an initial decline in the low UB group.

Although results from chapter 4 show that investment outcomes in the short run are marginally worse following product market deregulation in a higher unemployment benefit regime, differences in adjustment across unemployment benefit levels are more considerable relative to consumption. The results in this section provide tentative evidence of worse investment outcomes in the short run following product market deregulation when unemployment benefits are high.

The results for GDP suggest that product market deregulation lowers output in the short run more significantly in high UB countries, consistent with higher unemployment following deregulation. However, the difference across the groups is not statistically significant. In contrast to the adjustment of the other macroeconomic variables, the adjustment of consumption in the short run shows little difference between the two group, both quantitatively and qualitatively. Similar results were also reported in Chapter 4.

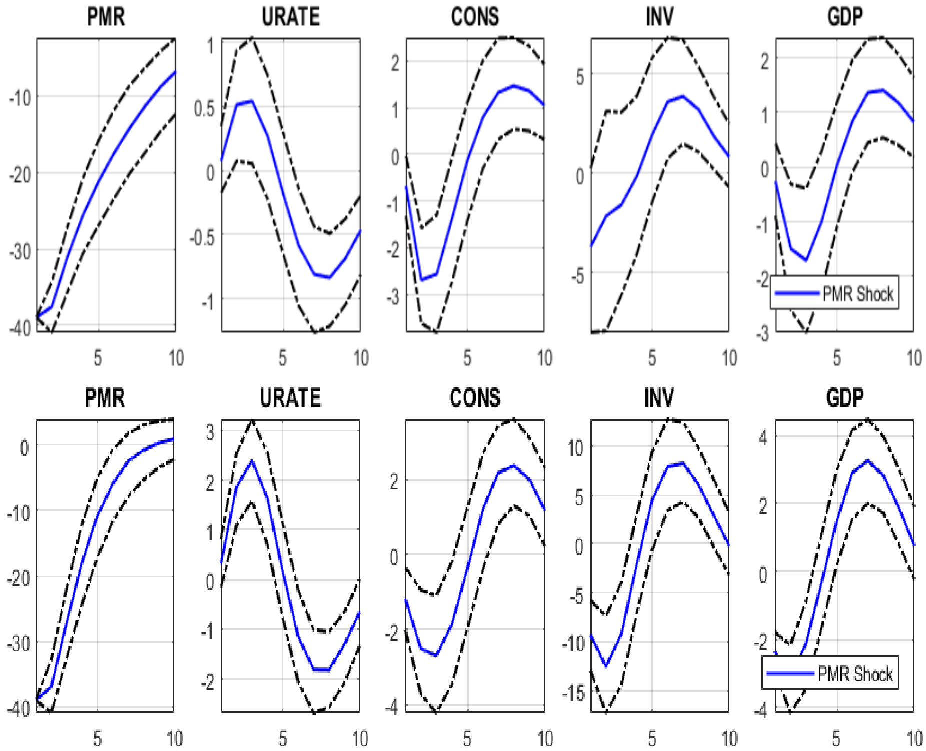


Figure 5.2: Panel VAR, impulse responses to a PMR shock in the low UB group (top panel) and high UB group (bottom panel)

GDP, Investment and Consumption are in percent from baseline; The unemployment rate is in deviations from baseline. *URATE*: Unemployment rate; *CONS*: Consumption; *INV*: Investment.

5.5.2.2 Unemployment benefits and an EPL shock

Figure 5.3 plots the results following an EPL shock. The confidence bands are relatively wider compared with the results from product market deregulation, particularly for the unemployment rate and GDP, which makes it more difficult to make inferences from the results. Compared with a PMR shock, there is less of a difference in responses across the country groups following an EPL shock. The most noticeable differences occur in the adjustment of the unemployment rate and investment. Investment rises in the short run in the low UB countries. In contrast, high UB countries experience a decline in investment in the short run. Investment stays below 5 percent from baseline for approximately two years before it begins to rise. Unemployment in the low UB group rises on impact following the shock before steadily declining shortly after. In the high UB group, on the other hand, the unemployment rate has a hump-shaped response and only starts to show a persistent decline after 5 years. However, the difference across groups is not statistically significant.

5.5.2.3 Employment protection and a PMR shock

Figure 5.4 shows the responses following a reduction in PMR for countries in low and high EPL groups, respectively. The results show that the responses to a PMR shock are largely similar across EPL groups, with the dynamics of consumption being the the most homogeneous. The unemployment rate has a higher peak response following a PMR shock in the high EPL group, similar to the analysis by UB group. The results support findings presented in Bassanini and Cingano (2019) which show that a PMR shock has a statistically significant negative effect on employment in the short run when employment protection is low. However, a similar finding is also made for the high EPL group of countries, in contrast to the findings of the authors. The initial rise in the unemployment rate following deregulation is however not statistically significant in the high EPL group.

Investment and GDP fall on impact in both groups. However, the decline in greater in the high EPL group. The response of consumption is quantitatively similar across the two groups, similar to findings in Figure 5.2. Similar to the subgroup analysis by unemployment benefit level, there is also tentative evidence that investment outcomes in the short run are worse following product market deregulation when EPL is high, relative to when it is low.

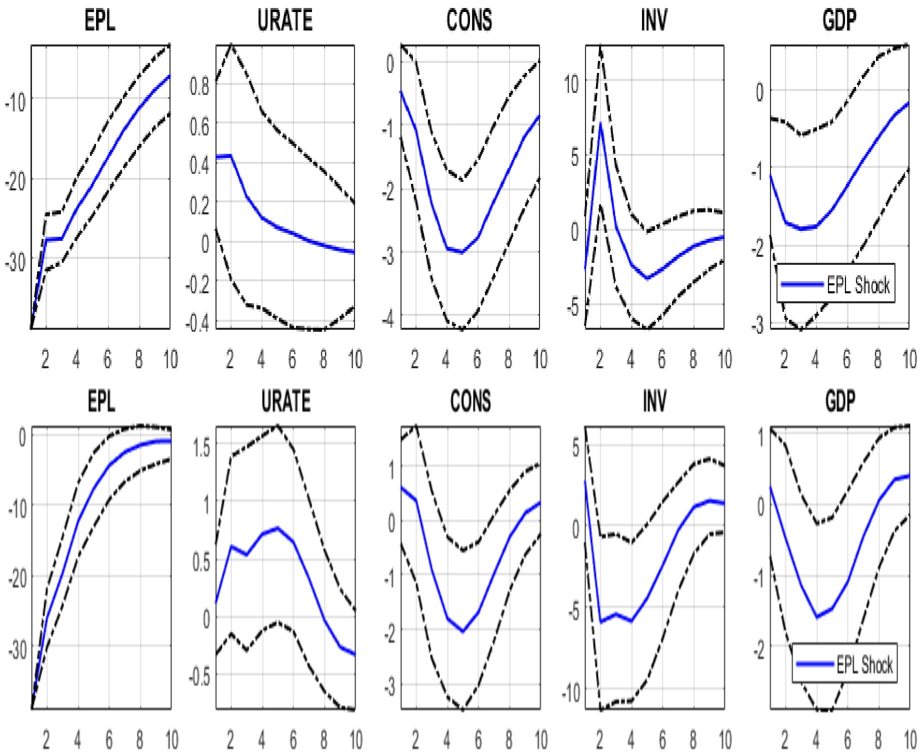


Figure 5.3: Panel VAR, impulse responses to an EPL shock in the low UB group (top panel) and high UB group (bottom panel)

GDP, Investment and Consumption are in percent from baseline; The unemployment rate is in deviations from baseline. *URATE*: Unemployment rate; *CONS*: Consumption; *INV*: Investment.

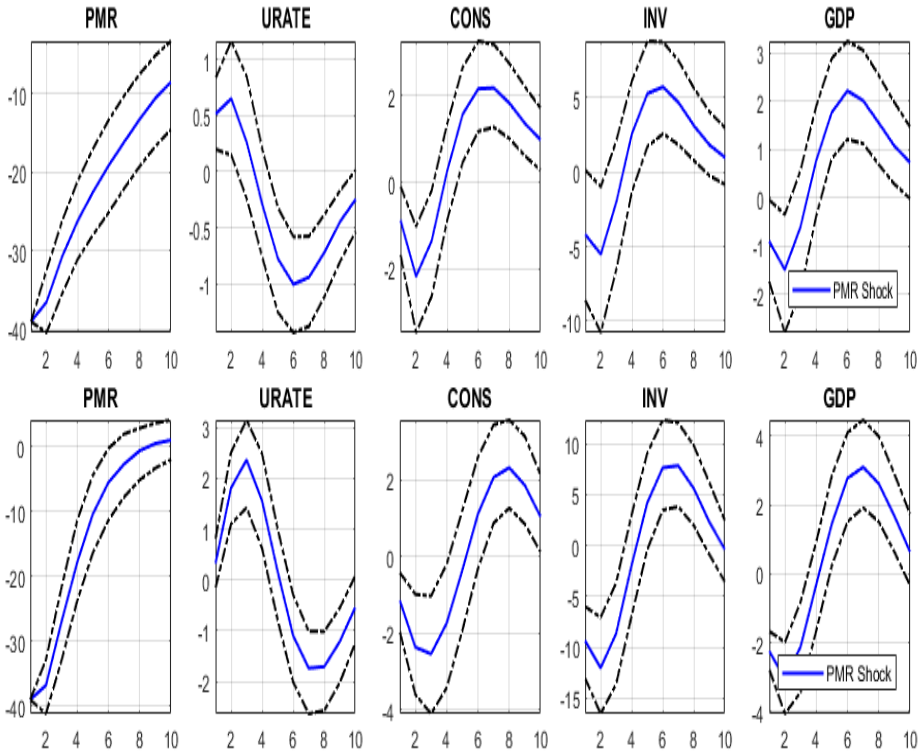


Figure 5.4: Panel VAR, impulse responses to a PMR shock in the low EPL group (top panel) and high EPL group (bottom panel)

GDP, Investment and Consumption are in percent from baseline; The unemployment rate is in deviations from baseline. *URATE*: Unemployment rate; *CONS*: Consumption; *INV*: Investment.

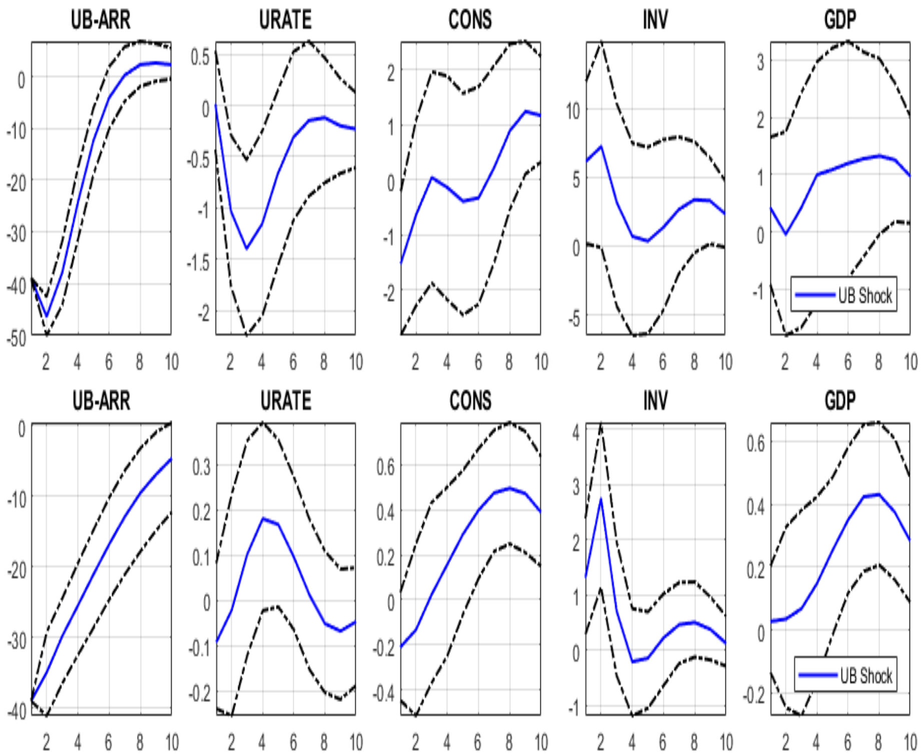


Figure 5.5: Panel VAR, impulse responses to a UB shock in the low EPL group (top panel) and high EPL group (bottom panel)

GDP, Investment and Consumption are in percent from baseline; The unemployment rate is in deviations from baseline. *URATE*: Unemployment rate; *CONS*: Consumption; *INV*: Investment.

5.5.2.4 Employment protection and a UB shock

Figure 5.5 shows the results for a reduction in the average benefit replacement rate across EPL groups. In the low EPL group, the response of the unemployment rate in the short run has a u-shape. The inverse obtains in the high UB group. This translates into unemployment rising by approximately 0.2 percentage points at its peak 4 years after the shock in the high EPL category. On the other hand, it reaches its lowest value at approximately 1.5% percentage points lower than its baseline 3 years following the shock. However, the confidence bands are wide and the difference is not statistically significant. There is also evidence that consumption rises by a greater extent in the medium run following a UB shock in the low EPL group.

5.6 Robustness: Individual deregulation

As a robustness check for the results presented in Figure 5.1, I include the other two policy variables in the panel VAR along with the reform variable, in addition to the macroeconomic variables. Under this specification, regulatory barriers to entry have a contemporaneous effect on labour market regulation and shocks to employment protection have a contemporaneous effect on the benefit replacement rate. However, the reverse does not hold in both cases. Figure 5.6 shows the results. I find that the effect of shocks to individual dimensions of regulation are quantitatively similar when all dimensions of regulation are included in the panel VAR.

5.7 Discussion and conclusion

This chapter examined the macroeconomic effects of product and labour market deregulation and interactions between reform and regulation. I find evidence which supports the finding of Cacciatore and Fiori (2016) that a reduction in barriers to entry and firing restrictions, respectively, negatively affect consumption in the short run. This finding is shown to be robust to the inclusion of all regulatory variables in the panel VAR when estimating the effect of a reduction in entry barriers and firing restrictions, respectively.

The finding from the panel VAR which shows that macroeconomic variables react negatively in the short run following a reduction in entry barriers is in contrast to theoretical predictions in the literature which suggest that employment rises or unemployment falls following product market deregulation. This can be explained by differences in the model assumptions. These studies generally abstract from firm entry in the short run and some do not consider endogenous job creation and job destruction within the framework.

As explained by Cacciatore and Fiori (2016), the entry of new firms into the market following a reduction in entry barriers requires the diversion of resources away from consumption and investment into product creation. The results also show that a reduction in employment protection legislation also has a negative effect on consumption in the short run. Lower firing costs increase job creation and destruction. However, because job creation is sluggish, unemployment rises and consumption falls in the short run. In contrast to predictions from the theoretical model, the results show that a reduction in the benefit replacement rate lowers

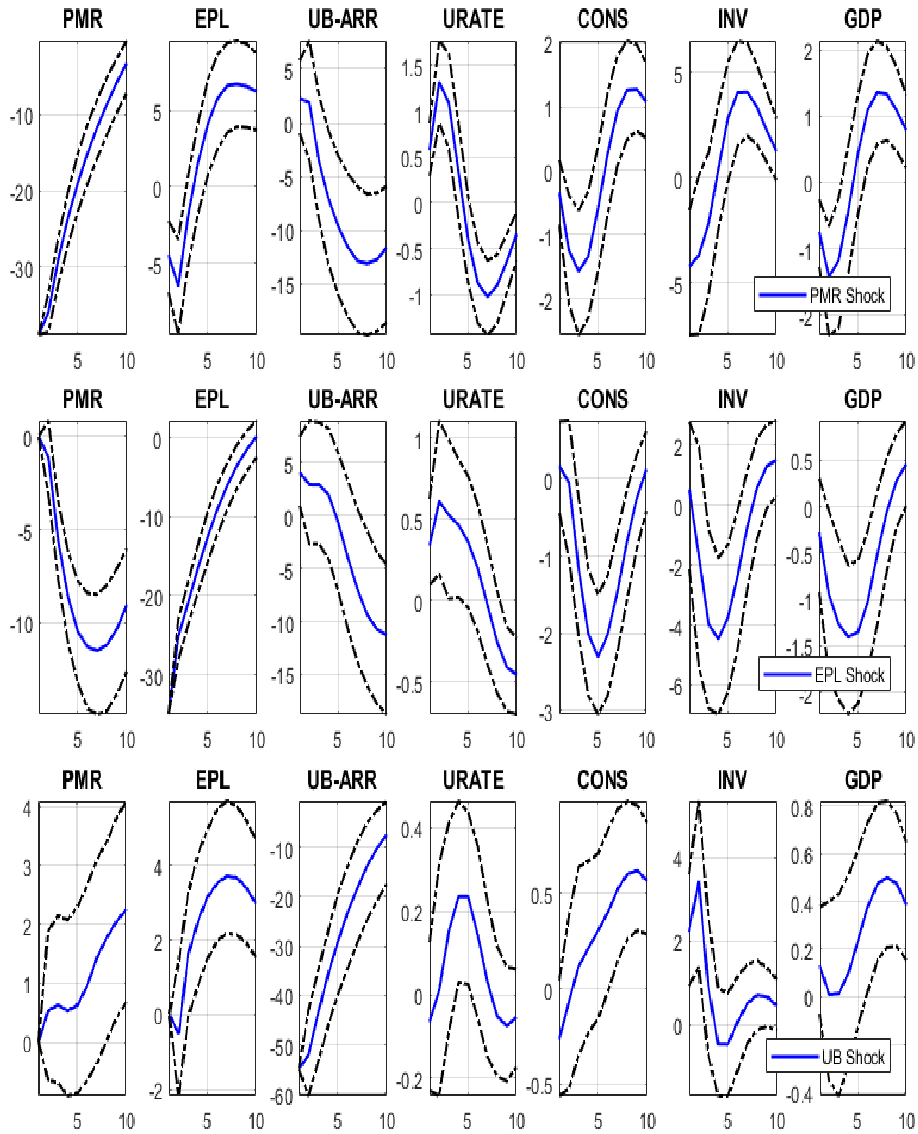


Figure 5.6: Panel VAR, impulse responses to regulation shocks

GDP, Investment and Consumption are in percent from baseline; The unemployment rate is in deviations from baseline. *UBARR*: Benefit replacement rate; *URATE*: Unemployment rate; *CONS*: Consumption; *INV*: Investment.

consumption on impact before it recovers. However, this result is not statistically significant.

The results from the sub group analysis of the effect of a reduction in entry barriers in countries with low and high benefit replacement rates, respectively, show that the response of consumption in the short run is almost identical across groups. This is supported by findings from Chapter 4 which show that the unemployment benefit level has a negligible effect on the dynamics of consumption in the short run following product market deregulation. Similar findings are made when countries are classified by the level of employment protection legislation. There is also tentative evidence that a reduction in employment protection raises investment in the short run in low unemployment benefit countries, whereas investment falls in countries with a high average benefit level.

Appendix A

Appendices to Chapter 2

A.0.1 Derivation of the product creation equation: marginal cost pricing and the rigid perspective

The firm's profit function including the firm's share of lump sum taxes to finance the subsidy is given by:

$$d_t = (1+\tau_t)\rho_t y_t - \frac{(1+\tau_t)\rho_t y_t}{\mu_t} - \theta_t \tau_t \rho_t y_t + (1-\alpha)\varphi_t y_t - \tilde{w}_t l_t - \kappa v_t - \frac{G(z^c_{\omega t}}{(1-G(z^c_{\omega t})} l_t F$$

This can be expressed as:

$$d_t = [1+\tau_t - \frac{(1+\tau_t)}{\mu_t} - \theta_t \tau_t]\rho_t y_t + (1-\alpha)\varphi_t y_t - \tilde{w}_t l_t - \kappa v_t$$

This is equivalently:

$$d_t = [1+\tau_t(1-\theta_t) - \frac{(1+\tau_t)}{\mu_t}]\rho_t y_t + (1-\alpha)\varphi_t y_t - \tilde{w}_t l_t - \kappa v_t - \frac{G(z^c_{\omega t}}{(1-G(z^c_{\omega t})} l_t F$$

The average value of a job to the firm, $\psi_t = (1-\alpha)\varphi_t \frac{y_t}{l_t} - \tilde{\omega}_t + \frac{\kappa}{q_t}$.

This implies that: $(1-\alpha)\varphi_t y_t = [\psi_t + \tilde{\omega}_t - \frac{\kappa}{q_t}]l_t$

Using this expression in the above profit function:

$$d_t = [1+\tau_t(1-\theta_t) - \frac{(1+\tau_t)}{\mu_t}]\rho_t y_t + \psi_t l_t + \tilde{\omega}_t l_t - \frac{\kappa}{q_t} l_t - \tilde{w}_t l_t - \kappa v_t - \frac{G(z^c_{\omega t}}{(1-G(z^c_{\omega t})} l_t F$$

This simplifies to:

$$d_t = [1+\tau_t(1-\theta_t) - \frac{(1+\tau_t)}{\mu_t}]\rho_t y_t + \psi_t l_t - \kappa(\frac{l_t}{q_t} + v_t) - \frac{G(z^c_{\omega t}}{(1-G(z^c_{\omega t})} l_t F$$

The equation which combines the Euler equation for product creation and the free entry condition is given by:

$$(f_T + f_R) + \kappa(\frac{l_t}{q_t} + v_t) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T + f_R) + \kappa(\frac{l_{t+1}}{q_{t+1}} + v_{t+1}) + d_{t+1}\right]$$

Inserting the profit function into this expression gives the following equation:

$$(f_T + f_R) + \kappa(\frac{l_t}{q_t} + v_t) - \Upsilon_{E,t} = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T + f_R) + \kappa(\frac{l_{t+1}}{q_{t+1}} + v_{t+1}) - \kappa(\frac{l_{t+1}}{q_{t+1}} + v_{t+1}) + [1 + \tau_t(1-\theta_t) - \frac{(1+\tau_t)}{\mu_t}]\rho_t y_t\right]$$

where $\Upsilon_{E,t} \equiv (1-\delta)E_t\beta_{t,t+1}\psi_{t+1}l_{t+1} - (1-\delta)E_t\beta_{t,t+1}[\frac{G(z_t^c)}{(1-G(z_t^c))}]$

As shown in CF, $\Upsilon_{E,t} \equiv \frac{\kappa}{q_t}[l_t + q_t v_t]$

Therefore, the product creation equation becomes:

$$(f_T + f_R) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T + f_R) + [1 + \tau_t(1-\theta_t) - \frac{(1+\tau_t)}{\mu_t}]\rho_t y_t\right]$$

Inserting the optimal value of τ_t, $1 + \tau_t = \mu_t$, this equation simplifies to:

$$(f_T + f_R) = (1-\delta)\mathbb{E}\left[\beta_{t,t+1}\right]\left[(f_T + f_R) + [1 + (1-\theta_t)(\mu_t - 1)]\rho_t y_t\right]$$

Appendix B

Appendices to Chapter 3

B.0.1 Wage derivation with labour income tax

A labour income tax, τ_t^n, enters into the surplus sharing rule:

$$\tilde{\Delta}_{\omega t}^W = (1-\tau_t^n)\frac{\eta}{1-\eta}\tilde{\Delta}_{\omega t}^F$$

The worker's surplus is given by:

$$\Delta_{\omega t}^W(z) = (1-\tau_t^n)w_{\omega t}(z) - \varpi_t + E_t\tilde{\beta}_{t,t+1}(1-G(z_{\omega t+1}^c))\tilde{\Delta}_{\omega t+1}^W$$

Therefore,

$$\Delta_{\omega t}^W(z) = (1-\tau_t^n)w_{\omega t}(z) - \varpi_t + (1-\tau_{t+1}^n)\frac{\eta}{1-\eta}E_t\tilde{\beta}_{t,t+1}(1-G(z_{\omega t+1}^c))(\tilde{J}_{\omega t+1}(z)+F)$$

$\Delta_{\omega t}^W(z)$ can be re-written as:

$$\Delta_{\omega t}^W(z) = (1-\tau_t^n)w_{\omega t}(z) - \varpi_t + (1-\tau_{t+1}^n)\frac{\eta}{1-\eta}[\frac{\kappa}{q_t}(E_t\tilde{\beta}_{t,t+1}F)]$$

$$\Delta_{\omega t}^F(z) = \Pi_{\omega t}(z) + w_{\omega t}(z) + \frac{\kappa}{q_t} + F$$

Inserting the expression for $\Delta_{\omega t}^W(z)$ and the expression for $\Delta_{\omega t}^F(z)$ into the sharing rule, we get:

$$\eta[\Pi_{\omega t}(z)+w_{\omega t}(z)+\frac{\kappa}{q_t}+F] = \frac{1-\eta}{1-\tau_t^n}[(1-\tau_t^n)w_{\omega t}(z)-\varpi_t+(1-\tau_{t+1}^n)\frac{\eta}{1-\eta}[\frac{\kappa}{q_t}+E_t\tilde{\beta}_{t,t+1}F]]$$

$$\eta w_{\omega t}(z) + \eta[\Pi_{\omega t}(z) + \frac{\kappa}{q_t} + F] = (1-\eta)w_{\omega t} - \frac{1-\eta}{1-\tau_t^n}\varpi_t + \frac{\eta(1-\tau_{t+1}^n)}{1-\tau_t^n}(\frac{\kappa}{q_t} + E_t\tilde{\beta}_{t,t+1}F)$$

$$w_{\omega t}(z) = \eta[\Pi_{\omega t}(z) + \frac{\kappa}{q_t} + F] + \frac{1-\eta}{1-\tau_t^n}\varpi_t - \frac{\eta(1-\tau_{t+1}^n)}{1-\tau_t^n}(\frac{\kappa}{q_t} + E_t\tilde{\beta}_{t,t+1}F)$$

B.0.2 Fiscal shocks and macroeconomic volatility

Table B.1: Fiscal shocks and macroeconomic volatility

Fiscal shock	**Standard deviation of variable**
Government spending shock	
GDP	0.0120
Consumption	0.0401
Investment	0.0355
Unemployment	0.0502
Markup	0.0017
Vacancies	0.0591
Job finding rate	0.0437
Job separation rate	0.0115
Capital income tax shock	
GDP	0.0409
Consumption	0.0450
Investment	0.1590
Unemployment	0.1392
Markup	0.0035
Vacancies	0.1634
Job finding rate	0.1208
Job separation rate	0.0319
Labour income tax shock	
GDP	0.0294
Consumption	0.0300
Investment	0.0562
Unemployment	0.3463
Markup	0.0018
Vacancies	0.4719
Job finding rate	0.3011
Job separation rate	0.1165

B.0.3 Fiscal shocks: 100 periods

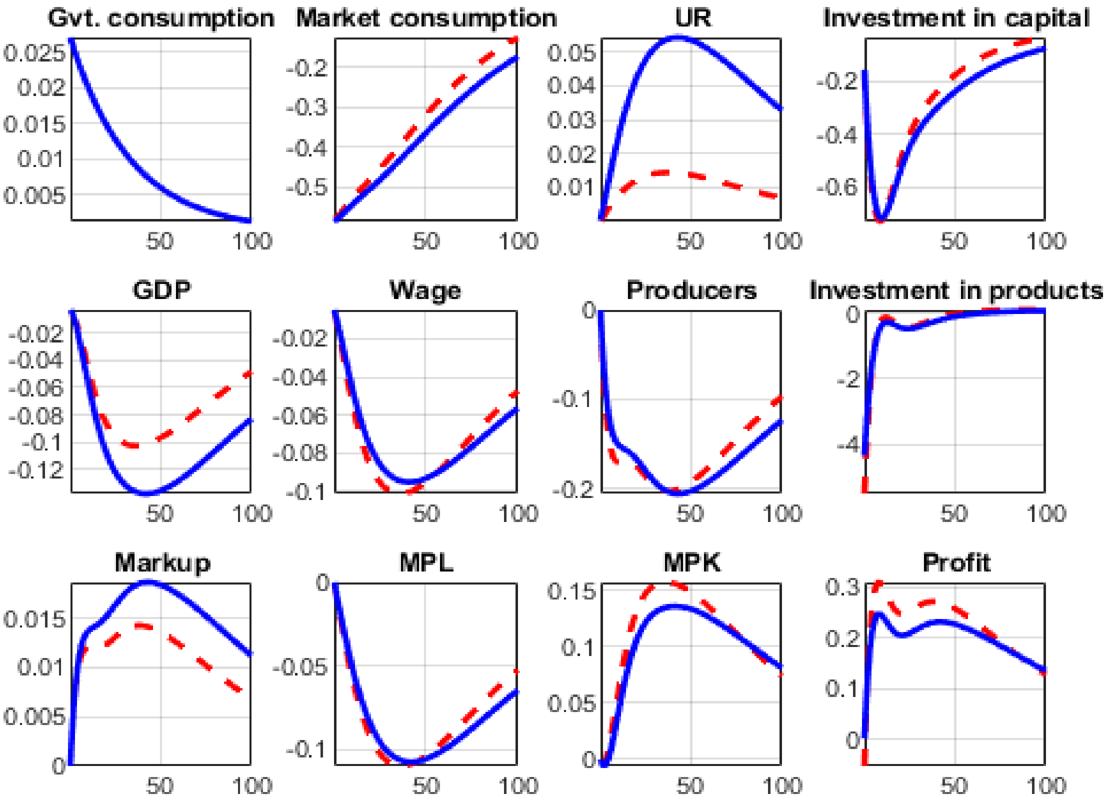


Figure B.1: Impulse responses, Government consumption shock

Blue line: Rigid economy; *Solid red line*: Low firing costs, high entry costs and benefit replacement rate; *Dashed red line*: Flexible economy.

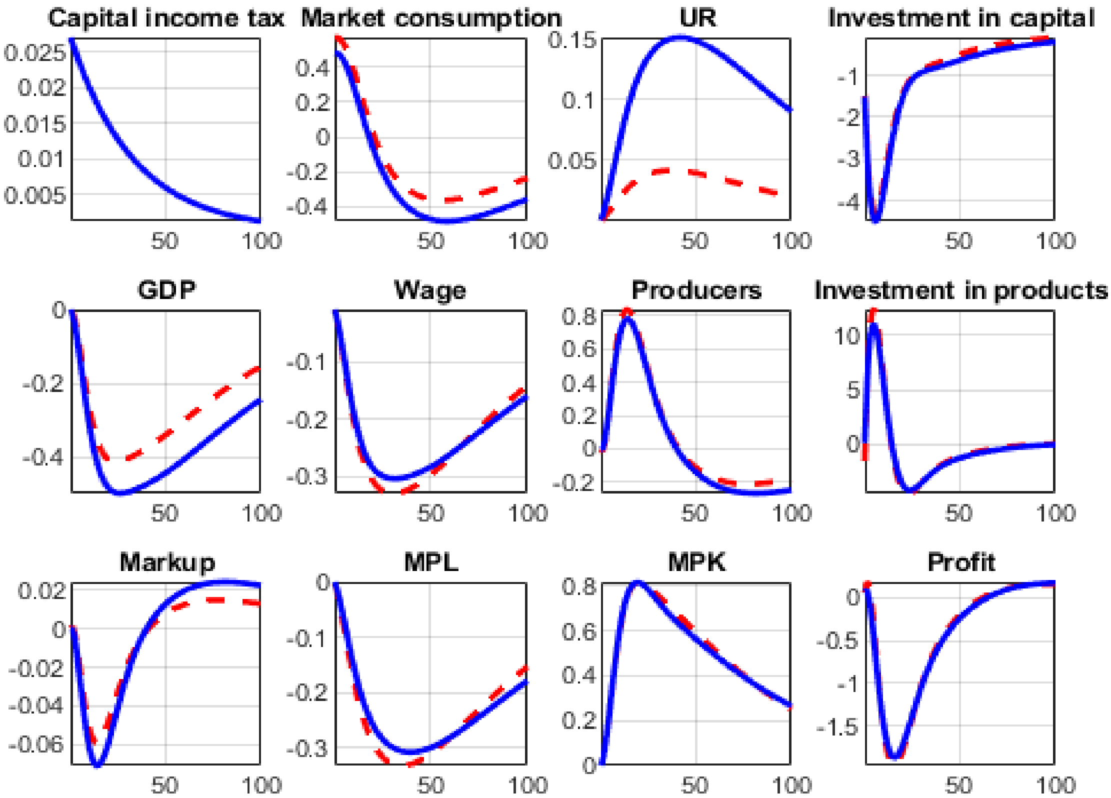


Figure B.2: Impulse responses, Capital income tax shock

Blue line: Rigid economy; *Solid red line*: Low firing costs, high entry costs and benefit replacement rate; *Dashed red line*: Flexible economy.

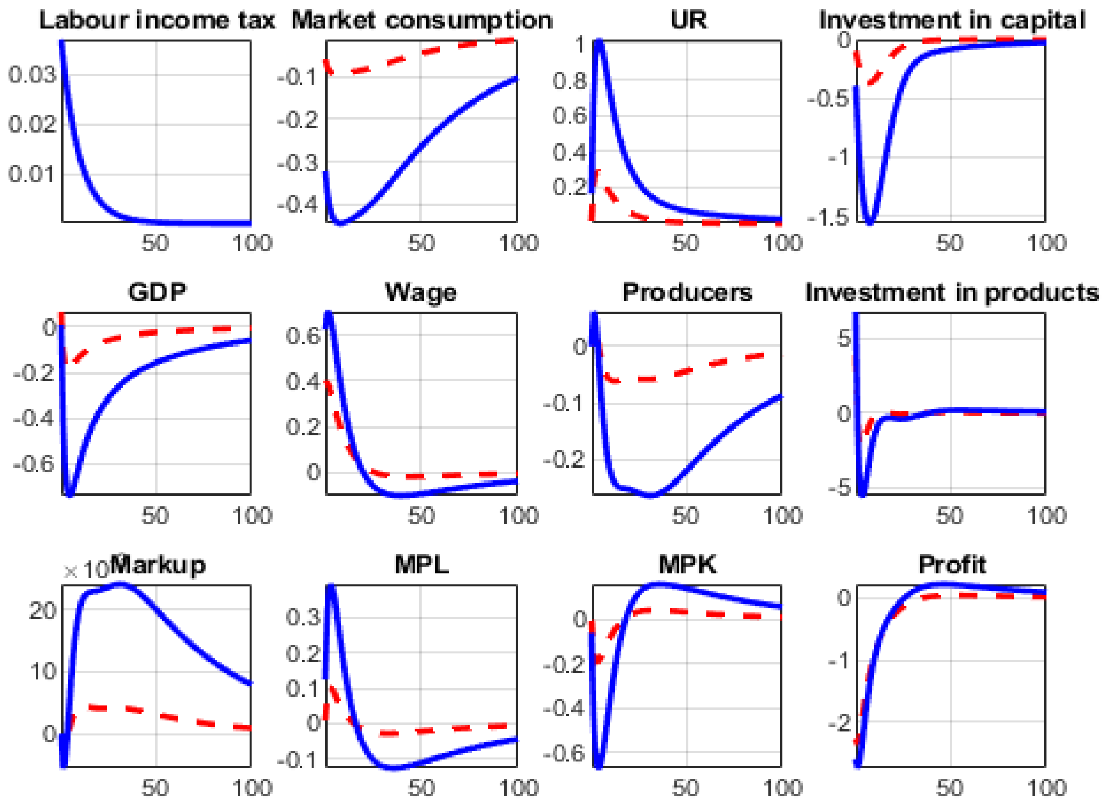


Figure B.3: Impulse responses, Income tax shock

Blue line: Rigid economy; *Solid red line*: Low firing costs, high entry costs and benefit replacement rate; *Dashed red line*: Flexible economy.

Appendix C

Appendices to Chapter 4

C.1 Deregulation and welfare

The computation of the percentage increase $\triangle$ in steady state consumption which makes the household indifferent between deregulating and not implementing a reform is given below:

$$\log[C^n(1+\frac{\triangle}{100})]\frac{\chi}{2}l^2\Sigma_{t=1}^{12}\beta^{t-1} = \Sigma_{t=1}^{12}\beta^{t-1}\ \log C_t - \frac{\chi}{2}l^2$$

$$[\log\ C^n\ +\log\ [1+\frac{\triangle}{100}] - \frac{\chi}{2}l^2]\frac{1-\beta^{12}}{1-\beta} = \Sigma_{t=1}^{12}\beta^{t-1}\ \log C_t - \frac{\chi}{2}l^2$$

$$(\frac{1-\beta^{12}}{1-\beta})[logC^n - \frac{\chi}{2}l^2] + (\frac{1-\beta^{12}}{1-\beta})log(1+\frac{\triangle}{100}) = \Sigma_{t=1}^{12}\beta^{t-1}\ \log C_t - \frac{\chi}{2}l^2$$

$$[logC^n - \frac{\chi}{2}l^2] + log(1+\frac{\triangle}{100}) = (\frac{1-\beta}{1-\beta^{12}})\Sigma_{t=1}^{12}\beta^{t-1}\ (\log C_t - \frac{\chi}{2}l^2)$$

$$log(1+\frac{\triangle}{100}) = (\frac{1-\beta}{1-\beta^{12}})\Sigma_{t=1}^{12}\beta^{t-1}(logC_t - \frac{\chi}{2}l^2) - (logC^n - \frac{\chi}{2}l^2)$$

$$(1+\frac{\triangle}{100}) = e^{(\frac{1-\beta}{1-\beta^{12}})\Sigma_{t=1}^{12}\beta^{t-1}(logC_t - \frac{\chi}{2}l^2) - (logC^n - \frac{\chi}{2}l^2)}$$

$$(1+\frac{\triangle}{100}) = \frac{e^{(\frac{1-\beta}{1-\beta^{12}})\Sigma_{t=1}^{12}\beta^{t-1}(logC_t - \frac{\chi}{2}l^2)}}{e^{(logC_t - \frac{\chi}{2}l^2) - (logC^n - \frac{\chi}{2}l^2)}}$$

$$\triangle = 100(\frac{e^{(\frac{1-\beta}{1-\beta^{12}})\Sigma_{t=1}^{12}\beta^{t-1}(logC_t - \frac{\chi}{2}l^2)}}{e^{(logC_t - \frac{\chi}{2}l^2) - (logC^n - \frac{\chi}{2}l^2)}} - 1)$$

C.2 Impulse responses from deregulation

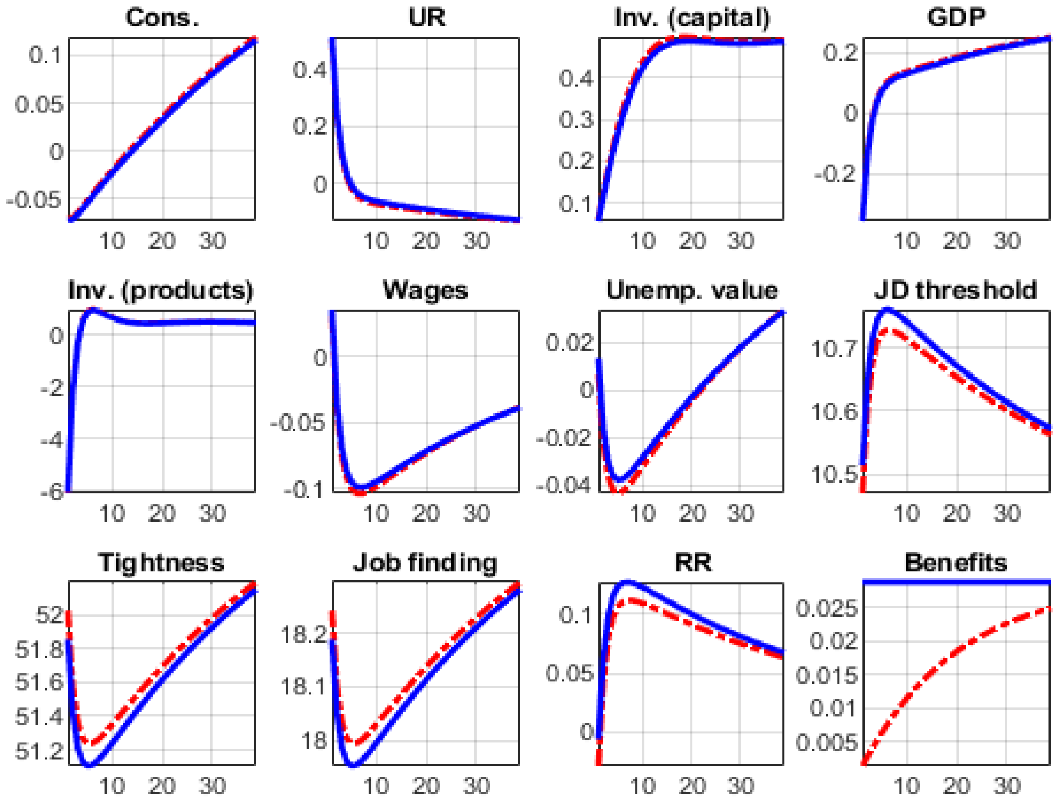


Figure C.1: Impulse responses, firing cost reduction

Steady state not optimized. *Red dash-dotted line*: αP in first variant of unemployment benefit rule equal to 0.95; *Blue line*: non-time varying unemployment benefit sequence as prescribed by first variant of unemployment benefit rule.

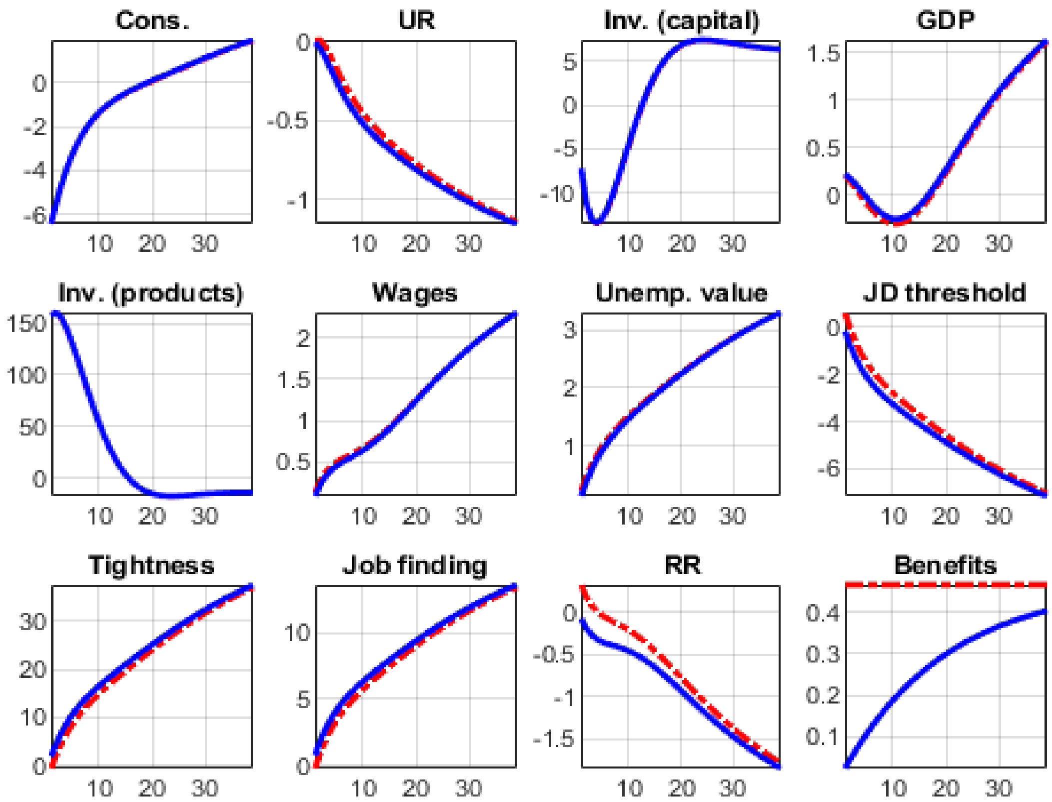


Figure C.2: Impulse responses, sunk entry cost reduction

Steady state optimized. *Red dash-dotted line*: unemployment benefits following product market deregulation optimized in steady state but not in transition; *Blue line*: αP in first variant of unemployment benefit rule equal to 0.95.

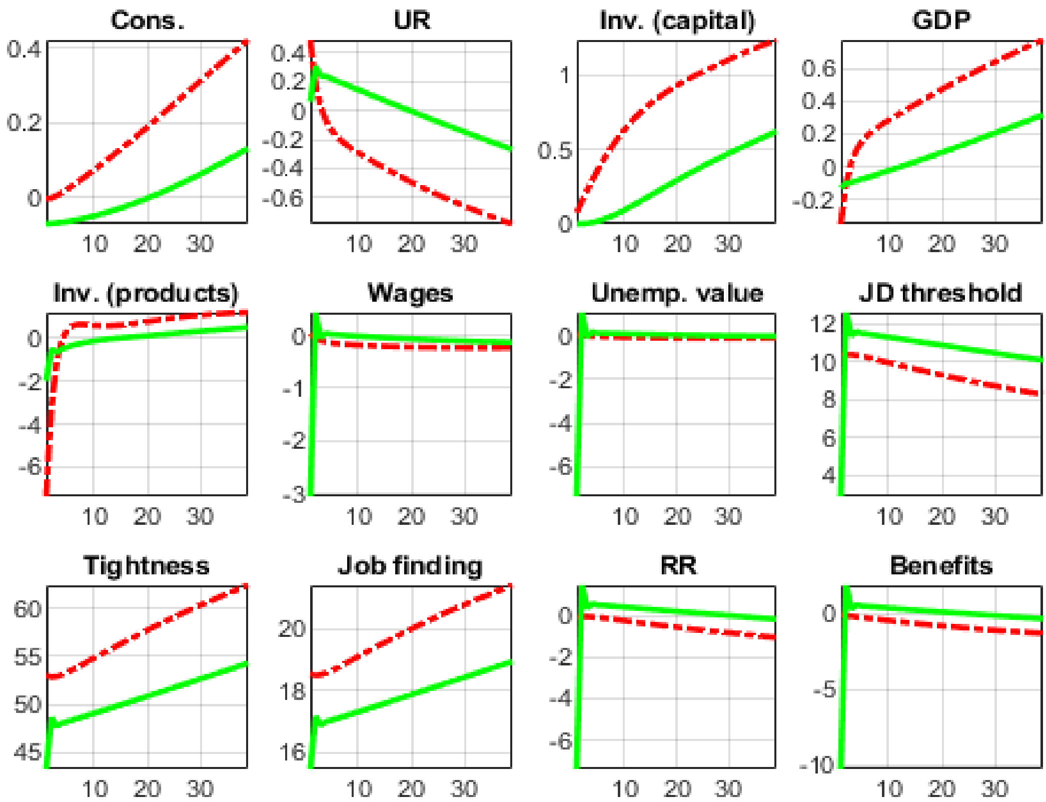


Figure C.3: Impulse responses, firing cost reduction

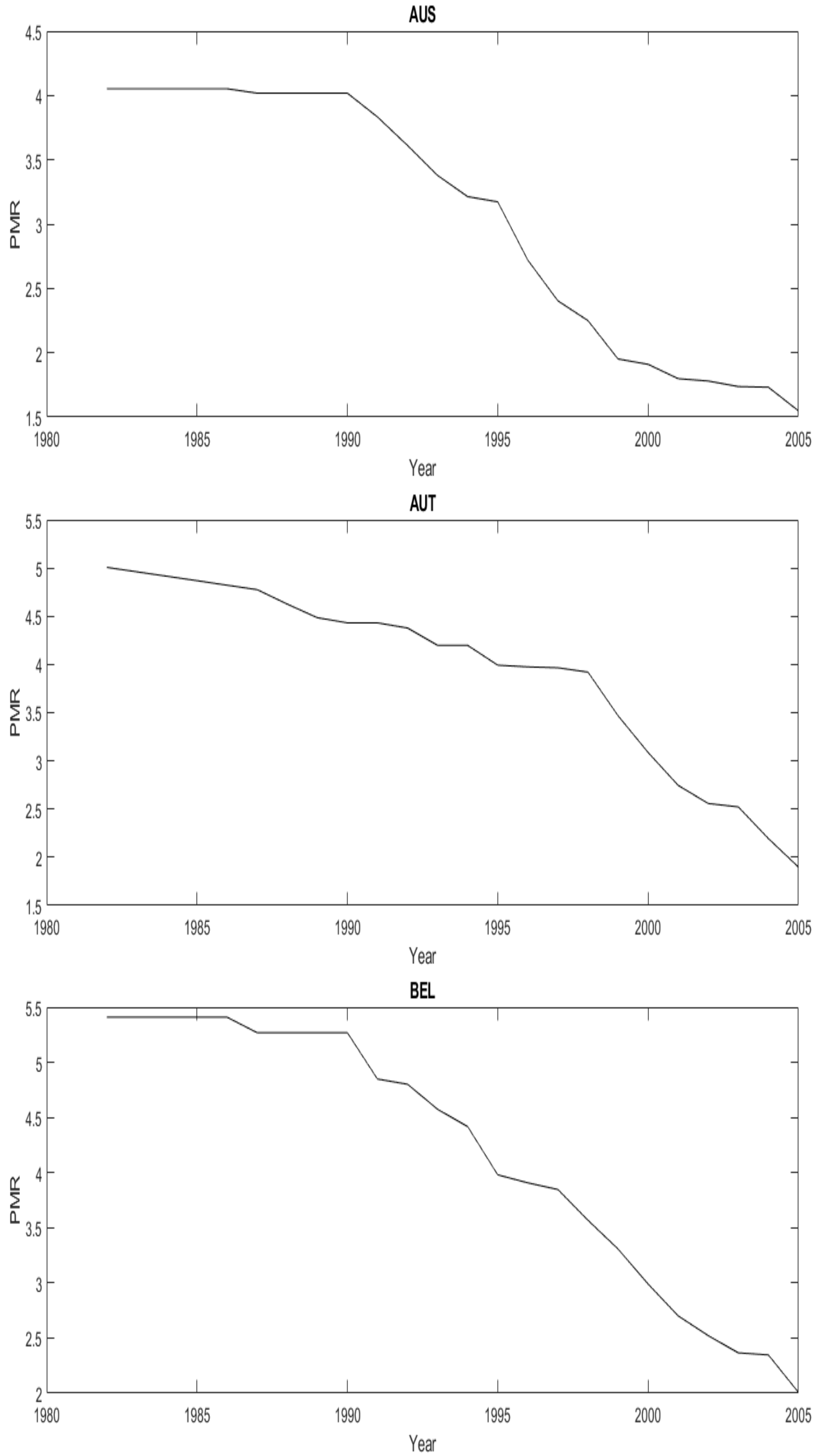
Optimization occurs both in transition and in steady state, with and without a GDP growth component in benefit rule, and in final steady state, respectively. *Red dash-dotted line*: unemployment benefit rule without a GDP growth component; *Green line*: unemployment benefit rule with a GDP growth component.

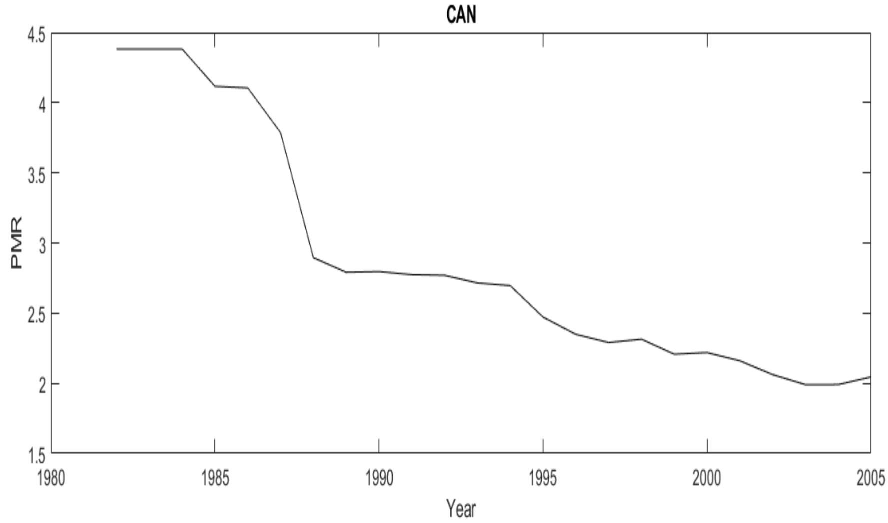
Appendix D

Appendices to Chapter 5

D.1 Product market regulation in OECD countries: 1982 - 2005

Figure D.1: Product market regulation in OECD countries: 1982 - 2005

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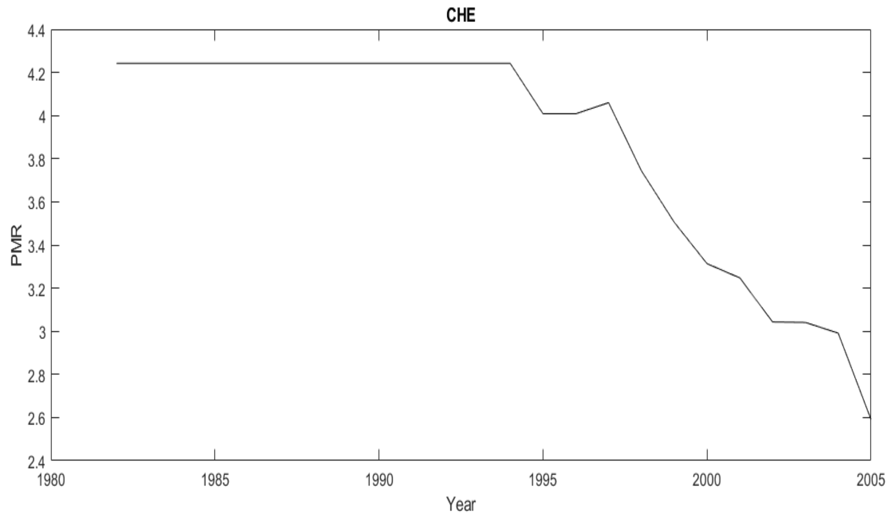
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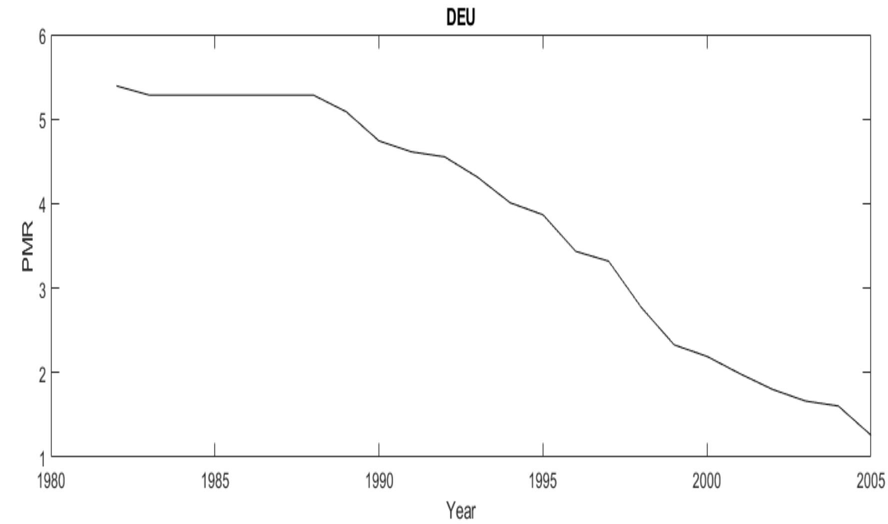
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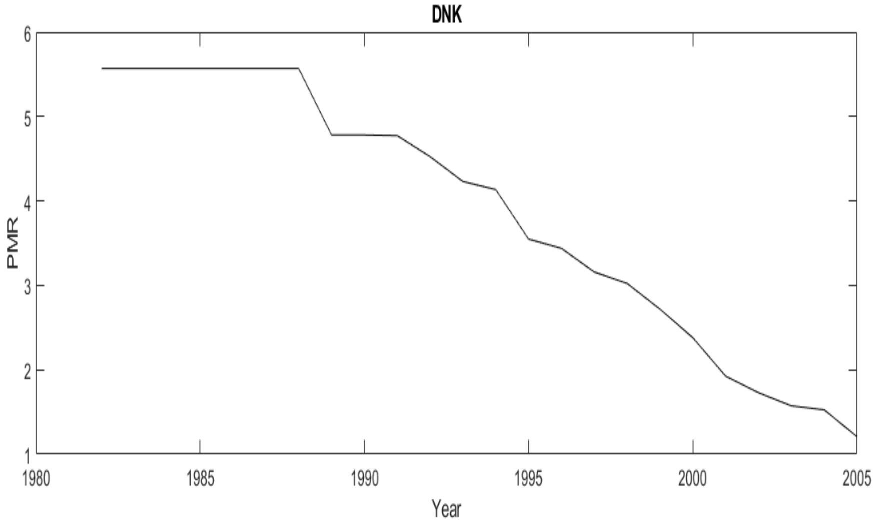
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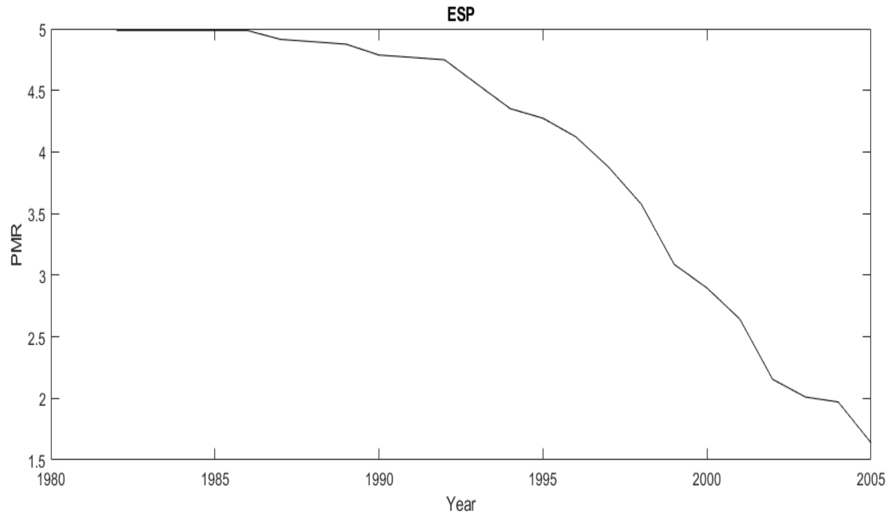
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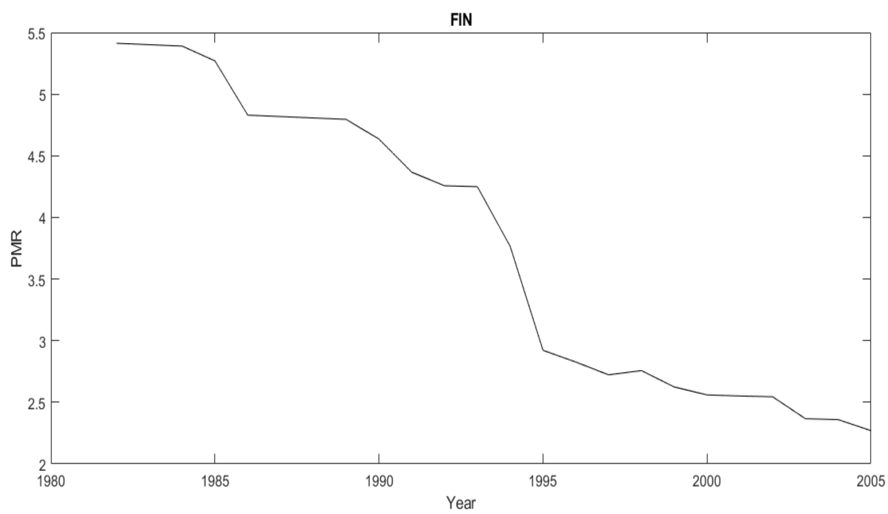
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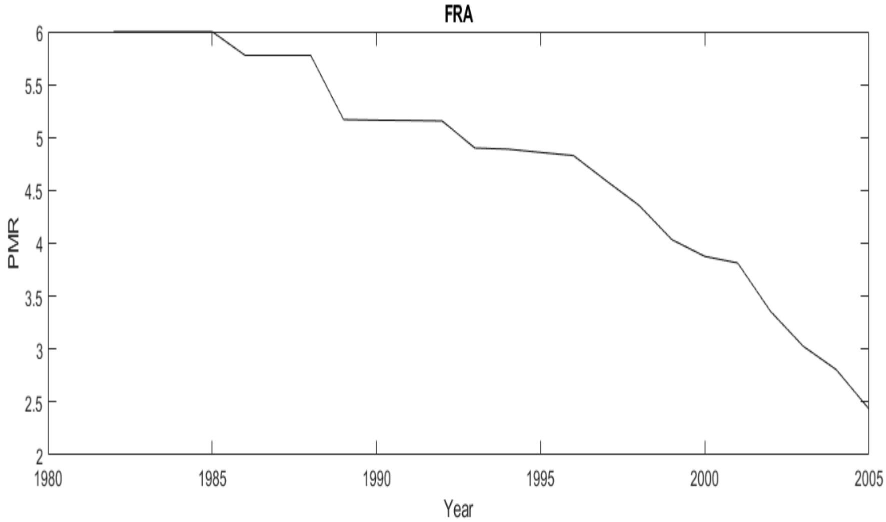
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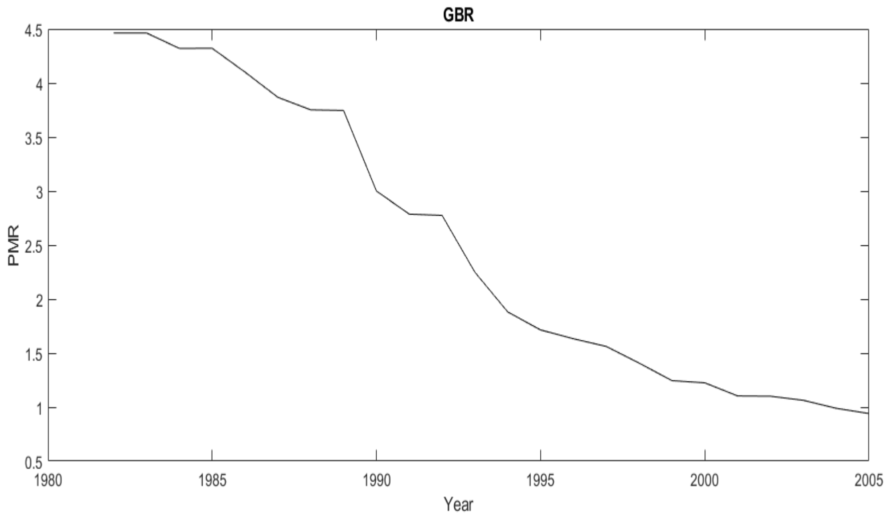
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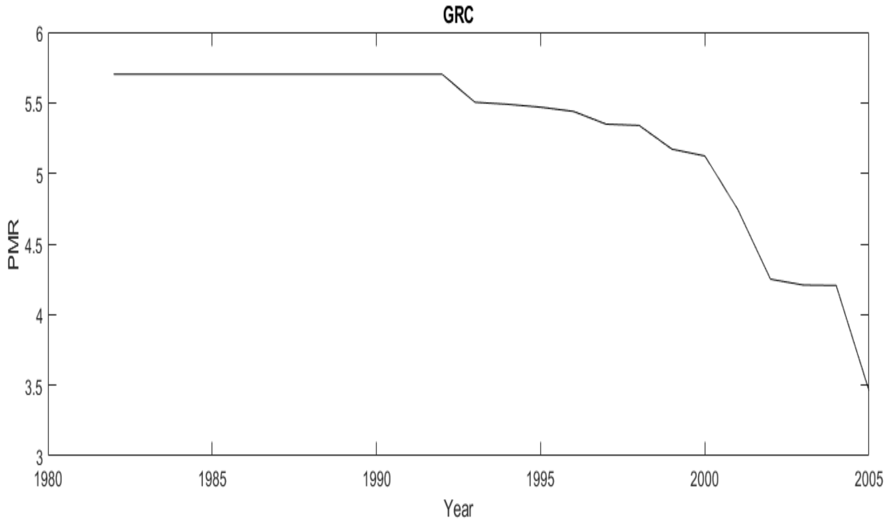
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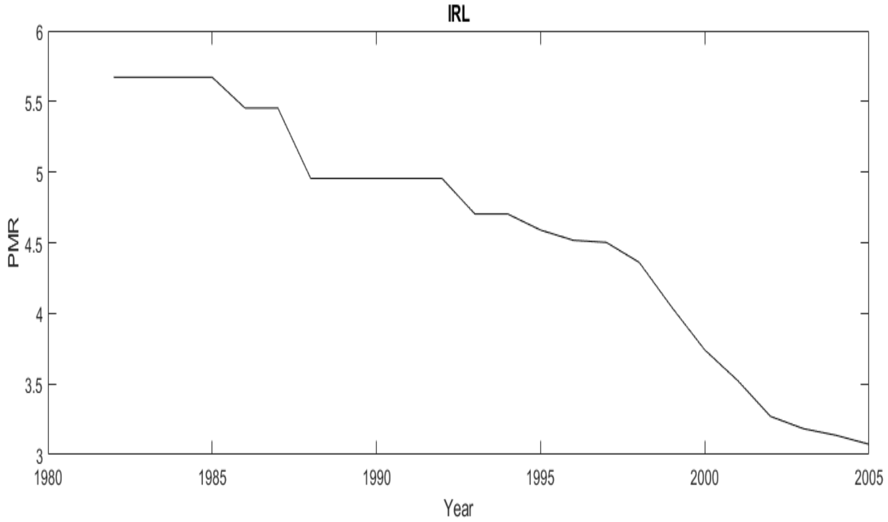
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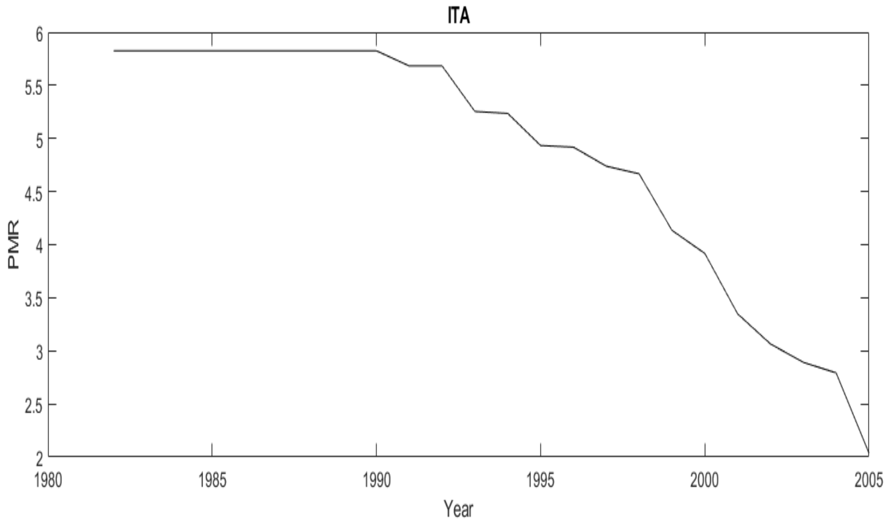
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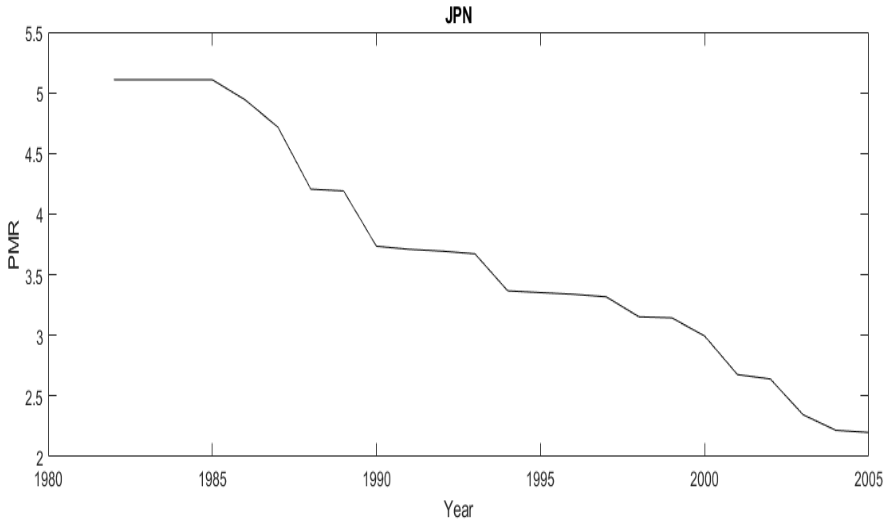
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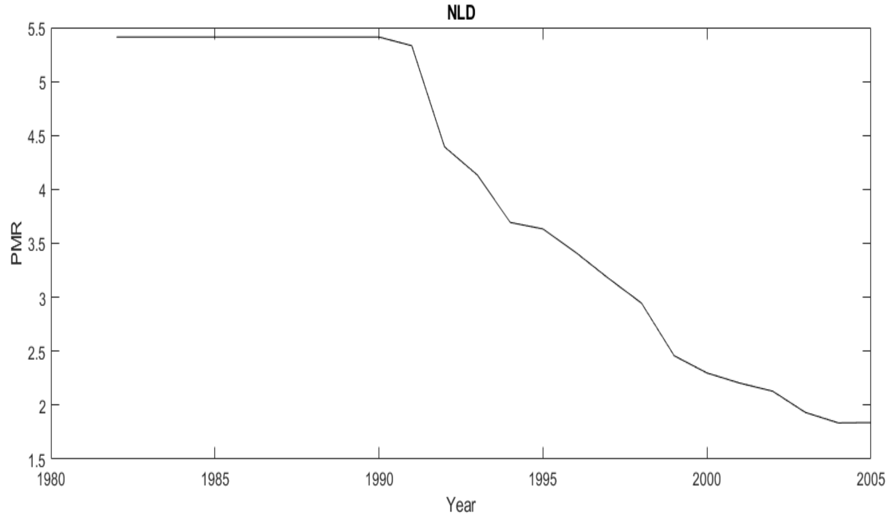
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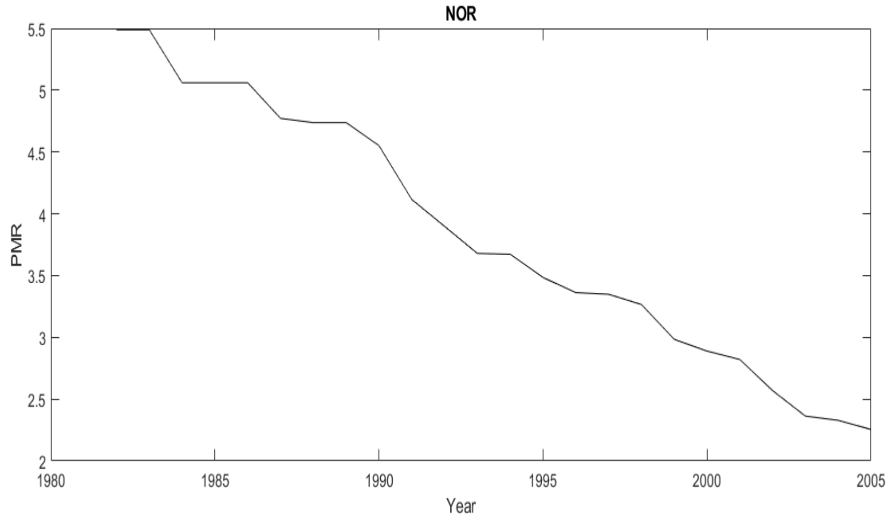
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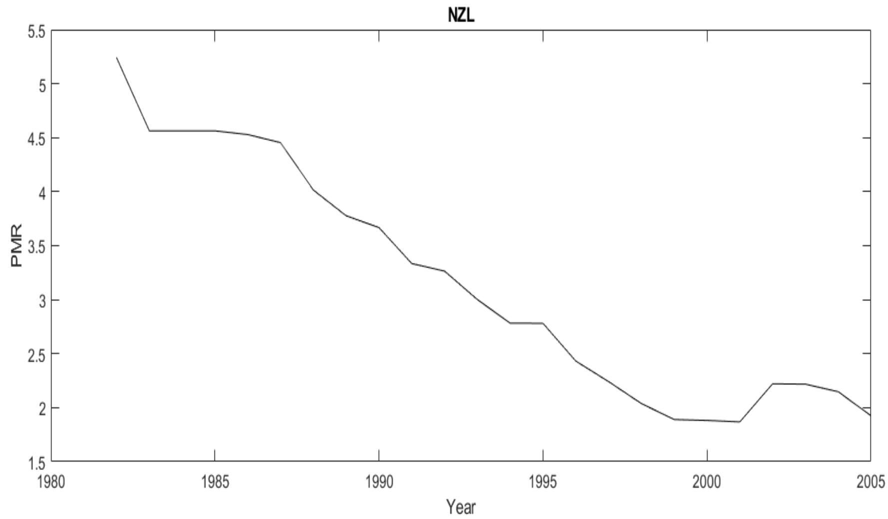
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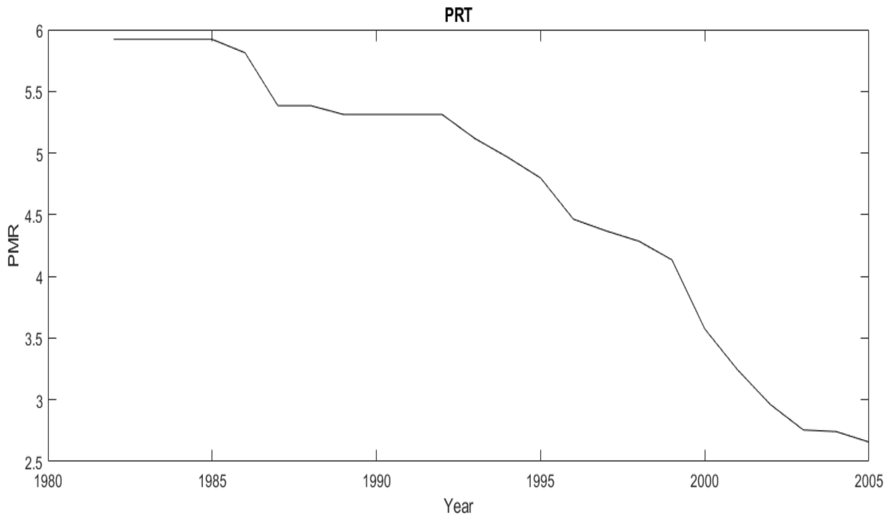
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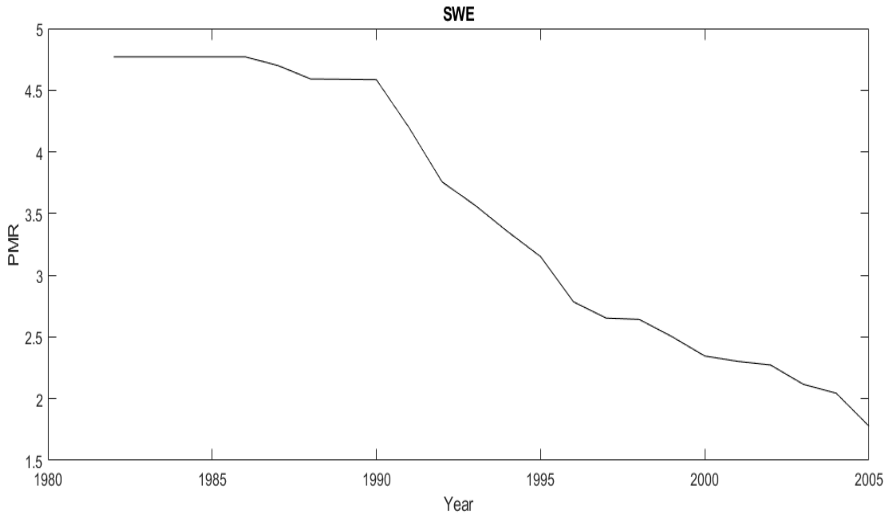
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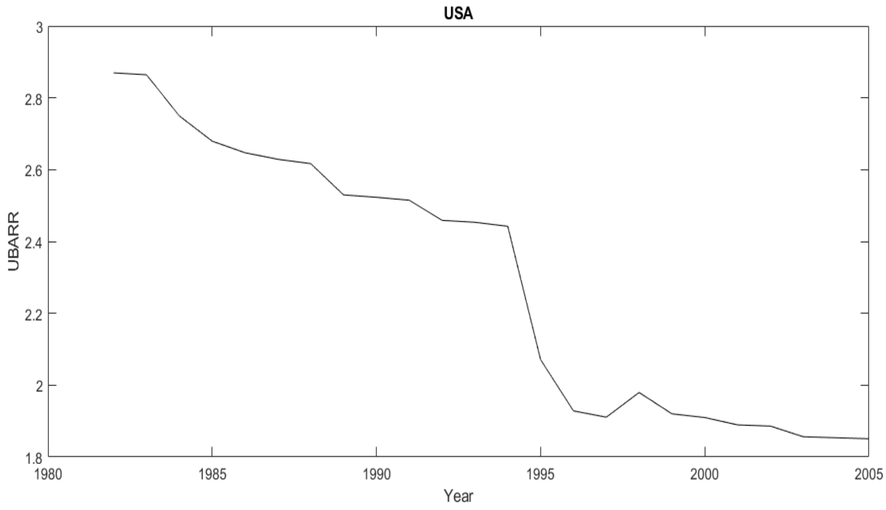
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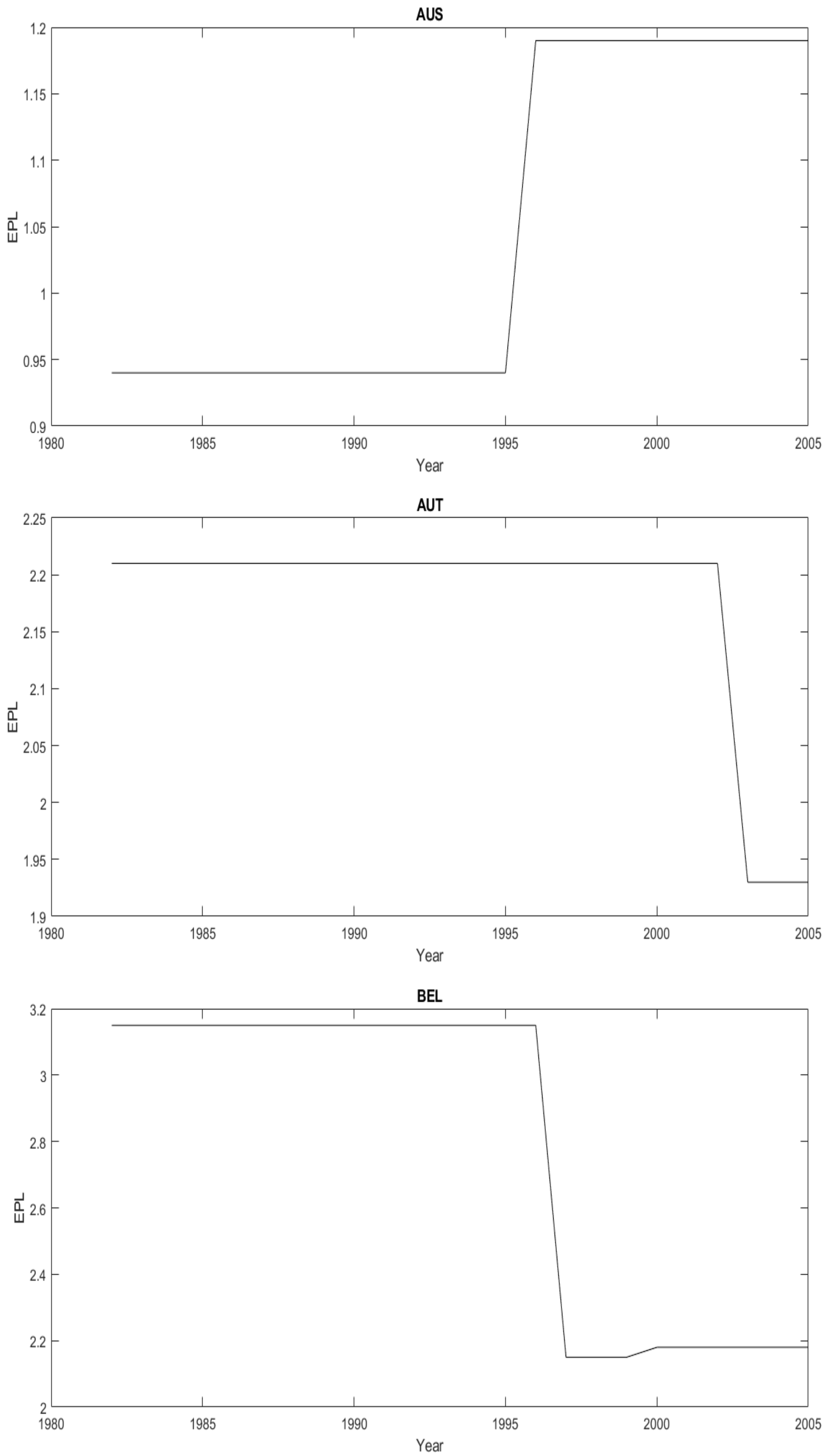
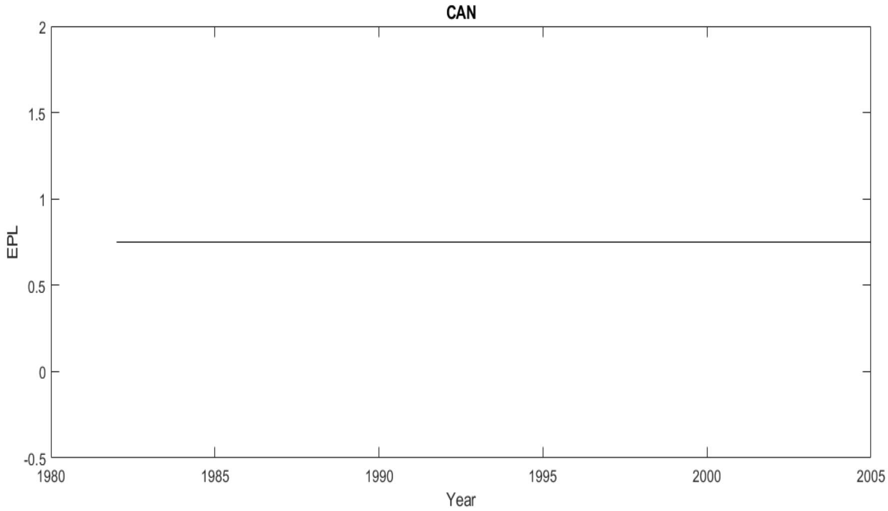
D.2 Employment protection legislation in OECD countries: 1982 - 2005

Figure D.2: Employment protection legislation in OECD countries: 1982 - 2005

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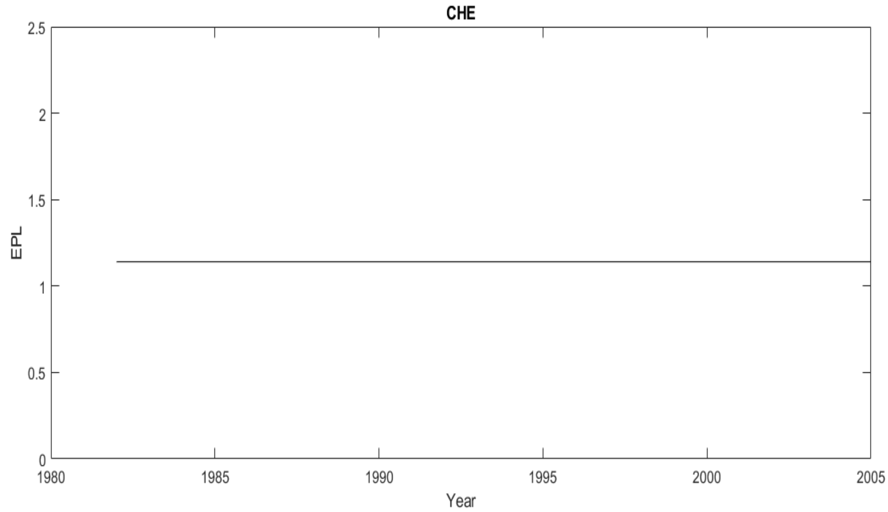
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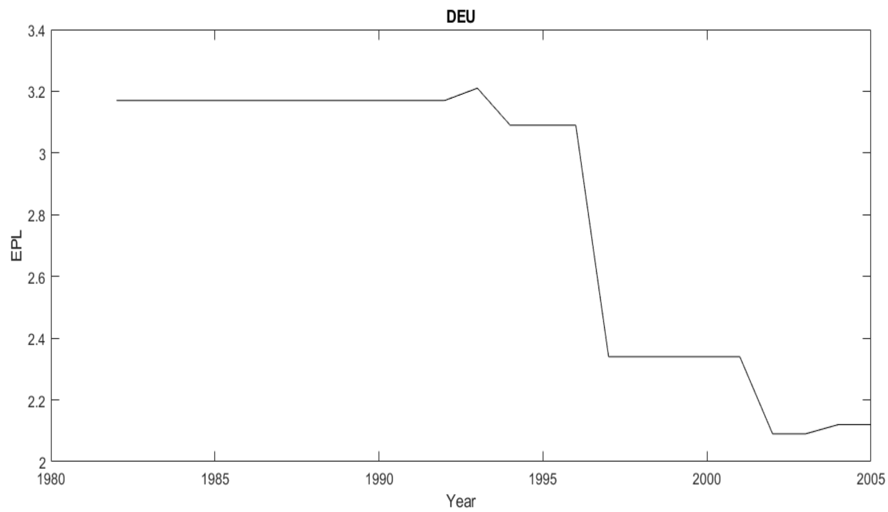
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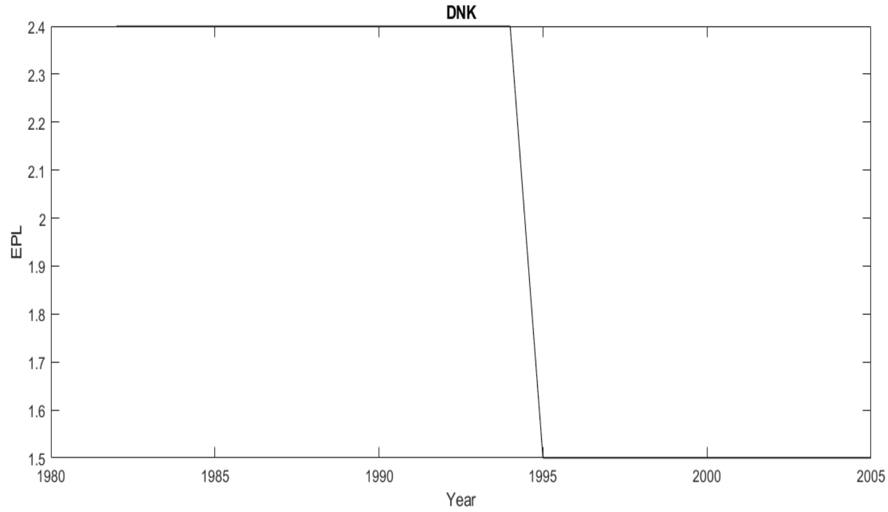
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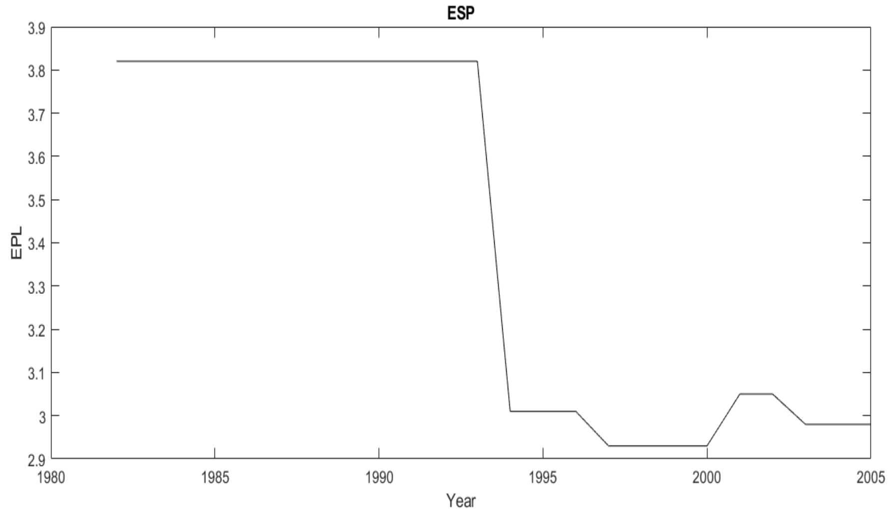
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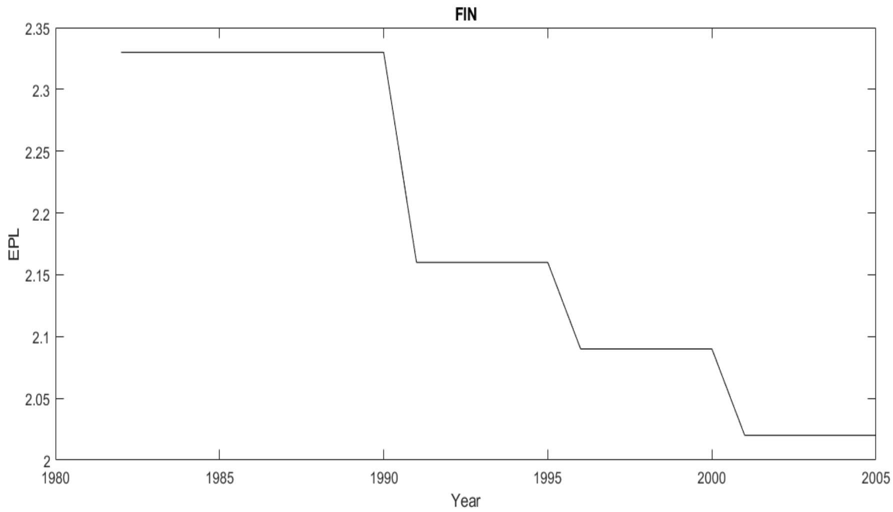
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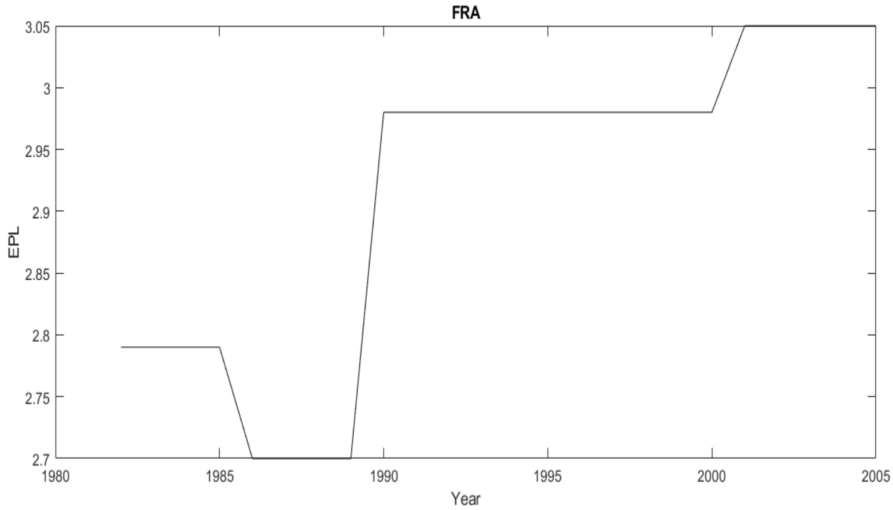
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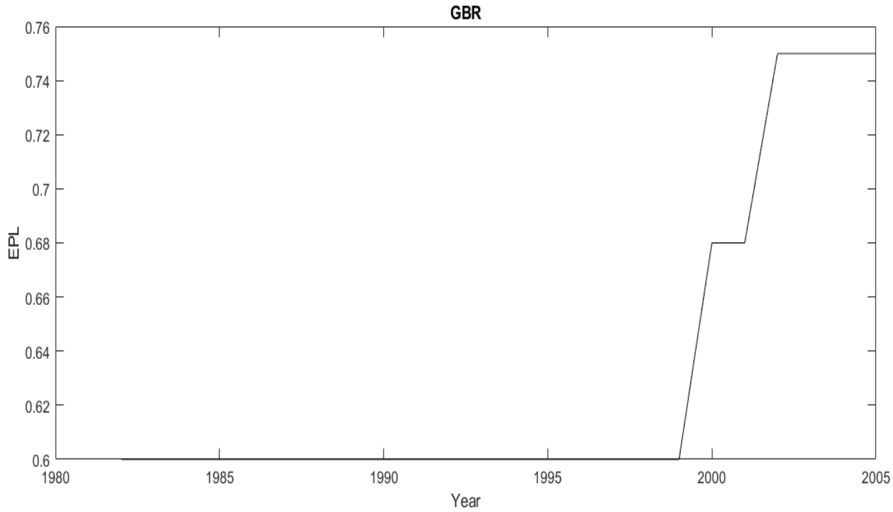
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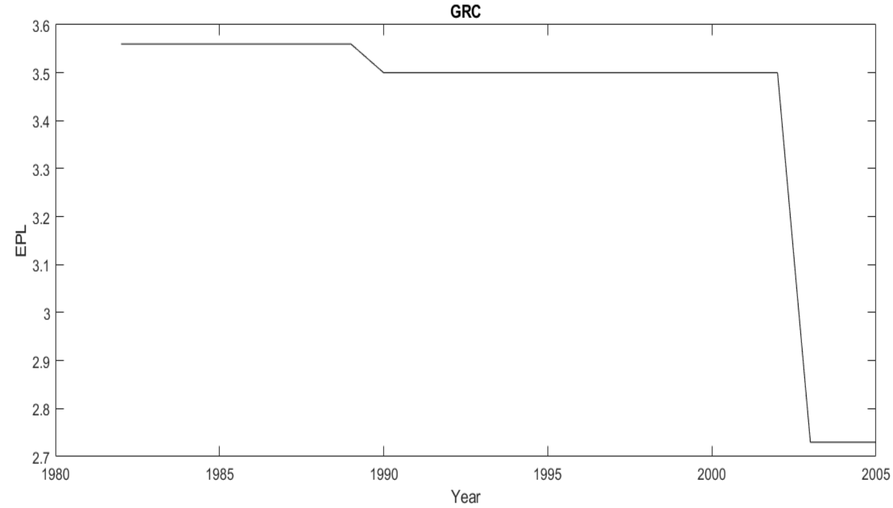
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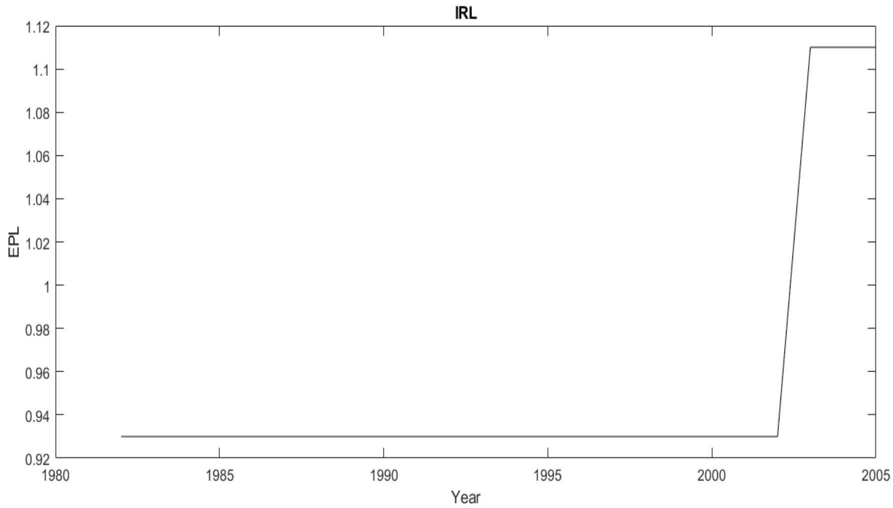
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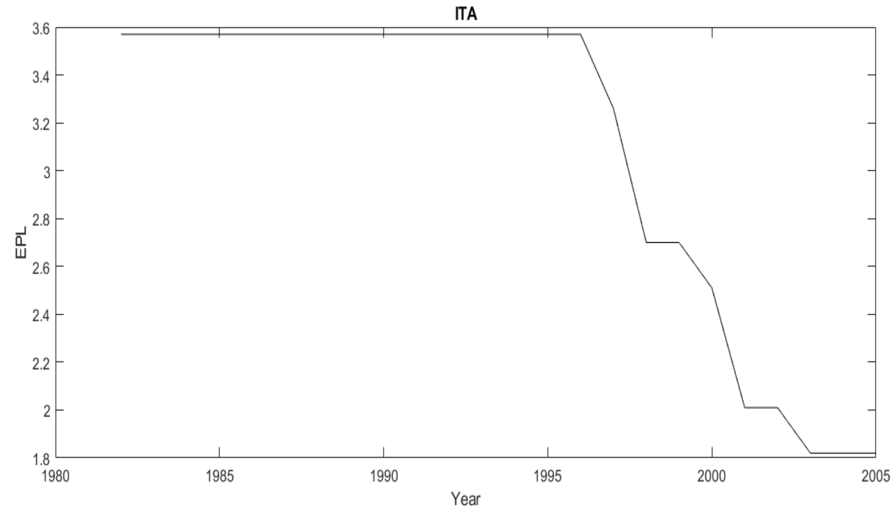
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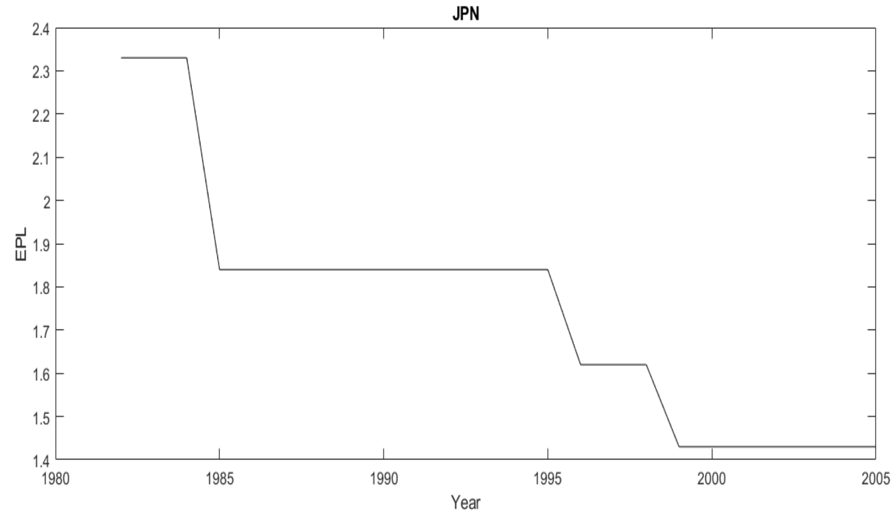
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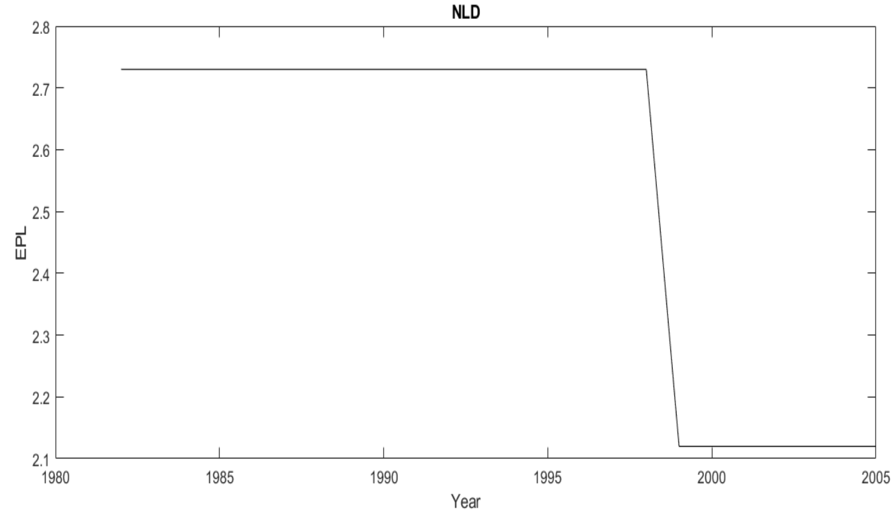
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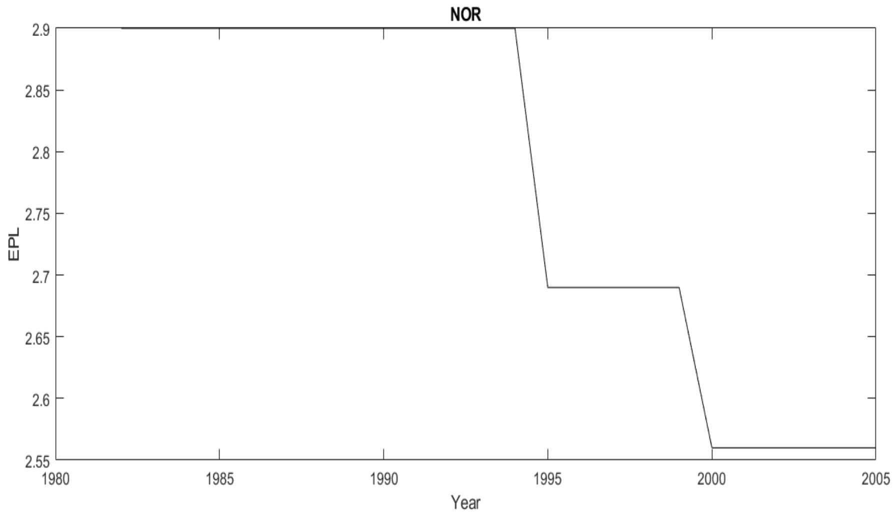
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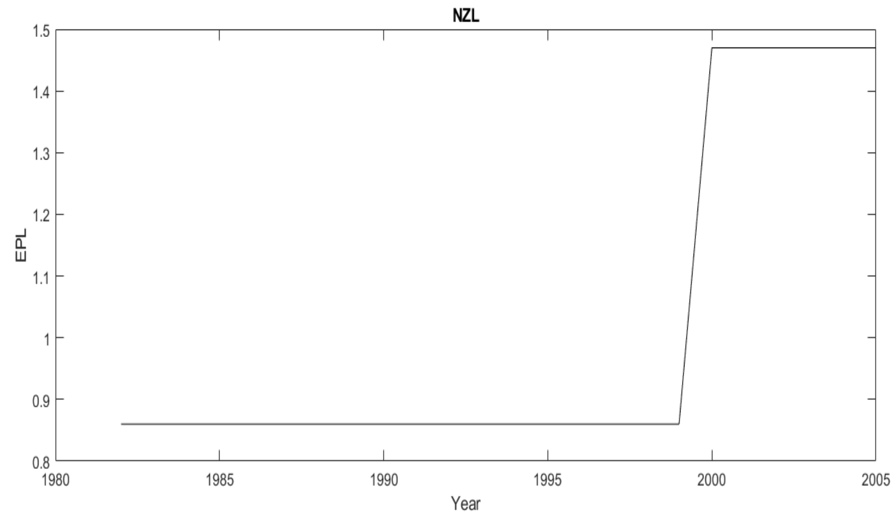
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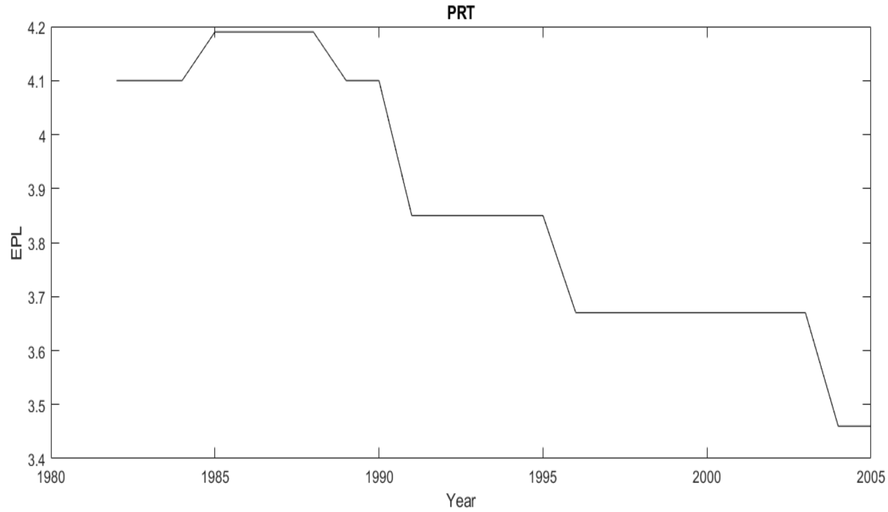
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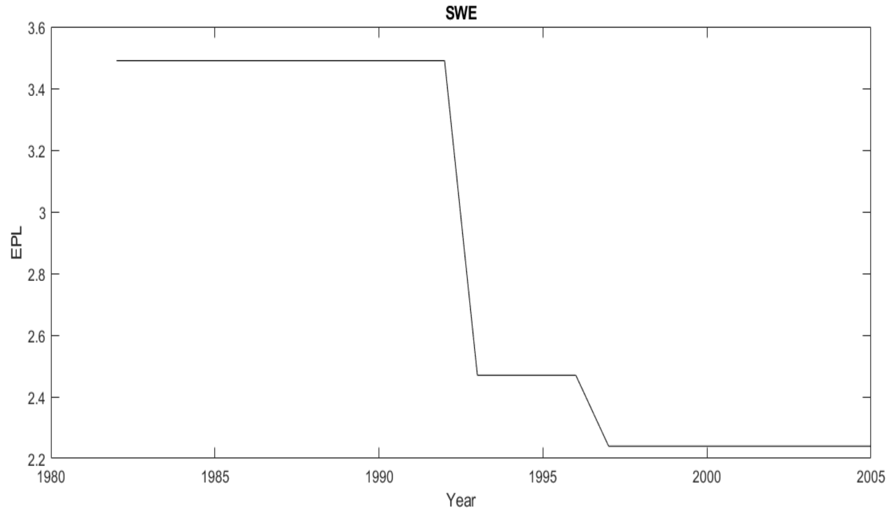
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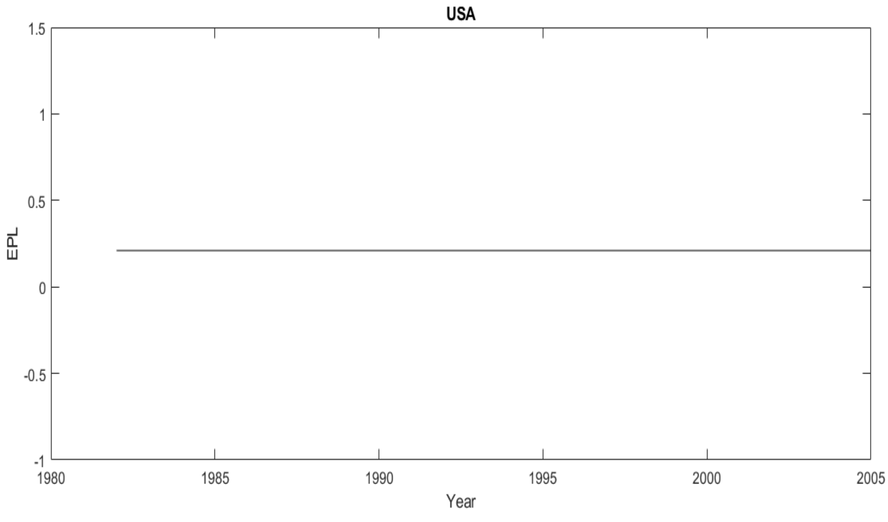
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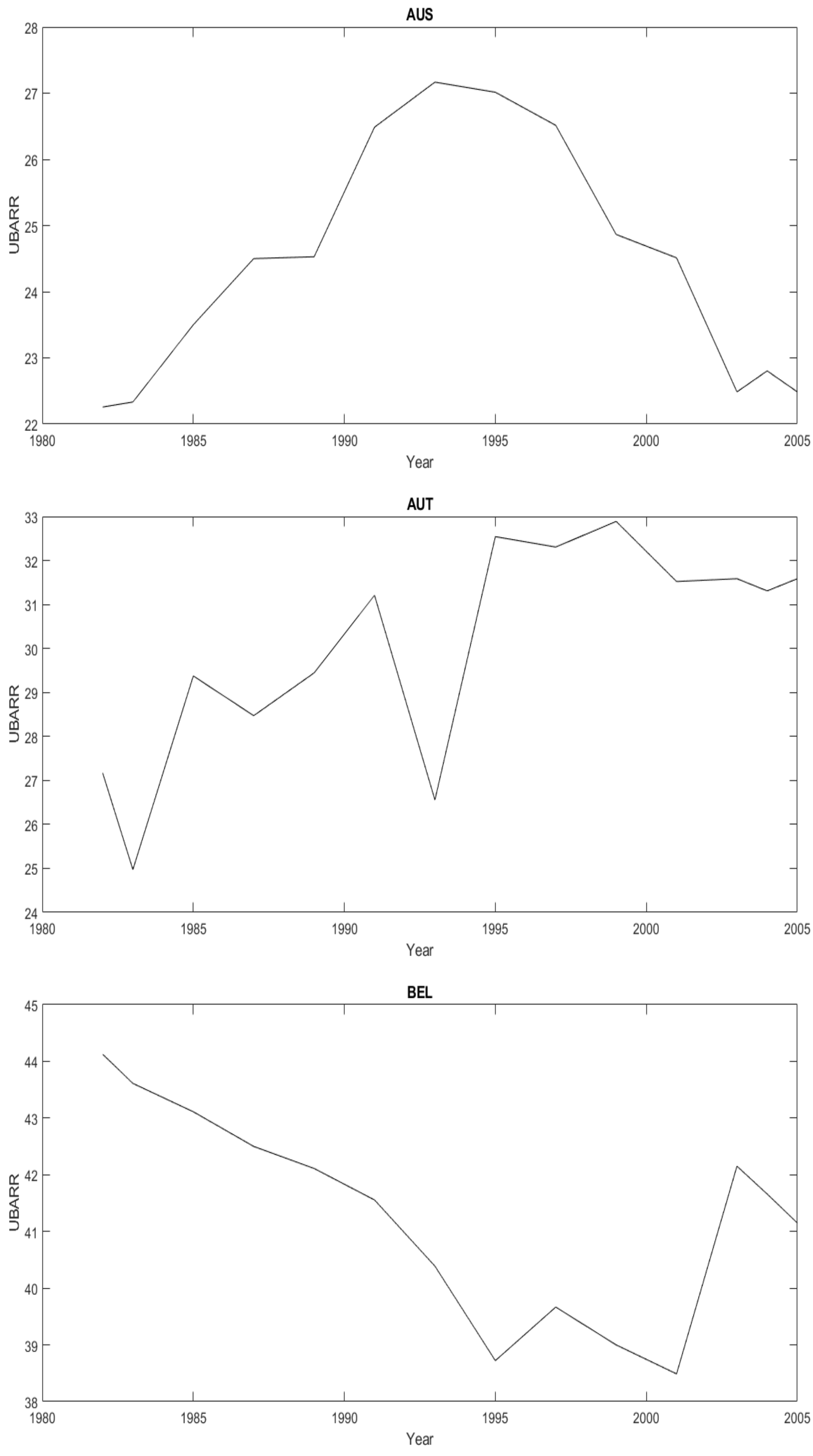
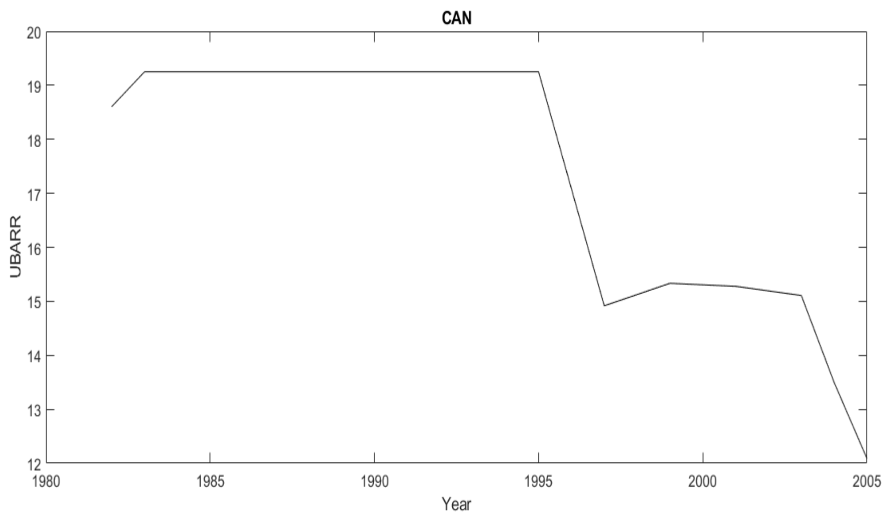
D.3 Benefit replacement rates in OECD countries: 1982 - 2005

Figure D.3: Benefit replacement rates in OECD countries: 1982 - 2005

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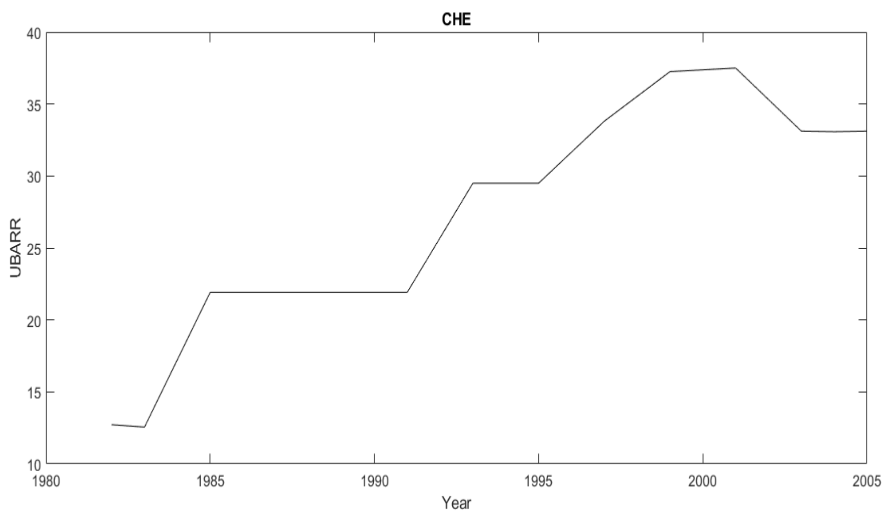
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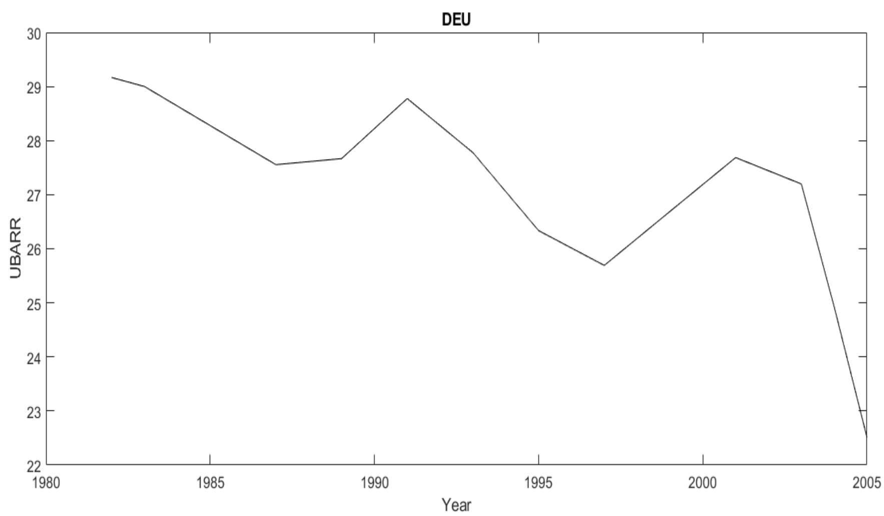
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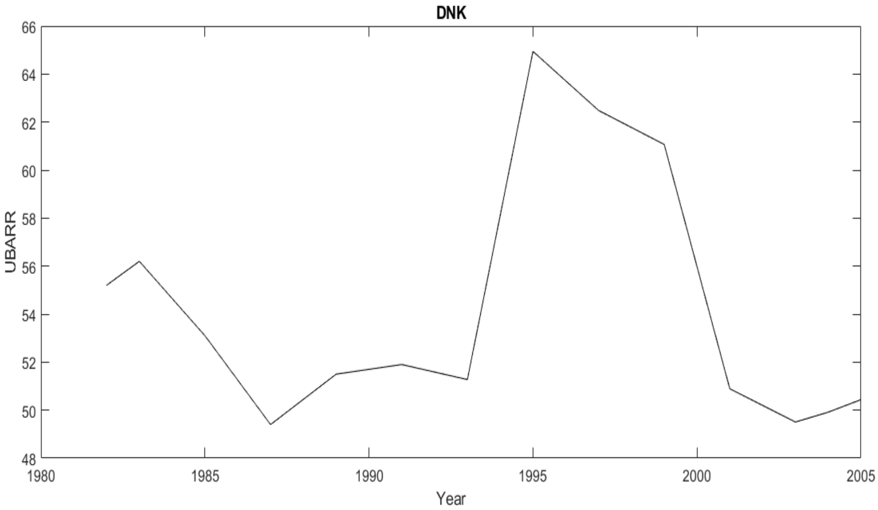
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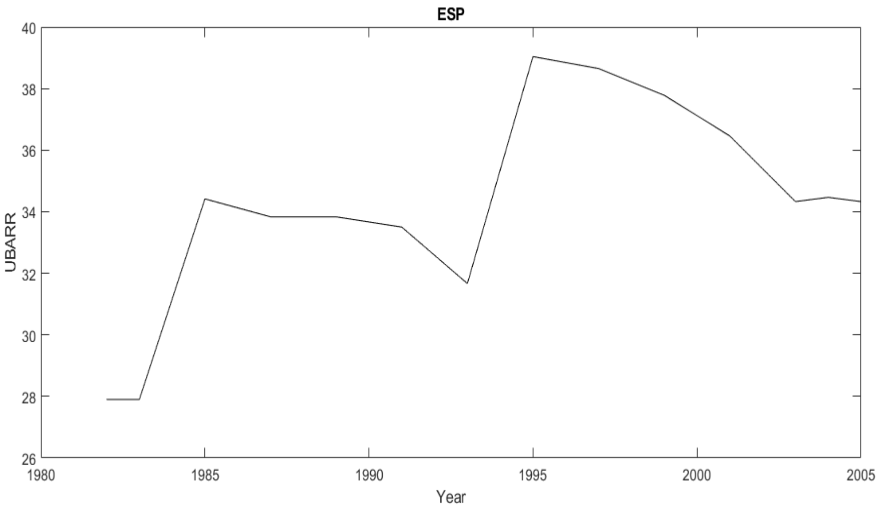
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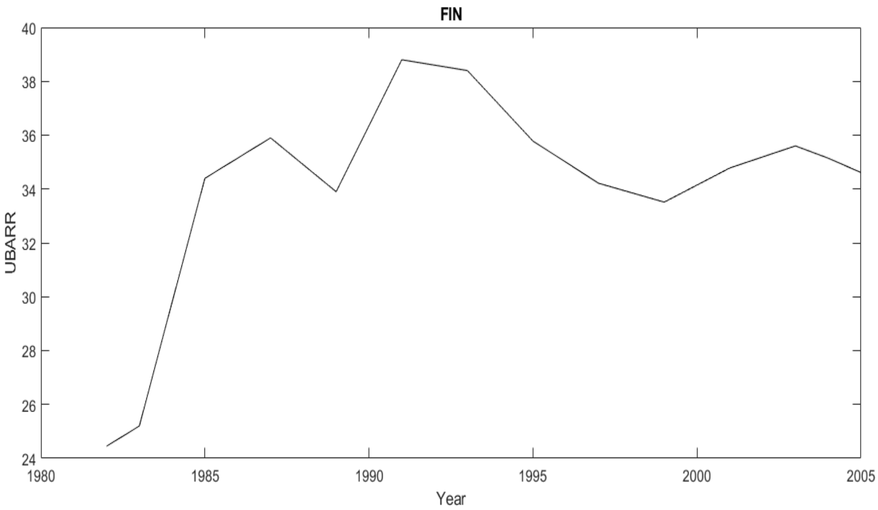
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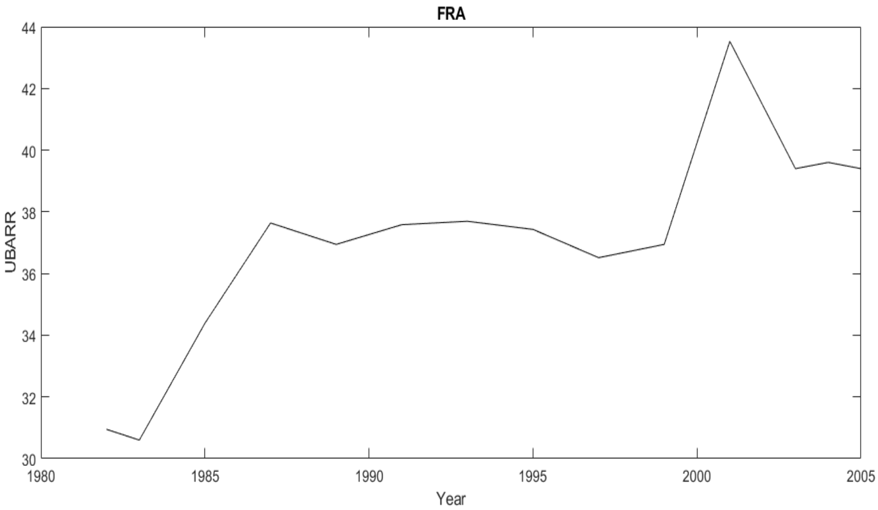
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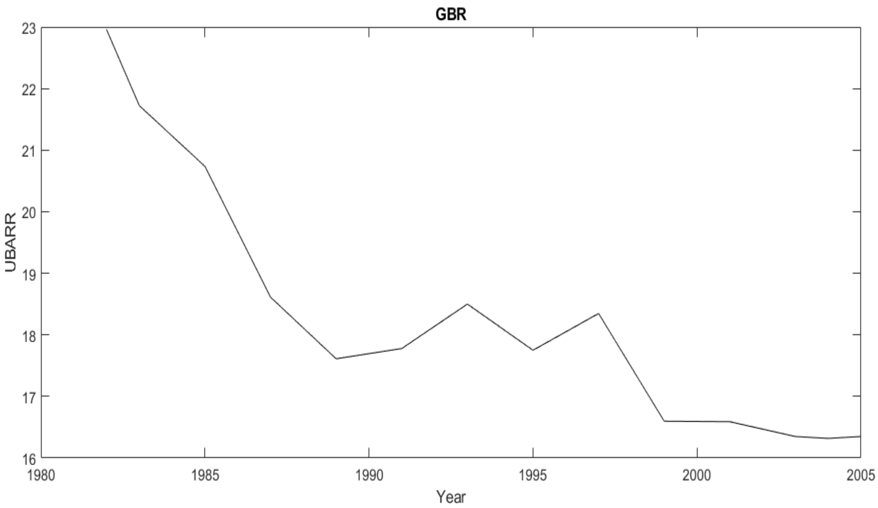
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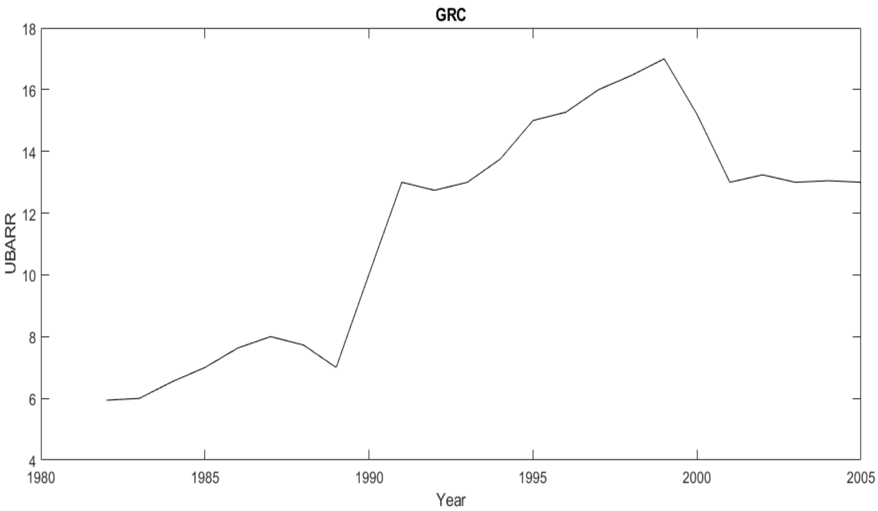
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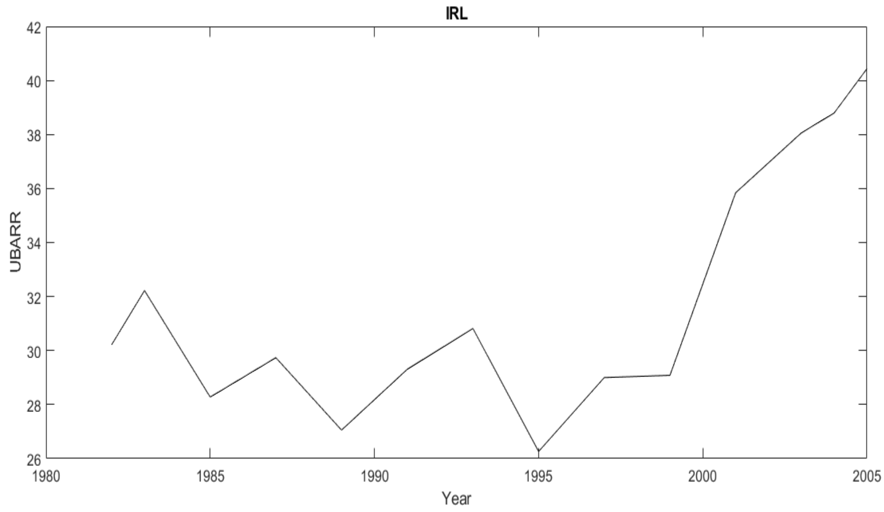
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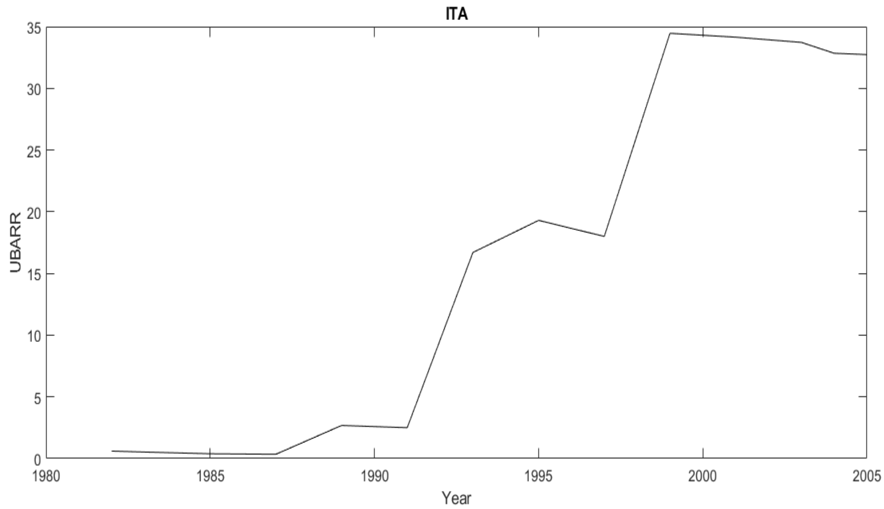
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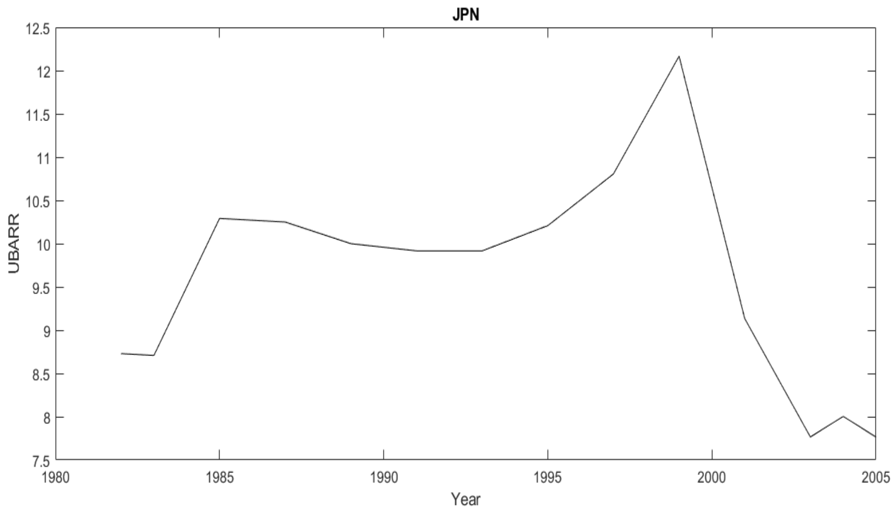
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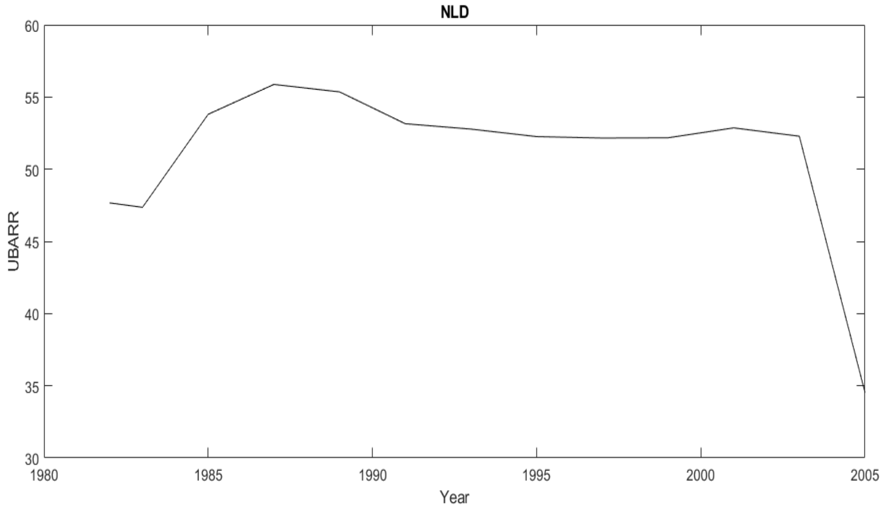
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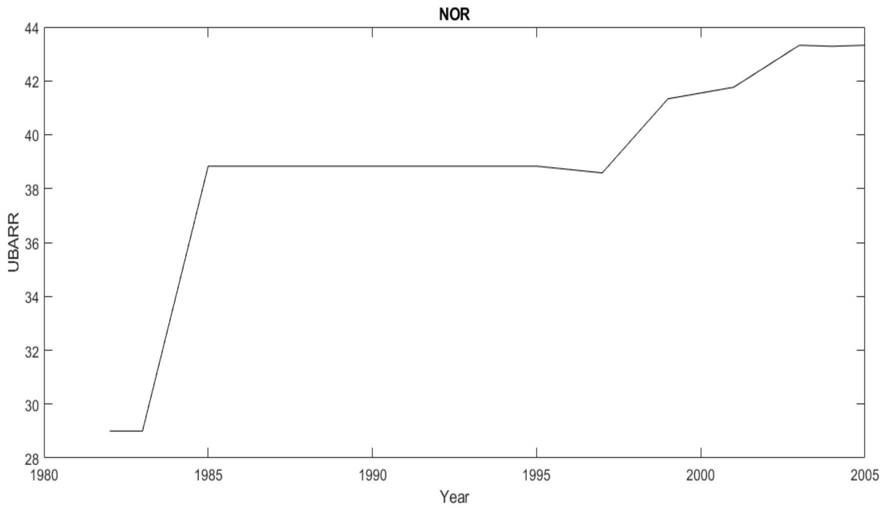
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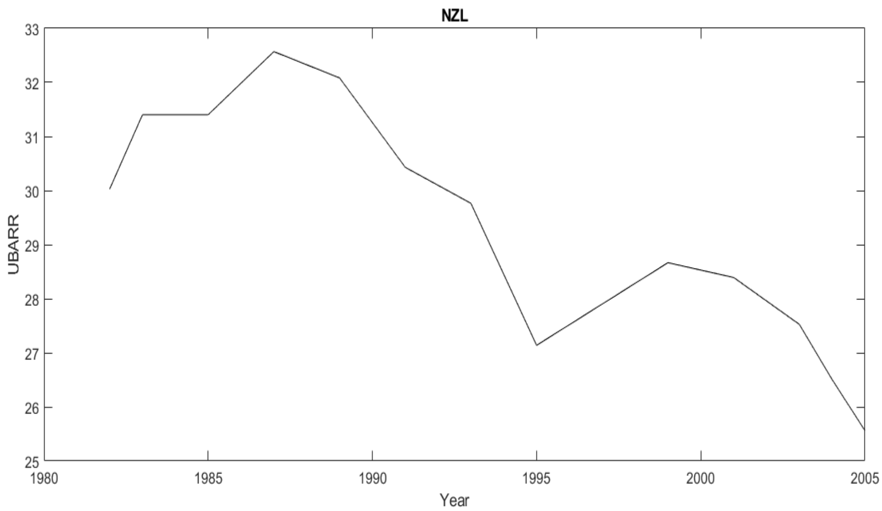
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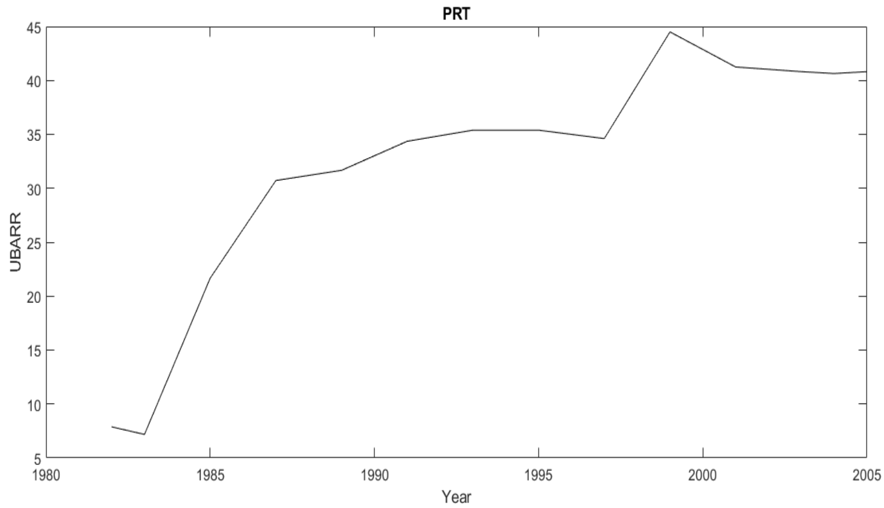
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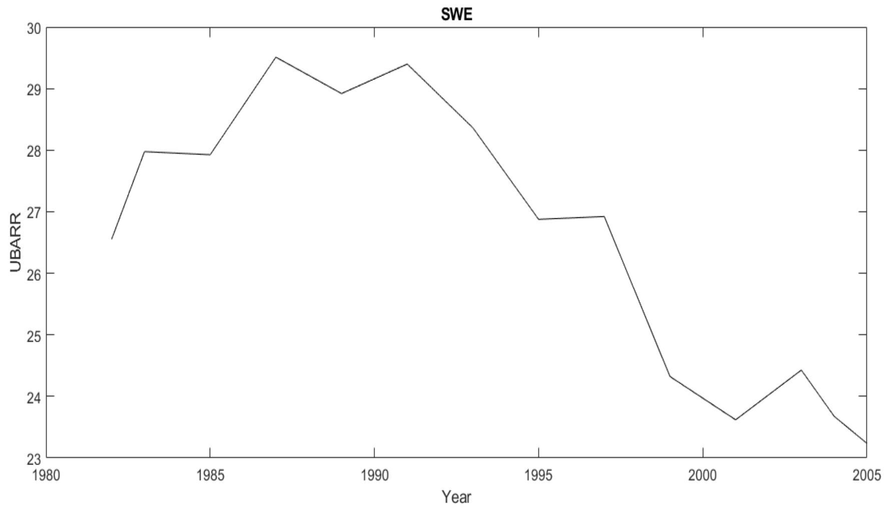
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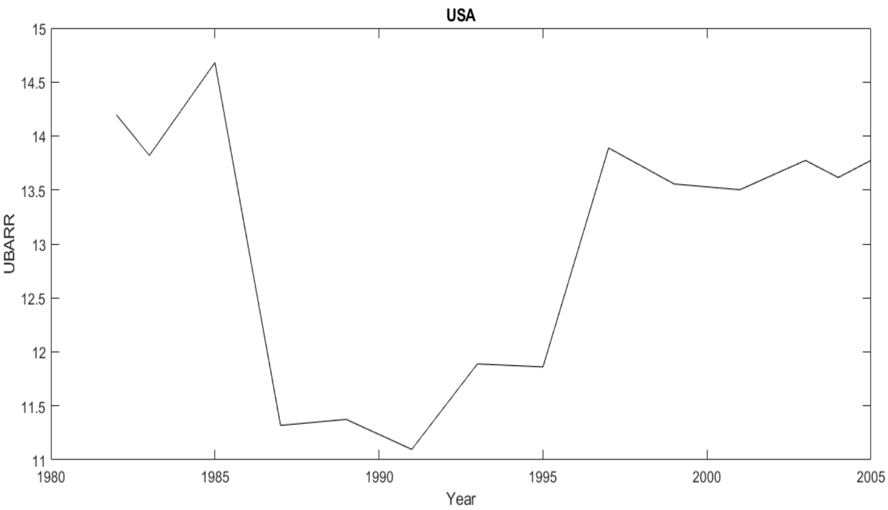
USA
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Abbreviations

Cons.	Consumption
EPL	Employment protection legislation
Inv.	Investment
JD	Job destruction
MPK	Marginal productivity of capital
MPL	Marginal productivity of labour
PMR	Product market regulation
RBC	Real business cycle
RR	Benefit replacement rate
UB	Unemployment benefits
UB-ARR	Average unemployment benefit replacement rate
Unemp. value	Value of unemployment
UI	Unemployment Insurance
UR	Unemployment rate
VAR	Vector autoregression

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