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Firing and training costs and labour market segmentation

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Abstract of the thesis

This dissertation consists of three essays on the labour market impact of firing and training costs. The modelling framework resorts to the search and matching literature. The first chapter introduces firing costs, both linear and non-linear, in a new Keynesian model, analysing business cycle effects for different wage rigidity degrees. The second chapter adds training costs to firing costs in a model of a segmented labour market, accessing the interaction between these two features and the skill composition of the labour force. Finally, the third chapter analyses empirically some of the issues raised in the second chapter.

Keywords: Labour market institutions; Search and matching; work-related training; fixed-term contracts.

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Introduction

The three essays that compose this dissertation focus on the interaction between the labour market and institutions, namely employment protection legislation (EPL) in the form of firing costs, and human capital issues, also conditioned by training costs. This analysis is pursued through a modelling framework that is largely based on the new Keynesian and search and matching literature. Two of the essays address directly the context of segmented labour markets which is a reality in several European countries. The first chapter analyses the business cycle impacts of introducing linear and non-linear firing costs in a new Keynesian model with different degrees of wage rigidity. The second chapter is based on a model of a segmented labour market in which both firing and training costs are present. The interaction between these two features and the skill composition of the labour force is analysed in this chapter. Finally, the third chapter analyses empirically some of the issues raised in the second chapter, namely the impact of employment protection and human resources policies on the type of contractual relationships prevailing in the labour market.

The first chapter draws on Krause and Lubik (2007) to analyse the impact of firing costs on the business cycle features of a new Keynesian model with monetary policy in which the labour market is modelled using a search and matching framework. These authors signal the limitations of this framework regarding some business cycle features like the its inability to generate the empirical negative correlation between unemployment and vacancies (the so called Beveridge curve) and the inflation persistence seen in the data and try to circumvent them by including wage rigidity in the model. This chapter extends this analysis by adding firing costs to this setup, in isolation and in interaction with wage rigidity. In a first approach, firing costs are considered to be linear, as commonly assumed in the literature. However, this assumption does not take into account that increasing separations may have intangible costs, like loss of job-specific human capital, which do not translate into symmetrical benefits when separations are reduced. It can also be viewed partially as a proxy for labour market regulation in a segmented labour market, where for a small number of dismissals only workers with fixed-term contracts with low firing costs are affected, while for high separation rates employees with open-ended contracts are also impacted. This chapter proposes an asymmetrical firing cost function as a reduced form to address this problem, and evaluates the impact of its implementation in the model and its business cycle properties. This setup allows for an improvement of the business features of the model when compared to the baseline similar to the one obtained with linear firing costs, but the response of output to monetary policy shocks is now asymmetrical and more muted in the case of a contractionary shock.

The second chapter tries to approach the issue of job-acquired human capital, embodied in on-the-job training, and its interaction with labour market protection in a more formalized way. In this model, the labour market is considered to be explicitly segmented, with fixed-term contracts functioning as a screening device for firms, in an environment where temporary contracts serve the purpose of fulfilling more undifferentiated tasks and open-ended contracts more specialized functions that require a skilled workforce. This skill level is however not static, and can be increased on the basis of on-the-job training. Firms face therefore a tradeoff between waiting to hire a skilled worker from the unemployment pool, which depends on the overall labour market tightness and the average skill level of the economy, or train an unskilled temporary employee. This equilibrium will be affected by labour market institutions, which therefore condition the long-run skill level and productivity of the economy. To the extent that human capital accumulation can be a source of economic growth, the long-run implications of labour market institutions are an important aspect to bear in mind, and so far relatively neglected in the literature. Although the consequences for economic growth are not addressed in the work, the analysis offers some insight on this issue. Results emphasize the analysis of the impact of recent and possible future reforms in European labour markets, showing that a policy along the lines of the single contract can have benefits in terms of increased employment and higher average skill level in the economy.

The third chapter tries to assess empirically one of the main assumptions of the second chapter, namely the nexus between training and transitions from fixed-term to open-ended contracts or to joblessness in Europe and how it is affected by employment protection legislation. In the analysis, intra and inter-firm transitions between temporary and permanent contracts are distinguished, a feature not explored in the literature. Results signal the positive impact of training and of the flexibility of labour regulations on transitions from temporary to permanent contracts, particularly in segmented labour markets. A strong feature of the results is that workers with a sequence of temporary jobs have a lower probability of making a transition both to permanent employment and to unemployment, suggesting the persistence of this form of contract in the careers of some workers.

In general, this work extends the discussion on the impact of labour market institutions, namely employment protection legislation, to the interaction with human capital, an aspect which has long-term impacts on workers careers, productivity, and growth potential of economies.

Chapter 1

Firing costs and real wage rigidity in a New Keynesian model

Abstract

Although the introduction of the search and matching framework in New Keynesian models has been successful, some caveats remain. Namely, these models fail to replicate some labour market stylized facts, as the negative correlation between vacancies and unemployment, the so called Beveridge curve. This paper introduces in such a setup the impact of employment protection legislation, namely firing costs, along the lines of Krause and Lubik (2007). The impact on business cycle dynamics of this relevant factor for European labour markets, as well as the interaction of this feature with real wage rigidity, is analysed in this paper. As an original contribution to the literature, the impact of non-linear firing costs is also object of analysis. Conclusions suggest that the introduction of firing costs in the model improves some business cycle features of models in this framework, although it maintains limitations in other aspects, like the estimated correlation between job flows.

JEL Classification: E24, E32, J64.

Keywords: Labour market; Search and matching; New Keynesian model; Labour market institutions; Asymmetric adjustment costs.

1.1 Introduction

Real Business Cycle and later New Keynesian models have become the reference economic models as regards business cycle analysis. However, in their initial versions, these models presented some limitations as to replicate business cycle facts. Given the importance of the labour market for welfare and policy definition, a serious shortcoming of these models was the absence of unemployment in equilibrium, as the labour market was usually modeled as frictionless. In an attempt to circumvent this limitation, more recently a labour market framework characterized by search and matching frictions (Mortensen and Pissarides (1994)) has been integrated in New Keynesian models (Trigari (2006), Blanchard and Galí (2010) and Christoffel et al. (2009) among others). The generalization of this approach to labour market modelling reflects some interesting features, like the presence of rational expectations, optimizing agents and a focus on flows into and out of unemployment. Although the matching function, that describes the process through which workers and firms meet in the labour market, lacks microeconomic foundations, the simplicity of its functional form and the fact that it is validated by the data (Petrongolo and Pissarides (2001)) also contributed to the popularity of this approach. Although the search and matching framework has helped to improve the business cycle properties of New Keynesian models, some empirical regularities are not yet replicated by the model, namely the volatility of vacancies, the negative correlation between this variable and unemployment (usually designated as the “Beveridge curve”) and between job creation and job destruction rates.[1] In addition, Christoffel et al. (2009) analyze the several variants of New Keynesian models with a search and matching framework available in the literature (right-to-manage, on-the-job search, endogenous destruction, etc.) and conclude that in general these models provide a response of inflation to monetary shocks that is much more volatile than in the data. They conclude that the model that most successfully addresses this problem combines right-to-manage bargaining with nominal wage stickiness. Other

[1] See Yashiv (2007) and Hornstein, Krusell and Violante (2005) for a survey of the search and matching framework and its applications in macroeconomics, as well as of its caveats.

works have tried to solve the empirical problems of the search and matching framework, in particular the muted response of unemployment and vacancies to productivity shocks, by adding wage rigidity, as in Hall (2005). However, Hornstein et al. (2005) argue that this approach also originates some results at odds with empirical evidence. Moreover, Krause and Lubik (2007) claim that although full wage rigidity allows a New Keynesian model with search and matching frictions to generate a Beveridge curve, other issues remain, namely as regards inflation persistence.

Another branch of the literature has focused on the role of institutions and in particular employment protection legislation (EPL) in the labour market. Strict employment protection regulation is a relevant feature of the labour market in many countries. In fact, Emerson (1988) concluded from a survey of European firms that the large majority considered that obstacles to the termination of employment contracts were fundamental or serious and that, in all but one case, more than half of the sample surveyed in each country found lack of hiring and firing flexibility to be an obstacle to employment creation. For an assessment of the relative importance of these type of institutional features across countries, see Venn (2009). Therefore, EPL assumes a very important role for labour market policy. This is reinforced by the fact that in general work on this matter concluded that EPL leads to a reduction in job flows. However, the effect on unemployment is less clear, given the opposing contributions created by the decrease in entry and exit job flows (see Arpaia and Mourre (2012) for a summary of the literature). This may lead economies with very different labour market institutions to have similar unemployment rates, despite very different size of job flows and unemployment duration (see Blanchard and Portugal (2001) for an application to the United States (US) and Portuguese labour markets). Ljungqvist (2002) demonstrates that the impact on employment of an increase in firing costs is actually model dependent, and that in search in matching models the impact hinges on the effect on the relative bargaining power of workers. Costs of dismissal are composed of a transfer from a firm to the worker, the severance payment, and other administrative, time and legal costs. Despite the fact that severance costs appear to be quantitatively more relevant (see Garibaldi and Violante (2005) for a computation of these costs for the case of the Italian economy), Emerson (1988) reports that for every country surveyed the redundancy payments related to dismissal were considered to be less important than the length of notice periods and the difficulty of legal procedures. Normally in the context of search and matching models only the costs that do not constitute a severance payment are considered, given that the effect of the transfer from firms from to workers could be in theory contractually annulled in an environment of rational, risk-neutral agents (see Lazear (1990) for an illustration). This is also the approach followed in the current work.

Some papers have combined to some extent the strands of the literature related to firing costs and some form of wage rigidity: Garibaldi and Violante (2005) prove that the above mentioned neutral effect of a severance payment does not hold under wage rigidity. Cahuc and Zylberberg (1999) conclude that the same is true when the hypothesis that wage renegotiations take place every period is dropped and Cassorla (2010) analyzes the interaction of firing costs and minimum wages.

In the above mentioned approaches to firing costs, these are considered to be linear, resulting in a cost of increasing separations which is identical to the savings for the firm by reducing them. However, increasing separations may carry effects other than the monetary ones, as loss of human capital (see Ljungqvist and Sargent (2005) for an application of the search and matching framework with loss of worker skills upon layoff) or loss of worker morale (Bewley (1995)). Several microeconomic studies have found evidence of asymmetry in costs of labour adjustment, despite measurement issues that hinder this analysis, because many of these costs are "internal", given that they are translated into changes in production but not directly measurable (see Hamermesh and Pfann (1996) for a survey of the literature).[2]

As a proxy for these effects, we implement an asymmetrical firing cost function, ac-

[2]These results are not however directly transposable to the current framework given that labour adjustment costs result from the joint costs associated with changes in creation and destruction of jobs.

cording to which increases in the separation rate amount to higher costs than the benefits induced by a reduction. Moreover, the costs are higher the larger the size of the increase in the separation rate, such that abrupt variations are more penalized than gradual ones, i.e, the cost function is convex. This approach is an application to firing costs of the work by Kim and Ruge-Murcia (2009) and Fahr and Smets (2010) regarding downward wage rigidity.

The current paper follows closely Krause and Lubik (2007) and to a smaller extent Walsh (2003) and den Haan, Ramey, and Watson (2000), adding to the setup of these models linear firing costs, along the lines of Zanetti (2011) or Thomas and Zanetti (2009). The current work differs from these references by analyzing the effects of productivity and monetary shocks not only with firing costs and wage rigidity considered separately, but also the interaction between these two features. In addition, the impact of introducing asymmetrical firing costs in the model is also analysed.

We conclude that firing costs, both in their linear and non-linear form, help to improve some of the results of a New Keynesian model augmented with search and market frictions, namely by replicating the negative correlation between unemployment and vacancies present in the data while requiring a less strict assumption than the full wage rigidity hypothesis in Krause and Lubik (2007). However, they do not contribute to replicate other features of the data, namely the persistent response of inflation to monetary shocks. The model that presents the best overall performance as concerns business cycle properties combines firing costs and wage rigidity, suggesting that further research is needed on interaction between labour market institutions.

The structure of this paper is as follows: Section 1.2 presents the model with linear firing costs and the wage rigidity variant. Section 1.3 presents the model calibration and the assessment of steady-state and business cycle properties. Section 1.4 presents the extension to non-linear firing costs. Section 1.5 concludes.

1.2 Model

1.2.1 Model with Linear Firing Costs

The baseline model largely follows Krause and Lubik (2007), whose results are taken to be a starting point of the analysis. Some details of the model, namely the law of motion for employment and the timing of events in the labour market, follow den Haan et al. (2000).

Households

There is continuum of households in the unit interval. Each household is composed of employed and unemployed agents and maximizes its expected lifetime utility at time *t*, given by the function U_t, which depends on real consumption (c) and the real stock of money $\left(\frac{M}{P}\right)$. For this optimization problem the only relevant constraint is the aggregate resource level of the household, an assumption that allows us to abstract from distributional issues among employed and unemployed agents.[3] The labour supply is fixed at one (therefore labour force equals population). Therefore, given that there are *(e)* employed workers, the remaining *(1-e)* agents are unemployed. The fact that the labour force is standardized to unity allows probabilities associated to labour market events and the corresponding labour flows to be identical in this model.

Therefore, the problem faced by the representative household is the following:

$$\max_{\left\{c_t, \frac{M_t}{P_t}, \frac{B_t}{P_t}\right\}_{t=1}^{\infty}} \bar{U}_t = E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\sigma} - 1}{1-\sigma} + \chi \ln \frac{M_t}{P_t} \right] \tag{1.1}$$

[3] Alternatively, the consumer problem for employed and unemployed agents could have been modelled separately, but in this case, given that they have the same utility function and there is no disutility from work, the same first order conditions would arise.

subject to the folllowing budget constraint (expressed in real terms, where high case letters denote nominal variables, while low case letters denote real variables):

$$c_t + \frac{M_t}{P_t} + \frac{B_t}{P_t} \leq w_t e_t + \frac{M_{t-1}}{P_t} + i_{t-1}\frac{B_{t-1}}{P_t} + b(1-e_t) + \frac{Prof_t}{P_t} + \frac{T_t}{P_t} \tag{1.2}$$

where β is the intertemporal discount factor of the household, which is assumed to be constant, and *M* and *B* are nominal money holdings and bonds, respectively. Note that given that the economy is closed, in equilibrium the supply of bonds will equal demand and bond holdings will be zero on average. Bonds yield a gross interest rate *i* per period and *w* and *b* represent the wage rate and unemployment benefits of the employed and unemployed members of the household, respectively. *P* stands for the average price level, *Prof* are the profits of the firms accruing to the household and *T* are transfers from the state.

The Lagrangian for the consumer problem is given by:

$$\mathscr{L}(c_t, m_t, b_t, \lambda_t) = \bar{U}_t +$$

$$E_0 \sum_{t=0}^{\infty} \beta^t \lambda_t \left[w_t e_t + m_{t-1}\frac{P_{t-1}}{P_t} + i_{t-1} b_{t-1}\frac{P_{t-1}}{P_t} + b(1-e_t) + Prof_t + T_t - c_t - m_t - b_t \right]$$

given $b_{-1} = \bar{b}, \;\; m_{-1} = \bar{m}$

$$\tag{1.3}$$

The first order conditions to this problem are:

$$\frac{\partial \mathscr{L}}{\partial c_t} = 0 \Leftrightarrow c_t^{-\sigma} = \lambda_t \tag{1.4}$$

where λ_t is the shadow value of an additional unit of income to the the household, thus implying that in equilibrium it equals the marginal utility of consumption.

$$\frac{\partial \mathscr{L}}{\partial m_t} = 0 \Leftrightarrow \chi \frac{1}{m_t} + \beta E_t \left[\lambda_{t+1} \frac{P_t}{P_{t+1}} \right] - \lambda_t = 0 \tag{1.5}$$

This condition implies that the marginal utility of holding money equals the utility cost of delaying consumption one more period.

$$\frac{\partial \mathscr{L}}{\partial b_t} = 0 \Leftrightarrow \beta E_t \left[\lambda_{t+1} i_t \frac{P_t}{P_{t+1}} \right] - \lambda_t = 0 \tag{1.6}$$

The first order condition regarding bonds implies that at the margin the consumer should be indifferent between consuming an unit of income today or investing it in bonds that yield a gross interest *i*.

Finally, the remaining first order conditions are given by:

$$\frac{\partial \mathscr{L}}{\partial \lambda_t} \lambda_t = 0; \;\; \frac{\partial \mathscr{L}}{\partial \lambda_t} \geq 0; \;\; \lambda_t \geq 0 \tag{1.7}$$

And the transversality conditions are given by:

$$\lim_{j\to\infty} \beta^j E_t \left[\lambda_{t+j} b_{t+j}\right] = 0; \quad \lim_{j\to\infty} \beta^j E_t \left[\lambda_{t+j} m_{t+j}\right] = 0 \tag{1.8}$$

Replacing (1.4) on (1.6) we obtain the definition of the nominal interest rate:

$$\beta E_t \left[c_{t+1}^{-\sigma} i_t \frac{P_t}{P_{t+1}} \right] = c_t^{-\sigma} \Leftrightarrow i_t = E_t \left(\left[\frac{c_{t+1}}{c_t} \right]^{\sigma} \frac{P_{t+1}}{P_t} \frac{1}{\beta} \right) = E_t \left(\left[\frac{c_{t+1}}{c_t} \right]^{\sigma} \pi_{t+1} \frac{1}{\beta} \right) \tag{1.9}$$

where $\pi_t = \frac{p_t}{p_{t-1}}$ defines the inflation rate.

Replacing (1.4) on (1.5) we obtain the equation for the demand for money, which depends on transaction and speculative motives:

$$m_t = \chi \frac{i_t}{i_t - 1} c_t^{\sigma} \tag{1.10}$$

The supply of real money balances is given by:

$$m_t = mg_t m_{t-1} \tag{1.11}$$

where:

$$ln(mg_t) = \rho_m ln(mg_{t-1}) + \varepsilon_{mt} \tag{1.12}$$

and ε_{mt} is a stochastic variable with a Normal distribution: $\varepsilon_{mt} \sim N(0, \sigma_m)$.

Given equations (1.10) and (1.11), the equilibrium condition in the money market can be written as:

$$\frac{i_t}{i_{t-1}} = mg_t \frac{i_{t-1}}{i_{t-1}-1} \left(\frac{c_t}{c_{t-1}}\right)^{-\sigma} \frac{1}{\pi_t} \tag{1.13}$$

which implies that the change in the nominal interest rate is a function of money growth, past interest rates, consumption growth and inflation.

Final Goods Firms

The household buys a final composite good that is the result of the assembly of a continuum of intermediate goods. We depart from Krause and Lubik (2007) in assuming that the assembly of these intermediate goods is carried out not by the household but by a final goods firm behaving competitively. This distinction, which is mostly formal, allows a clearer separation between the production and expenditure approaches to GDP calculation. The final goods firm bundles the intermediate goods according to the following rule:

$$Y_t = \left(\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{1.14}$$

where y_i represents the amount of goods of type i, i.e., produced by firm i, and Y_t is the final consumption good. In equilibrium, the demand by the final goods firm of each of the intermediate goods is given by (see the Appendix for a derivation):

$$y_{it} = \left(\frac{P_t}{P_{it}}\right)^{\varepsilon} Y_t \tag{1.15}$$

Replacing equation (1.15) in (1.14) the following expression for the general price level P is obtained:

$$P_t = \left[\int_0^1 P_{it}^{1-\varepsilon} di\right]^{\frac{1}{1-\varepsilon}} \tag{1.16}$$

Intermediate Goods Firms

The intermediate goods firms are responsible both for the pricing and labour demand decisions in the economy.

As regards the characterization of the production and labour market frameworks, the variable n corresponds to the beginning of period number of employment relationships or jobs. These include both previously employed workers and new matches that were formed in end of the previous period. Each period wages are (re)negotiated. Each agent *j* within an employment relationship in firm *i* is associated to a general productivity level A, and to a specific productivity level a_{ij}, which is an independent and identically distributed (both across time and across agents) stochastic variable with cumulative distribution function $F(a_{ij})$ and positive support. The production function depends linearly on labour, and therefore in period *t* each agent involved in an employment relationship potentially produces $y_{ijt} = A_t a_{ijt}$.

The law of motion of A_t is given by:

$$ln(A_t) = \rho_z ln(A_{t-1}) + \varepsilon_{zt} \tag{1.17}$$

where ε_{zt} is a stochastic variable with a Normal distribution: $\varepsilon_{zt} \sim N(0, \sigma_z)$.

The decision of a firm to employ a given agent in period t can be summarized by the following Bellman equation:

$$V_{ijt}^{J} = \max\{-\delta, A_t a_{ijt} - w_{ijt} + \beta E_t V_{ijt+1}^{J}\} \tag{1.18}$$

where δ is the firing cost per separation.

By the envelope condition,

$$\frac{\partial {V_{ijt}}^{J}}{\partial a_{ijt}} = A_t > 0$$

The value function is increasing in the job-specific productivity level, and consequently the relevant decision for the firm will be a threshold level $\tilde{a}_{it}$ such that above that level employment relationships will be maintained and below will be severed. Therefore, the probability of an employment relationship being endogenously severed is given by $\rho_{it}^{n} = Pr[a_{it} < \tilde{a}_{it}] = F(\tilde{a}_{it})$. Additionally, there is a probability of exogenous separation given by ρ^{x}. Assuming that exogenous separations happen before the endogenous, the overall probability of separation is given by:

$$\rho_{it} = \frac{\rho^{x} n_{it-1} + \rho_{it}^{n}(1-\rho^{x}) n_{it-1}}{n_{it-1}} = \rho^{x} + (1-\rho^{x}) F(\tilde{a}_{it}) \tag{1.19}$$

where n_t is the number of jobs (employment relationships existent prior to production).

Given this, actual employment (resources used in production) is defined as:

$$e_{it} = (1-\rho_{it}) n_{it-1} \tag{1.20}$$

And the aggregate production of firm *i* is given by:

$$Y_{it} = A_t(1-\rho_{it})n_{it-1}E[a_{it} \mid a_{it} > \tilde{a}_{it}] \Leftrightarrow Y_{it} = A_t(1-\rho_{it})n_{it-1}\int_{\tilde{a}_{it}}^{\infty}\frac{a_{it}}{1-F(\tilde{a}_{it})}f(a_{it})da_i \equiv$$

$$A_t(1-\rho_{it})n_{it-1}H(\tilde{a}_{it}) = A_t e_t H(\tilde{a}_{it}) \tag{1.21}$$

After production has taken place in period *t*, each firm adjusts (if deemed necessary) the number of vacancies v_{it} it wishes to post in the labour market, and subsequently a number of new matches is attributed to firm *i*, according to the following matching function:

$$m(s_t, v_t) = m s_t^{\mu} v_t^{1-\mu} \tag{1.22}$$

where *m* is a scale parameter that denotes matching efficiency and $s_t = 1-(1-\rho_t)n_{t-1}$ is the number of "searchers" in the labour market, i.e., agents looking for a match, which includes both agents that were unemployed in the beginning of the period ($u_t = 1-n_{t-1}$) and agents whose jobs was severed during period *t* (a total of $\rho_t n_{t-1}$ agents). Note that matching depends on aggregate labour market variables $\left(v_t = \int_0^1 v_{it}di\right)$, therefore giving rise to thick market and congestion externalities. Given that the matching function has constant returns to scale, it can be written as:

$$\frac{m(s_t, v_t)}{v_t} = m\left(\frac{s_t}{v_t}, 1\right) = q(\theta_t) \tag{1.23}$$

where labour market tightness is defined as $\theta_t = \frac{v_t}{s_t}$, the relative share of vacancies to searchers, $q(\theta_t)$ is the probability of a firm filling a vacancy, and $q(\theta_t)\theta_t$ is the probability of a searcher finding a job. Given this, the law of motion of jobs is given by:

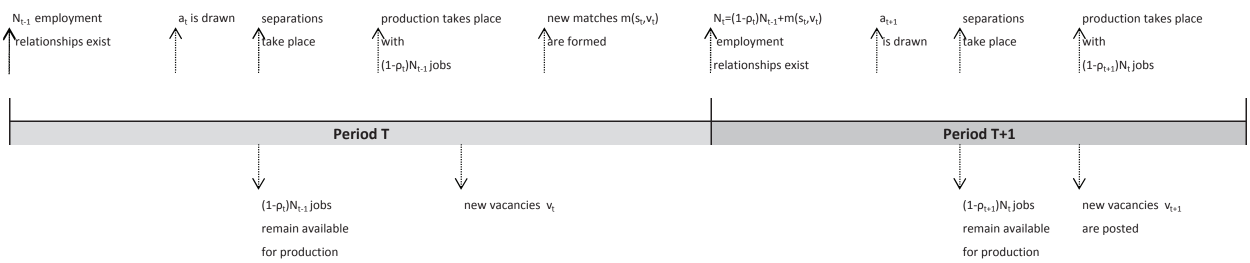
$$n_{it} = (1 - \rho_{it})n_{it-1} + v_{it}q(\theta_t) \tag{1.24}$$

or in terms of actual employment:

$$e_{it+1} = (1 - \rho_{it+1})[e_{it} + v_{it}q(\theta_t)] \tag{1.25}$$

The timing of events in the labour market is summarized in Figure 1.1 and follows den Haan et al. (2000).[4]

Figure 1.1: Timing of events in the labour market



Considering that costs per separation are given by δ, total expected firing costs, considering that all separations are affected, are given by:[5]

$$FC_{it} = \rho_{it}n_{it-1}\delta = \frac{\rho_{it}}{1 - \rho_{it}}e_{it}\delta \tag{1.26}$$

[4] This approach differs (although only formally) from the one of Krause and Lubik (2007) because in their model the variable *n* corresponds to actual employment (*post* separation) while in this paper it corresponds to employment relationships (*pre* separation).

[5] Alternatively, the case where exogenous separations are not subject to firing costs could also be considered. This would not lead to significant changes in results, while making the analytical framework less clear.

The problem of the firms is given by real profit maximization subject to (1.15), (1.21) and (1.25):

$$\max_{\{\tilde{a}_{it},n_{it},v_{it},P_{it},y_{it}\}_0^\infty} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left[\frac{P_{it}}{P_t} y_{it} - w_{it}(1-\rho_{it})n_{it-1} - v_{it}c \right. \\ \left. - \frac{\psi}{2}\left(\frac{P_{it}}{P_{it-1}} - \pi\right)^2 Y_t - \rho_{it} n_{it-1}\delta \right] \tag{1.27}$$

subject to:

$$y_{it} = \left(\frac{P_t}{P_{it}}\right)^{\varepsilon} Y_t$$

$$y_{it} = A_t(1-\rho_{it})n_{it-1}H(\tilde{a}_{it}) = A_t e_t H(\tilde{a}_{it})$$

$$n_{it} = (1-\rho_{it})n_{it-1} + v_{it}q(\theta_t) = e_{it} + v_{it}q(\theta_t)$$

$$0 \leq n_{it} \leq 1$$

where $w_{it} = \int_{\tilde{a}_{it}}^{\infty} w(a_{it}) \frac{f(a_{it})}{1-F(\tilde{a}_{it})} da_{it}$ is the average wage rate of firm *i*, given that a different wage will be paid to each employee as a function of his idiosyncratic productivity level. There is also a quadratic adjustment cost term associated with price deviations from objective inflation π, as in Rotemberg (1982), that will lead to price rigidity in the model. Alternatively, price rigidity could have been introduced through the Calvo (1983) price-setting mechanism. However, the Rotemberg approach has the advantage of giving rise to a symmetric equilibrium, while the results do not differ much from the Calvo setup given the appropriate calibration, as pointed out by Zanetti (2011).

Considering that ζ_i, φ_i, and ξ_i are the lagrangian multipliers associated respectively with each of the constraints above and that $E_t(\beta_{t+1}) = E_t(\beta\lambda_{t+1}/\lambda_t)$ is the intertemporal discount factor between *t* and *t+1* (which expresses profits in terms of the value to households, which own firms), the first order conditions for this problem are (the problem is formalized in the Appendix):

$$\frac{\partial \mathscr{L}}{\partial n_{it}} = 0 \Leftrightarrow \xi_{it} = E_t \left[\beta_{t+1}(1-\rho_{it+1})\left(\varphi_{it+1}A_{t+1}H(\tilde{a}_{it+1}) - w_{it+1} + \xi_{it+1}\right) + \rho_{it+1}\beta_{t+1}(-\delta)\right] \tag{1.28}$$

This intertemporal condition implies that the value of an employment relationship in period *t* (ξ_{it}) should equal the expected discounted value of an employment relationship in period *t+1*. If the job is not severed in period *t+1*, which happens with probability $(1-\rho_{it+1})$, the value of an employment relationship in period *t* equals its continuation value, which consists of the corresponding asset value, plus the flow of income it generates, $(\varphi_{it+1}A_{t+1}H(\tilde{a}_{it+1}) - w_{it+1})$. With probability (ρ_{it+1}) the job is severed and the value of the employment relationship is negative and amounts to the firing cost δ.

$$\frac{\partial \mathscr{L}}{\partial v_{it}} = 0 \Leftrightarrow c = q(\theta_t)\xi_{it} \tag{1.29}$$

The first order condition for vacancies simply states that the cost of posting a vacancy equals the corresponding expected benefit. This consists of the value of an employment relationship adjusted by the probability that the vacancy is filled.

$$\frac{\partial \mathscr{L}}{\partial \tilde{a}_{it}} = 0 \Leftrightarrow \left[\varphi_{it}A_tH(\tilde{a}_{it}) - w_{it} + \xi_{it} + \delta\right]\frac{\partial \rho_{it}}{\partial \tilde{a}_{it}} = \left[\varphi_{it}A_t\frac{\partial H(\tilde{a}_{it})}{\partial \tilde{a}_{it}} - \frac{\partial w(H(\tilde{a}_{it}))}{\partial \tilde{a}_{it}}\right](1-\rho_{it})$$

(1.30)

In equilibrium the net marginal cost of increasing $\tilde{a}_{it}$ equals the marginal benefit. The marginal cost comprises the value of those employment relationships severed and the firing cost associated to dismissal. The marginal benefit results from the increase in average productivity of the remaining jobs net of the marginal change in the average wage.

$$\frac{\partial \mathscr{L}}{\partial P_{it}} = 0 \Leftrightarrow \frac{1}{P_t} y_{it} - \psi \left(\frac{P_{it}}{P_{it-1}} - \pi \right) \frac{1}{P_{it-1}} Y_t - E_t \left[\psi \beta_{t+1} \left(- \frac{P_{it+1}}{P_{it}^2} \right) \left(\frac{P_{it+1}}{P_{it}} - \pi \right) Y_{t+1} \right]$$
$$- \varepsilon \zeta_{it} \left(\frac{P_t}{P_{it}^2} \right) \left(\frac{P_t}{P_{it}} \right)^{\varepsilon - 1} Y_t = 0 \tag{1.31}$$

The optimality condition for the price level takes into account the additional income generated by a marginal increase in prices when the current production level is y_{it}, as well as the impact of this increase on demand given the monopolistic competition setup and the price adjustment costs in periods *t* and *t+1*.

$$\frac{\partial \mathscr{L}}{\partial y_{it}} = 0 \Leftrightarrow \zeta_{it} = \frac{P_{it}}{P_t} - \varphi_{it} \tag{1.32}$$

Finally, the condition for the optimal production level simply implies that marginal revenue ζ_{it} equals the relative price minus the real marginal cost φ_{it}.

Equations (1.28) and (1.29) give rise to the job creation condition:

$$c = q(\theta_t)E_t\left[\beta_{t+1}(1-\rho_{it+1})\left[\varphi_{it+1}A_{t+1}H(\tilde{a}_{it+1}) - w_{it+1} + \frac{c}{q(\theta_{t+1})}\right] - \beta_{t+1}\rho_{it+1}\delta\right] \quad (1.33)$$

This condition states that the cost of posting a vacancy equals the expected value of an employment relationship, which is created with probability $q(\theta_t)$. This employment relationship will accrue income to the firm next period, when it is used for production. This consists of the value of employment if the job is not severed (with probability $(1-\rho_{it+1})$) and the cost δ otherwise (with probability ρ_{it+1}). The value of employment includes $E_t\left(\frac{c}{q(\theta_{t+1})}\right)$, which is the continuation value of the job, i.e., the expected discounted stream of income that the job will generate in the future if not severed.

This equation can be expressed as a function of the expected real marginal cost $E_t(\varphi_{it+1})$:

$$E_t(\varphi_{it+1}) = E_t\left[\left(\frac{c}{q(\theta_t)} + \beta_{t+1}\rho_{it+1}\delta - \frac{c}{q(\theta_{t+1})}\beta_{t+1}(1-\rho_{it+1})\right)\frac{1}{A_{t+1}H(\tilde{a}_{it+1})}\frac{1}{\beta_{t+1}(1-\rho_{it+1})}\right] + E_t\left(\frac{w_{it+1}}{A_{t+1}H(\tilde{a}_{it+1})}\right) \quad (1.34)$$

The last term on the right hand side equals real unit labour costs. The first term in round brackets, which is larger than unit in steady-state, translates the fact that the presence of search and matching frictions leads to an increase in expected marginal costs, as a firm cannot ascertain that a vacancy will be filled in the period it is posted given that this happens only with probability $q(\theta_t)$. This implies that the average duration of an open vacancy is $\frac{1}{q(\theta_t)}$ and therefore the total expected cost associated to a vacancy is $\frac{c}{q(\theta_t)}$. The presence of firing costs reinforces this effect by making employment relationships costly even when they are not selected to production. This setup reduces the value of an employment relationship when compared to a frictionless environment.

Equation (1.30) yields, after some algebra, the job destruction condition (see the Appendix for details):

$$\varphi_{it} A_t \tilde{a}_{it} - w(\tilde{a}_{it}) + \frac{c}{q(\theta_t)} = -\delta \tag{1.35}$$

The term φ_{it} captures the fact that an increase in output does not imply a one to one gain in revenue due to the monopolistic competition setup. Condition (1.35) implies that the real profits generated by the job with productivity $\tilde{a}$ plus the continuation value of the job equals the firing cost. This means that the firm is indifferent between employing or dismissing the worker with productivity $\tilde{a}$.

Replacing equation (1.32) in equation (1.31) and simplifying, we obtain the new Keynesian Philips curve (see the Appendix for the complete derivation):

$$1 - \psi\Big(\pi_{it} - \pi\Big)\pi_{it} + E_t\left[\psi\beta_{t+1}\Big(\pi_{it+1} - \pi\Big)\pi_{it+1}\frac{Y_{t+1}}{Y_t}\right] = \varepsilon(1 - \varphi_{it}) \tag{1.36}$$

Due to the symmetry of firms, all firm specific equilibrium conditions are also economy wide conditions, and therefore the subscript *i* is dropped henceforth.

Labour market

The labour market is characterized in this model by the equations describing the asset values for the worker of the states of being employed and unemployed and the asset values for the firm of having a filled or a vacant job. In addition, the bargaining process between workers and firms determines wages. These conditions are composed of a flow of income resulting from being in a given state at time *t* and the expected discounted asset value of that state in the following period. The derivation of these laws of motion for the representative household and intermediate goods firm problems can be found in the Appendix.

In the case of a worker employed at time *t*, the flow of income accruing to him is the wage rate. In the following period, the worker will receive at least the value of his outside option, corresponding to the state of unemployment. In addition, with probability $(1 - \rho_{t+1})$, the match will not be severed and the worker will also obtain the additional value of being employed in *t+1*, W_{t+1}, has in excess of the other possible state. Given that the match was not severed, this expected value implicitly ranges over values of idiosyncratic productivity above $\tilde{a}_{t+1}$. Therefore, the value of being employed can be expressed as:

$$W_t(a_t) = w(a_t) + E_t \left[\left(\beta_{t+1}(1-\rho_{t+1})W_{t+1} + \beta_{t+1}\rho_{t+1}U_{t+1} \right) | a_{t+1} > \tilde{a}_{t+1} \right] \Leftrightarrow$$

$$W_t(a_t) = w(a_t) + E_t \left[\beta_{t+1}(1-\rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} \left(\frac{W_{t+1}}{1-F(\tilde{a}_{t+1})} - \frac{U_{t+1}}{1-F(\tilde{a}_{t+1})} \right) f(a)da + \beta_{t+1}U_{t+1} \right] \tag{1.37}$$

where the last equality makes use of the fact that U_{t+1} does not depend on $\tilde{a}_{t+1}$.

The value function for an unemployed worker includes the unemployment benefit received at time *t*. In the end of period *t*, with probability $\theta_t q(\theta_t)$, the agent is associated with a match, but this is only converted into actual employment with probability $(1 - \rho_{t+1})$, in which case he receives the asset value of being employed. In any case the agent receives at least the discounted value of the asset value in period t+1, U_{t+1}.

$$U_t = b + E_t \left[\beta_{t+1}\theta_t q(\theta_t)(1-\rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} \left(\frac{W_{t+1}}{1-F(\tilde{a}_{t+1})} - \frac{U_{t+1}}{1-F(\tilde{a}_{t+1})} \right) f(a)da + \beta_{t+1}U_{t+1} \right] \tag{1.38}$$

Regarding the value of a job for a firm (J_t), this has associated a stream of income at time *t* composed of the real value generated by the job net of wage costs. The following period the asset value of the job will correspond to the discounted value of the outside option, the value of a vacancy. If the job is maintained (with probability $(1-\rho_{t+1})$), the firm receives the additional value it has vis-à-vis the outside option of a vacancy. In addition, the firm will pay a firing cost δ if the job is severed:

$$J_t(a_t) = \varphi_t A_t a_t - w(a_t) + E_t \left[\beta_{t+1}(1-\rho_{t+1}) \left(\int_{\tilde{a}_{t+1}}^{\infty} \left(\frac{J_{t+1}}{1-F(\tilde{a}_{t+1})} - \frac{V_{t+1}}{1-F(\tilde{a}_{t+1})} \right) f(a)da \right) \right]$$
$$+ E_t(\beta_{t+1}V_{t+1}) - E_t(\rho_{t+1}\beta_{t+1}\delta) \tag{1.39}$$

Finally, posting a vacancy has a cost *c* per period, and yields the net asset value of a job in the following period, $J_{t+1} - V_{t+1}$, with probability $q(\theta_t)(1-\rho_{t+1})$. In addition, the firm obtains its outside option, the value of maintaining that vacancy open in the following period, V_{t+1}.

$$V_t = -c + q(\theta_t)E_t \left[\beta_{t+1}(1-\rho_{t+1}) \left(\int_{\tilde{a}_{t+1}}^{\infty} \left(\frac{J_{t+1}}{1-F(\tilde{a}_{t+1})} - \frac{V_{t+1}}{1-F(\tilde{a}_{t+1})} \right) f(a)da \right) \right] \tag{1.40}$$
$$+ E_t(\beta_{t+1}V_{t+1}) - E_t\left[q(\theta_t)\rho_{t+1}\beta_{t+1}\delta\right]$$

Given that separations affect all matches and not only employed workers, if a vacancy is filled, but severed in the following period (before production takes place), the firm also has to pay firing costs. The creation of a match implies in this framework a precommitment on both parties that yields a compensation by the firm if it abandons the bargaining table. The assumption that only wage renegotiations are affected by firing costs would require the need to consider the problem of newly hired and continuing workers separately, as in Zanetti (2011). This would complicate the analysis without significant changes to the overall economy results, given the likely reduced relative share of new versus continuing workers. This assumption, however, affects wage determination, as described below.

Given that firms always enter the labour market by posting a vacancy, the assumption of free entry in this market implies that in equilibrium $V_t(a_t) = 0 \Rightarrow E_t\left[V_{t+1}(a_{t+1})\right] = 0$. Given this, equation (1.40) becomes:

$$E_t\left[\left(\frac{c}{q(\theta_t)}+(\rho_{t+1}\beta_{t+1}\delta)\right)\frac{1}{\beta_{t+1}(1-\rho_{t+1})}\right] = E_t\left[\int_{\tilde{a}_{t+1}}^{\infty}\frac{J_{t+1}f(a)}{1-F(\tilde{a}_{t+1})}da\right] \tag{1.41}$$

This expression, along with equation (1.39), implies:

$$J(a_t) = \varphi_t A_t a_t - w(a_t) + \frac{c}{q(\theta_t)} \tag{1.42}$$

Due to firing costs, if a match is not turned into a job or a job is not maintained, the firm will incur in a loss of δ per separation. Given this, the firm will be willing to accept a wage that implies a negative surplus from a job, as long as it is smaller than the corresponding firing costs to be paid.

The relevant condition for the firm no to severe an employment relationship with productivity level a_t is therefore:

$$J(a_t) - V_t \geq -\delta \Leftrightarrow J(a_t) - V_t + \delta \geq 0$$

This condition, evaluated at the threshold $\tilde{a}_t$, considering equation (1.42), yields exactly the job destruction condition given by equation (1.35).

Wage determination is considered to be the result of a process of bargaining between the worker and the firm in order to share the economic rents arising from their match. This is assumed to be achieved through Nash Bargaining. The fact that the workers are aware of the structure of the problem faced by firms leads firing costs to affect the relevant threat point of firms in the Nash Bargaining problem.[6] Therefore the relevant Nash Bargaining problem, with defines the equilibrium wage, is given by:

$$\max_{w(a_t)} (W_t(a_t) - U_t)^{\eta}(J_t(a_t) - V_t + \delta)^{(1-\eta)} \tag{1.43}$$

The first order condition of this problem implies the Nash Bargaining optimality condition (see the Appendix for the derivation):

$$(1-\eta)[W_t(a_t) - U_t] = \eta(J_t(a_t)+\delta) \tag{1.44}$$

This condition is consistent with the assumption that firing costs apply to all bargaining negotiations, independently of whether the worker and the firm meet for the first time or simply renegotiate wages. In fact, that Ljungqvist (2002) proves that assuming that firing costs affect

[6]See Cassorla (2010) and the references herein for a description of the application of Nash bargaining to non cooperative equilibria in which there are payoffs to agents in case of breakdown in negotiations.

Nash bargaining when wages are renegotiated but not when the worker and firms first meet, as in Garibaldi and Violante (2005) or Zanetti (2011), is equivalent to assuming that, apart from the wage profile over time, threat points are never affected by firing costs.

Equation (1.44) can be expressed equivalently as a function of the joint total surplus of the match, i.e., the quasi-rent that a match generates for workers and firms when compared to the value of their outside options (U_t and V_t), respectively. Defining the joint surplus of the match as $\Omega_t = W(a_t) + U_t + J(a_t){+}\delta - V_t$, the share accruing to firms and workers is respectively:

$$J_t(a_t){+}\delta = (1-\eta)\Omega_t \Rightarrow E_t\left(J_{t+1}(a_{t+1}){+}\delta\right) = E_t\left[(1-\eta)\Omega_{t+1}\right]$$

and (1.45)

$$W_t(a_t) - U_t = \eta\Omega_t \Leftrightarrow E_t\left(W_t(a_{t+1}) - U_{t+1}\right) = E_t\left(\eta\Omega_{t+1}\right)$$

Replacing the first equation of (1.45) in equation (1.41), gives rise to an expression that shows that the expected discounted surplus of a match for a firm equals of the opportunity cost of destroying the match, which includes paying the firing cost and posting a new vacancy (see the Appendix for details):

$$E_t\left[\left(\frac{c}{q(\theta_t)}{+}\beta_{t+1}\delta\right)\frac{1}{\beta_{t+1}(1-\rho^x)(1-\eta)}\right] = E_t\left[\left(\int_{\tilde{a}_{t+1}}^{\infty}\Omega_{t+1}f(a)da\right)\right] \tag{1.46}$$

Subtracting equation (1.38) from equation (1.37) and replacing the second expression in (1.45) yields the equivalent expression for a worker. In this case, the value of employment for a worker in excess of his outside option is composed of the wage net of the lost unemployment benefits plus his share of the joint surplus of the match.

$$
\begin{aligned}
W_t(a_t) - U_t &= w(a_t) - b + E_t\left[\beta_{t+1}(1-\rho^x)(1-\theta_t q(\theta_t))\left(\int_{\tilde{a}_{t+1}}^{\infty} \eta\Omega_{t+1} f(a)da\right)\right] \\
W_t(a_t) - U_t &= w(a_t) - b + E_t\left[\frac{\eta}{1-\eta}(1-\theta_t q(\theta_t))\left(\frac{c}{q(\theta_t)} + \beta_{t+1}\delta\right)\right]
\end{aligned} \tag{1.47}
$$

Replacing equations (1.46) and (1.47) in equation (1.44) we obtain the real wage schedule:

$$
w(a_t) = \eta[\varphi_t A_t a_t - b+\delta] + b + \eta\theta_t q(\theta_t)\left\{\frac{c}{q(\theta_t)} + E_t(\beta_{t+1}\delta)\right\} - \eta\delta E_{t+1} \tag{1.48}
$$

The wage is composed of the worker's share of net the flow of income generated by employment and the value of his outside option (unemployment). The value of this outside option increases with the value of the match and the probability of finding a job.

Aggregating over the relevant values of the idiosyncratic productivity, we obtain the average wage in the economy:

$$
w_t = \int_{\tilde{a}_t}^{\infty} w(a)\frac{f(a)}{1-F(\tilde{a}_t)}da = \eta\varphi_t A_t H(\tilde{a}_t) + \eta\theta_t c + (1-\eta)b \underbrace{+\eta\delta[1-(1-\theta_t q(\theta_t))E_t(\beta_{t+1})]}_{>0} \tag{1.49}
$$

The presence of firing costs leads to an increase in the average wage, given that due to Nash Bargaining, workers are able to appropriate part of the amount that the firm saves in firing costs when the match is not dissolved.

At the threshold $\tilde{a}_t$, the firm would be willing to accept a value for a job as low as $-\delta$, but the worker will only accept as low a surplus as $W_t - U_t$=0. Using equations (1.47) and (1.48) evaluated at $\tilde{a}_t$, we obtain the equilibrium threshold productivity (see the Appendix for details):

$$\tilde{a}_t = \left[b - \frac{1-\eta\theta q(\theta_t)}{1-\eta}\left(\frac{c}{q(\theta_t)}\right) - \delta - \frac{\eta}{1-\eta}\delta(1-\theta_t q(\theta_t))E_t(\beta_{t+1})\right]\frac{1}{\varphi_t A_t} \tag{1.50}$$

The equilibrium level of threshold productivity depends positively on the level of unemployment benefits b, given that this increases the reservation wage. On the other hand, it depends negatively on the effective cost of posting a vacancy and on firing costs to be paid upon severance of a low productivity job. Notice that without labour market frictions or firing costs we would have $\varphi_t A_t \tilde{a}_t = b$, i.e, the firm would set the productivity threshold such that the value of the marginal productivity of the least productive agent to be employed would equal his reservation wage. Because it is costly and takes time to fill a vacancy, and because separations are costly, firms become less demanding as regards idiosyncratic productivity in that setup, retaining more workers in employment than would happen in a frictionless environment.

Finally, the expressions for the endogenous job creation rate (*jcr*) and job destruction rate (*jdr*) are given respectively by:

$$jcr_t = \frac{m_t}{n_{t-1}} - \rho^x \tag{1.51}$$

$$jdr_t = \rho_t - \rho^x \tag{1.52}$$

The term ρ^x is deducted from the job flows because it corresponds to exogenous worker turnover, not contributing to relevant information regarding the dynamics of the labour market of the economy.

Other equilibrium conditions of the model

Some additional conditions are necessary to close the model, namely the government budget constraint, which simply states that revenues (from seignorage and return from bonds) equal costs (unemployment benefits and transfers) on a period-by-period basis.

$$\frac{M_t - M_{t-1}}{P_t} + \frac{B_t}{P_t} - \frac{i_{t-1}B_{t-1}}{P_t} - b(1-e_t) - \frac{T_t}{P_t} = 0 \tag{1.53}$$

Replacing this equation on the budget constraint in (1.1), we obtain that consumption equals all the real income generated by firms, given that the households own the firms in this model.

$$I_t = w_t e_t + \frac{Prof_t}{P_t} = c_t$$

On the production side, the gross income generated by firms equals the real value of the total amount of goods generated in the production process minus the costs which are independent of the production level (cost of posting vacancies and firing costs):

$$I_t = A_t e_t H(\tilde{a}_t) - cv_t - \delta\rho_t n_{t-1} = w_t e_t + \frac{Prof_t}{P_t} \tag{1.54}$$

Therefore, in equilibrium we have:

$$y_t = c_t + cv_t + \delta\rho_t n_{t-1} \tag{1.55}$$

1.2.2 Wage Rigidity

Following Krause and Lubik (2007), wage rigidity was introduced in the form of a wage norm, as in Hall (2005), a concept related to the idea of a focal point. This wage norm is assumed to correspond to the value of the average wage in the baseline model, i.e., the model described in Section 1.2 without firing costs. Under this framework, the observed wage is a weighted average of the wage prevailing in the economy without wage rigidity (w^n) and the wage norm:

$$\begin{aligned} & w(a_t) = \gamma w_t^n + (1-\gamma)\overline{w} \Leftrightarrow \\ & w(a_t) = \gamma\eta\varphi_t A_t a_t + \gamma\eta c\theta_t + \gamma(1-\eta)b + \gamma\eta\delta[1-(1-\theta_t q(\theta_t))E_t(\beta_{t+1})] + (1-\gamma)\overline{w} \end{aligned} \tag{1.56}$$

The threshold $\tilde{a}_t$ is assumed in Krause and Lubik (2007) to be determined by the demand side in the labour market, that is, by equations (1.35) and (1.56). This implies the new condition for threshold determination, given by:

$$\begin{aligned} \tilde{a}_t = & \frac{1}{\varphi_t A_t}\left[\frac{\gamma\eta\theta_t}{(1-\gamma\eta)}c + \frac{\gamma(1-\eta)}{(1-\gamma\eta)}b + \frac{(1-\gamma)}{(1-\gamma\eta)}\overline{w}\right] \\ & + \frac{1}{\varphi_t A_t}\left[\frac{\gamma}{(1-\gamma\eta)}\eta\delta[1-(1-\theta_t q(\theta_t))E_t(\beta_{t+1})] - \frac{1}{(1-\gamma\eta)}\delta - \frac{1}{(1-\gamma\eta)}\frac{c}{q(\theta_t)}\right] \end{aligned} \tag{1.57}$$

When there is wage flexibility, i.e. $\gamma = 1$, this expression reduces to equation (1.50). In addition, notice that if the average wage is higher than the threshold wage ($w(\tilde{a}_t) < \overline{w}$), wage rigidity implies some degree of wage compression, which will lead to an increase in the steady-state threshold productivity. This effect is also observed by Cassorla (2010) for minimum wages.

1.3 Assessment of the Model Properties

1.3.1 Calibration

In order to approximate the results of Krause and Lubik (2007) to the maximum extent, the calibration used follows their work as closely as possible. These values are listed in the right-hand side of Table 1.1. In addition, the threshold productivity term $\tilde{a}$ was considered to follow a log-normal distribution, with the mean and standard deviation of the corresponding normal distribution being given by $E(ln(\tilde{a}))$ and $\sigma_{ln(\tilde{a})}$. The values in the left-hand side are derived from the model's equations in steady-state (namely b, c m and $\bar{w}$). The value for the steady-state percentage of workers searching for a job in the economy without firing costs or wage rigidity was calibrated to 23 per cent, which implies a baseline unemployment rate close to Krause and Lubik (2007) calibration of 12 per cent. The value for χ, the parameter regarding the preference for real money holdings in the utility function, does not enter the model's equations directly, but it allows to recover the real money stock value. This was calibrated according to McCandless (2008). Finally, the standard deviations of the productivity and monetary shocks were calibrated to approximate the output volatility of the simulations in Krause and Lubik (2007).[7]

As regards the calibration of the firing cost parameter δ, several approaches have been followed in the literature. Zanetti (2011) assumes that firing costs amount to 30 per cent of the mean wage, which in the current baseline model would correspond to a value of approximately 0.27. Garibaldi and Violante (2005) compute estimates of severance payments and other firing costs based on Italian data and conclude that the latter total 3.5 months of wages, which corresponds in the current

[7]Note that these standard deviations are larger than those used by Krause and Lubik (2007). This is related to the fact that the impact of a shock on output in the current framework is immediately muted because of the response in the opposite direction of the threshold productivity and consequently of the separation rate. Moreover, although the standard deviation of the technology shock is relatively large by US standards, it is in line with the values found for Spain by Thomas (2006).

Table 1.1: Model Calibration

Parameter	Calibrated value	Parameter	Calibrated value
Intertemporal discount factor (β)	0.99	Preference for money parameter (χ)	0.01
Reciprocal of elasticity of substitution (σ)	2	Share of job searchers (s)	0.23
Overall separation rate (ρ)	0.1	Technology shock standard deviation (σ_a)	0.07
Exogenous separation rate (ρ^x)	0.068	Monetary shock standard deviation (σ_m)	0.08
Inflation rate (π)	1		
Technology shock persistence (ρ_z)	0.95		
Monetary shock persistence (ρ_m)	0.49		
Probability of filling a vacancy ($q(\theta)$)	0.7	Cost of posting a vacancy (c)	0.06
Monopolistic competition parameter (ε)	11	Unemployment benefits (b)	0.87
Price adjustment cost (ψ)	40	Matching function scale factor (m)	0.54
General productivity level (A)	1	Wage norm ($\bar{w}$)	0.91
Expected value of idiosyncratic productivity ($E(\ln(\tilde{a}))$)	0		
Matching function elasticity (μ)	0.4		
Nash barganing parameter(η)	0.5		
Idiosyncratic productivity standard deviation ($\sigma_{\ln(\tilde{a})}$)	0.12		

model to approximately one quarterly wage, and thus to a value of 0.91. Thomas (2006) assumes that firing costs correspond to sixty per cent of the expected unemployment insurance received by a worker during an unemployment spell, where this unemployment insurance is given by a replacement rate of the wage of 20 per cent. The application of this formula to the present work would yield a value of 0.17. Finally, Wesselbaum (2009) assumes the value of 0.1. We take this value as an upper threshold (as it leads the endogenous separation rate in the model to fall to very close to zero in steady-state) and simulate the model's sensitivity to a grid of firing costs levels.

1.3.2 Steady-State Analysis

As a first assessment of the properties of the model, the characteristics of the steady-state are analysed, in particular the impact in the baseline resulting from the inclusion of firing costs and full wage rigidity. The general conclusion is that firing costs and wage rigidity have opposite effects in the steady-state values of the main labour market variables. The change in steady-state values of the main variables of the model stemming from the introduction of firing costs and wage rigidity is shown in Figure (1.2).

Firing costs limit the reallocation process in the labour market, leading to a lower level of vacancies, separations and size of job flows and to a higher percentage of searchers in the labour force, resulting in a lower level of labour market tightness. While the result regarding job flows is relatively common in the EPL literature (see Arpaia and Mourre (2012)), the impact on the unemployment rate is less clear and crucially depends on the way the labour market is modelled. On the one hand there is less reallocation of labour, given that due to more costly firing, firms avoid dismissals more strongly than before, but on the other hand, there is also less job creation, given that the expected value of a job decreases. In the current work, firing costs lead to a reduction in employment, which confirms the result in Ljungqvist (2002) that the effect of firing costs on employment is negative in a matching model if there is a relative increase in the share of the match surplus received by workers, i.e., if firing costs affect the threat point of firms but not the one of workers. Another effect worth mentioning about the steady-state of the model when compared to the baseline is the decrease in threshold productivity, resulting from the decrease in the separation rate, as firms keep workers in employment more time given that it is more costly to fire them. However the conditional productivity expectation $H(\tilde{a})$ remains almost unchanged. The change the steady-state level of wages due to the introduction of firing costs is marginal, but negative. This result is entirely determined by the current calibration, given that a smaller steady-state rate of searchers would lead wages to increase. In this case, the positive term added to the wage expression as a result of firing costs, translating an increased bargaining weight obtained by workers, is overturned by the strong decrease in labour market tightness. The negative impact of firing costs in employment leads to a decrease in household income and consequently in consumption.

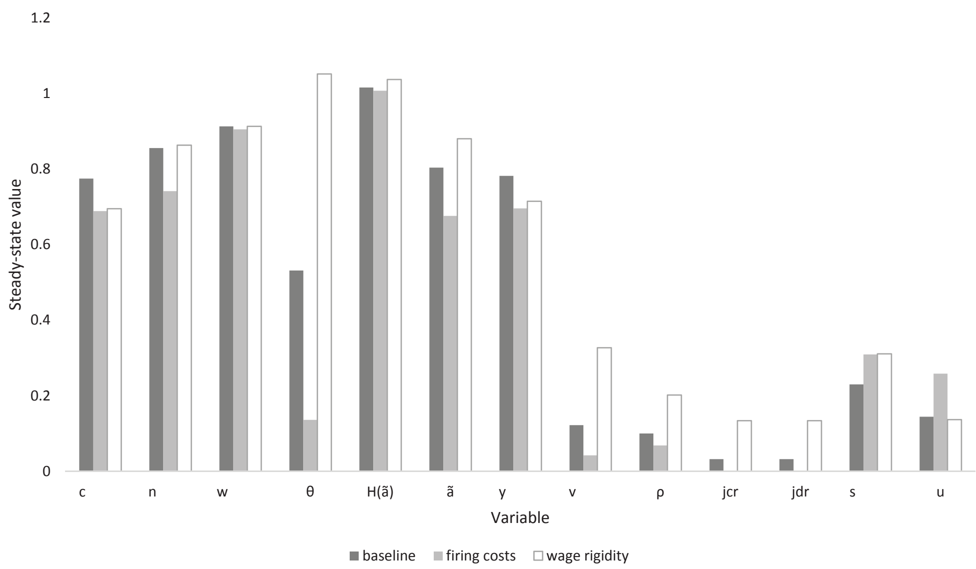
On the other hand, full wage rigidity increases the labour market reallocation process, leading the number of vacancies, the separation rate and the size of job flows to be higher. As mentioned in Section 1.2.2, wage rigidity implies to some extent wage compression, given that now all wage rates, including the one corresponding to the threshold productivity level, depend on the wage norm. This leads to an increase in the threshold productivity level, and consequently in the separation rate and job flows (given that job destruction is identical to job creation in steady-state). However, the average wage rate remains unchanged by definition. With wage flexibility, firms realize that an increase in treshold productivity implies a corresponding change in wages, thus partially annulling the effect of higher idiosyncratic productivity in profits. With full wage rigidity, this effect disappears, and therefore new profit opportunities arise. Symmetrically to what happens with firing costs, the expected value of a job increases, given that $\tilde{a}$ increases while the wage rate is unchanged. This leads to an increase in the number of vacancies posted and consequently in labour market tightness, and therefore the probability of filling a vacancy ($q(\theta)$) decreases until the effective cost of a vacancy rises to the new value of a job. The number of searchers increases, although less than the number of vacancies, reflecting the increase in the separation rate, given that unemployment remains almost unchanged. Despite the fact that the level of output is almost unchanged, the steady-state level of consumption decreases, reflecting the cost for the economy of the additional vacancies posted.

1.3.3 Business Cycle Properties Analysis

Impulse Response Functions

In order to analyze the business cycle properties of the model, its responses to productivity and monetary shocks where simulated for several possible degrees of wage rigidity and firing costs levels, in order to analyze the interaction between these two features. A loglinear approximation

Figure 1.2: Steady-State Comparison



Legend: The calibration underlying the steady-state values is displayed in Table (1.1). The baseline model does not include firing costs and wages are fully flexible. The firing cost model includes firing costs through the parameter $\delta = 0.09$. The wage rigidity model corresponds to full wage rigidity at the wage norm $\bar{w}$, corresponding to the baseline wage rate.

to the model was therefore simulated using a generalization of Uhlig's toolkit Matlab code (see Uhlig (2001) and Uhlig (2006)).

Figures (1.3) and (1.4) show the response of the model to a 1 per cent increase in A, the non-specific productivity level, and to a 1 per cent increase in money growth, for different levels of firing costs and degrees of wage rigidity. The figures show that the baseline responses (δ=0 and γ=1) replicate fairly well those of Krause and Lubik (2007).

Technology shock

As regards the baseline response to a supply side shock, this implies that the amount of goods produced by each employee increases. Marginal costs decrease due to the unit labour costs component of equation (1.34), thus creating incentives for inflation to decrease. Due to the existence of adjustment costs, prices are not set immediately to their new level, and therefore marginal revenue remains above steady-state level for some time, increasing the value of a job. This creates incentives for firms to expand their labour force, what is achieved both by reducing job destruction (which implies a decrease in the separation rate and consequently on the threshold productivity level) and, to a smaller extent, by increasing vacancy creation. The separation channel dominates the adjustment given that they are costless and have an immediate impact in the employment level. The increase in vacancies and decrease in the number of searchers drives labour market tightness upwards, up to a point where the increased real cost of posting vacancies balances the expected higher profitability of firms (see equation (1.33)). In the period of impact of the shock there is a temporary increase in separations and a decrease in wages. This short-lived effect results from the fact that demand does not react immediately to increased supply, due to the sluggish adjustment of prices.

Monetary shock

In the case of the monetary shock, the increase in the real stock of money balances leads to a decrease in the real interest rate, and consequently to an increase in demand. Increased demand leads to an increase in the prices set by intermediate goods firms, although not immediately to the new desired level due to the presence of adjustment costs. Upon the impact of the shock, given that the number of employment relationships was determined in the previous period, the only way firms can adjust their labour force in response to higher demand is by decreasing separations. This happens in an abrupt and more substantial way than in the case of the productivity shock. This effect gives rise to a decrease in threshold productivity. The lower number of job searchers drives labour market tightness upwards, increasing the expected cost of posting a vacancy, $\left(\frac{c}{q(\theta)}\right)$. This effect creates upward pressure on wages and marginal costs, which eliminates the incentives to post additional vacancies. Moreover, vacancies and job creation actually decrease, given that the increase in current and expected profits is more muted than in the case of the technological shock and rapidly compensated by increasing marginal costs. This response precludes the existence of a Beveridge Curve as well as the labour market stylized fact of negative correlation between the business cycle responses of job creation and job destruction rates.

Wage rigidity

As regards the impact of wage rigidity in this framework, Figures (1.3) and (1.4) show that for a given level of firing costs, wage rigidity amplifies the response of most real variables to both the productivity and the monetary shock. In a flexible wage setting, wage adjustments would limit the real effects of the shocks in the labour market by restraining the increase in the expected value of a job for the firm. This counterbalancing effect disappears with wage rigidity, which leads to increased incentives to hiring and vacancy posting and consequently to stronger effects in employment and production. In the case of the monetary shock, the additional posting of vacancies actually leads, for a large enough degree of wage rigidity, to a change in the sign of the response of vacancies, which shifts from negative to positive. This apparently creates a Beveridge curve relationship that was absent in the baseline, as pointed out by Krause and Lubik (2007). However, a very high degree of wage rigidity is required for this feature to emerge. Moreover, the impact of wage rigidity on the inflation response is relatively limited, reflecting the almost unchanged response of marginal costs.

Firing costs

In a wage flexibility scenario, increasing firing costs makes the threshold productivity level less sensitive to cyclical fluctuations, leading to a more muted response of the separation rate in the case of both shocks.[8] Therefore, prices gain importance as an instrument available for firms

[8] Despite the fact that the threshold productivity level becomes more sensitive to the job finding rate ($\theta q(\theta)$) as the level of firing costs increases (see equation (1.50)), the steady-state level of $\tilde{a}$ also decreases. Given the shape of the cumulative distribution function, the latter effect dominates, and the response of the separation rate is increasingly subdued as the firing cost increases.

to react to increased supply or demand. Given that, prices fall more intensely than in the baseline in response to a productivity shock, leading to an amplification of the size and persistence of the response of real variables, in particular labour market tightness, but also output and consumption. In the case of the monetary shock, the effect is similar although of opposite sign: prices react more strongly upwards and this increase is largely concentrated in the period of impact of the shock. As a result, the impact of the shock on real variables becomes more muted.

Given that the response of the separation rate is more moderate for both shocks, vacancies assume an increasing role for labour market adjustment. In the case of the monetary shock, for a large enough size of the firing costs this leads the response of vacancies to turn from positive to negative. As regards job flows, the response of the job creation and destruction rates is now smaller, which confirms the results of several studies regarding EPL (see Arpaia and Mourre (2012)). The impulse response functions for these variables, as well as for unemployment, expressed in percentage points, are presented in Figures (1.3) and (1.4).

Interaction between firing costs and wage rigidity

As a result of the above analysis, the interaction of firing costs and wage rigidity amplifies the impact of productivity shocks on real variables, given that these features have complementary effects as regards the strength and persistence of responses. On the contrary, in the case of monetary shocks, firing costs and wage rigidity act as substitute forces, given that wage rigidity increases the response of the expected value of a job to a shock, while the introduction of firing costs decreases it. The effect of firing costs seems to dominate until the degree of wage rigidity is above 50 per cent. For higher degrees of wage rigidity, the response of output and inflation becomes largely unaffected by the level of firing costs. This may be related to the fact that because the wage is almost unchanged when the shock takes place, job destruction is less sensitive to changes in labour market tightness. As the destruction margin of adjustment is not much affected by the increase in the level of firing costs, the response of marginal costs and consequently inflation and consumption is also relatively unchanged. However, the relevant labour market stocks are still responsive to the level of firing costs in this case. Given that the expected value of a job increases after the shock, the cost of a vacancy also has to increase in order to restore equilibrium in the labour market. Thus labour market tightness increases, although the required adjustment is smaller the higher the level of firing costs. Given that the separation decision is relatively insensitive to the firing costs level for a relatively large degree of wage rigidity, this adjustment is provided on impact by an increase in vacancies, whose response is increasing in the level of firing costs. This implies that the decrease in unemployment recorded after the shock becomes more muted as the level of firing costs increases.

Moments (Business Cycles)

The assessment of the business cycle features of the model and its extensions can be complemented by the analysis of some moments of simulated data and their comparison with actual observations. Again Krause and Lubik (2007) results are used as a starting point of the analysis.

The sources for US data and the methods used to extract its business cycle component are described in Table 1.2. These follow as close as possible the sources mentioned in Krause and Lubik (2003). The similarity between the moments in Table 1.2 and those in Krause and Lubik (2007) is high, with the exception of the job creation and destruction rates, possibly because a shorter sample was used (see the notes on Table 1.2). As regards the model simulations, all moments correspond to percentage deviations from the baseline steady-state and are expressed in relative terms to the standard deviation of output. Moments are based on the average of 100 HP-filtered simulations of the model. Each of the simulations considered has an extension of 300 periods, but the first 100 were not considered to avoid the potential influence of the starting-point of the simulations on the results. The simulations that refer to wage rigidity correspond to $\gamma = 0$, i.e., full wage rigidity, while in those involving firing costs these are calibrated to 0.09. The persistence of output and inflation is evaluated by the first order autocorrelation of the simulated moments.

The moments obtained for the baseline model, reported in Table 1.3, replicate Krause and Lubik (2007) relatively well, being the least accomplished in what concerns job creation and destruction rates, namely as regards both their standard deviation and their correlation, possibly because the specification used in the present work for these variables is somewhat different than the one in Krause and Lubik (2007) (see equations (1.51) and (1.52)). The fact that the relevant concept of the number of agents available for work, namely for the computation of labour market tightness, was considered to be the number of searching agents and not of unemployed may also have affected the volatility of vacancies and labour market tightness. Overall, the baseline model and its version with full wage rigidity reproduce the conclusions of Krause and Lubik (2007) that the New Keynesian model with labour market frictions is not able to replicate the negative correlation between unemployment and vacancies or between job creation and destruction rates observed in the data. Introducing wage rigidity in this setup solves part of these problems, giving rise to a Beveridge curve, although reducing the models' ability to reproduce the volatility seen in the data for some of the variables, as output and inflation. Moreover, although the results are for an extreme form of wage rigidity, in the case of monetary shocks only a small negative correlation between unemployment and vacancies arises and some empirical features of the labour market are still not reproduced under this setup, given that the volatility of vacancies remains too low and the positive correlation between job creation and destruction rates is maintained. Krause and Lubik (2007) argue moreover that inflation dynamics are not much affected by wage rigidity, given that the response or marginal costs is relatively unchanged when compared to the baseline, as mentioned in the previous subsection.

Results with firing costs confirm what was suggested by the impulse response functions in the previous subsection, given that the existence of a Beveridge curve is now visible in simulated moments. However, inflation volatility increases, and output volatility decreases, as suggested by the impulse response functions, a result similar to Zanetti (2011). but that contrasts to that of Thomas and Zanetti (2009), who conclude that changes in firing costs have little impact on inflation volatility. The most significative difference between the models in these two papers is the assumption that new matches only enter the production process in the period following their creation (the most common assumption in the search and matching framework), which is absent from the latter. In the current model changes in volatility stem largely from the monetary shock, and the impulse response functions show that the largest variation in inflation in this case is concentrated in the initial period after the shock, when inflation accommodates an increasing demand to a lagged supply response (in view that a change in the number of employment relationships will only affect production in the following period). These features suggest that probably these changes in volatility are in fact related to the assumption that new matches only enter the production process in the period following their creation. This view is also supported by the comparison of the results of Zanetti (2011) and Thomas and Zanetti (2009), whose models differ in this assumption.

Although firing costs significatively affect the volatility of most variables in the case of a monetary shock, in the case of real shocks the effects are not so visible for most variables. The combined effect of both shocks results in volatility levels that are relatively close to those in the data for output and inflation. In the case of the monetary policy shock, the job destruction rate volatility remains close to the baseline, while the job creation rate volatility decreases. The opposite happens for the productivity shock. These dynamics are probably related to a large extent to the response on impact of the separation rate, which is negative in the case of the monetary shock (and therefore firing costs do not pose an active restriction) and positive in the case of the technology shock.

Regarding the simulated moments of the model that combines wage rigidity and firing costs, these show a negative correlation between unemployment and vacancies. In addition, there is a degree of inflation persistence similar to the one observed in the data (although in the latter case this results from productivity shocks only). Moreover, this model generates a negative correlation between job creation and destruction rates, although this is not immediately visible in the impulse response functions. This fact is possibly related to the profile of job creation and destruction responses, given that the response of the destruction rate is relatively short-lived while the response of job creation is much more persistent. It should be noted however that this result hinges on the extreme assumption of full wage rigidity and that, similarly to the firing cost model, the model that includes a combination of firing costs and wage rigidity exhibits very low inflation persistence in response to monetary policy shocks.

1.4 Non-linear firing costs

1.4.1 Model

This section considers an extension of the previous model by allowing firing costs to assume a non-linear form. This approach aims at formalizing the fact that some costs may be present (possibly at an increasing rate) for an increase in firing costs although not representing benefits associated to their reduction. Such could be the case for loss of job-specific human capital or effects associated to worker morale for those not fired when a large dismissal takes place.

Empirically, Di Tella and MacCulloch (2005) find some support of the hypothesis suggested in Lazear (1990) that the effects of the flexibility level on the labour market may be non linear. In addition, Pfann and Palm (1993) find empirical evidence of convex and asymmetrical firing and hiring adjustment costs for the English and Dutch manufacturing sector leading to heterogeneous behavior towards production and non-production workers at different cyclical moments. A survey of the literature of factor input adjustment costs by Hamermesh and Pfann (1996) concludes that although it is not clear whether one particular specification fits the adjustment costs of employment best, given that they differ across characteristics like skill levels, the hypothesis of symmetry of these costs (initially the standard in this literature) is always rejected. In a more recent study, Kramarz and Michaud (2010) analyse for the French labour market the shape of termination costs (which include severance payments and firing costs) as a function of the characteristics of the termination and of the workers involved. They find evidence that termination costs are increasing and mildly concave in the number of terminations, but that they increase sharply when the threshold that turns terminations into a collective dismissal is crossed. Moreover, they attribute the concavity to the large share of blue collar workers in the sample, given that for other levels of skills this property does not arise. Furthermore, they find termination costs to be increasing in the skill of the worker.

Firing costs are in this context assumed to take the form of a function that penalizes increases in separations in an almost exponential way and weights decreases in a quasi-linear way. The structure of this penalty is defined by the linex function, introduced by Varian (1974), and this approach is based on the application to wage rigidity in Kim and Ruge-Murcia (2009) and Fahr and Smets (2010). The linex function is given by:

$$\Phi_t = \Phi\left(\frac{\rho_t}{\rho_{t-1}}\right) = \phi\left(\frac{\exp\left(\psi\left(\frac{\rho_t}{\rho_{t-1}} - 1\right)\right) - \psi\left(\frac{\rho_t}{\rho_{t-1}} - 1\right) - 1}{\psi^2}\right) \tag{1.58}$$

where ϕ defines the degree of asymmetry and ψ the convexity of the function, i.e., the rate of increase of the firing costs as agents move away from the steady-state.

When ρ_t is higher than ρ_{t-1}, the exponential term dominates, and therefore the cost increases exponentially. The opposite happens when ρ_t is lower than ρ_{t-1}, in which case the linear term dominates and the cost decreases linearly. Notice that this function encloses the particular case of a quadratic function when $\psi \to 0$.

Total firing costs are expressed as:

$$FC_t = \rho_t(a_t)n_{t-1}\Phi_t \tag{1.59}$$

Deriving the firms' first order optimization conditions as before results in the following job creation condition:

$$\left[\frac{c}{q(\theta_t)} + E_t(\beta_{t+1}\rho_{t+1}\Phi_{t+1})\right] = E_t\left\{\beta_{t+1}(1-\rho_{t+1})\left[\varphi_{t+1}A_{t+1}H(\tilde{a}_{t+1}) - w_{t+1} + \frac{c}{q(\theta_{t+1})}\right]\right\}$$

$$c = q(\theta_t)E_t\left\{\left[\beta_{t+1}(1-\rho_{t+1})\left[\varphi_{t+1}A_{t+1}H(\tilde{a}_{t+1}) - w_{t+1} + \frac{c}{q(\theta_{t+1})}\right] - \beta_{t+1}\rho_{t+1}\Phi_{t+1}\right]\right\} \tag{1.60}$$

On the other hand, the derivation of the job destruction condition now has the particularity that the penalty function depends indirectly on $\tilde{a}_t$ trough ρ_t:

$$\frac{\partial\Phi_t}{\partial\tilde{a}_t} = \frac{\partial\Phi_t}{\partial\rho_t}\frac{\partial\rho_t}{\partial\tilde{a}_t} = \frac{\phi}{\psi}\frac{1}{\rho_{t-1}}\left\{exp\left[\psi\left(\frac{\rho_t}{\rho_{t-1}} - 1\right)\right] - 1\right\}\frac{\partial\rho_t}{\partial\tilde{a}_t} \tag{1.61}$$

Therefore the marginal change in firing costs is an exponential function of the change in the destruction rate, which is zero when $\rho_t = \rho_{t-1}$, so when the separation rate exhibits an upward trend, marginal firing costs increase very fast.

This gives rise to the following first order condition, which a non-linear version of equation (1.35):

$$\begin{aligned}&\left[\xi_t - w_t + \varphi_t A_t H(\tilde{a}_t) + \Phi_t + \rho_t \frac{\partial \Phi_t}{\partial \rho_t}\right] \frac{\partial \rho_t}{\partial \tilde{a}_{it}} = \left[\varphi_t A_t \frac{\partial H(\tilde{a}_t)}{\partial \tilde{a}_t} - \frac{\partial w(H(\tilde{a}_t))}{\partial \tilde{a}_t}\right](1-\rho_t) \\ &\Leftrightarrow \varphi_t A_t \tilde{a}_t - w(\tilde{a}_t) + \Phi_t + \rho_t \frac{\partial \Phi_t}{\partial \rho_t} + \frac{c}{q(\theta_t)} = 0\end{aligned} \tag{1.62}$$

Notice that

$$\Phi_t + \rho_t \frac{\partial \Phi_t}{\partial \rho_t} = \frac{\partial fc_t}{\partial \rho_t} \tag{1.63}$$

which implies that, as before, the job destruction condition is adjusted by the marginal effect that a change in ρ implies to firing costs per worker, but now this includes not only the direct impact of the penalty function, but also the indirect impact of ρ on the value of that penalty function. This is the relevant impact to be considered by firms when taking the marginal decision to dissolve a match and thus it is also the relevant change in the threat point of wage negotiations to be considered in the Nash Bargaining condition in this setup.

The Nash Bargaining condition in now therefore given by:

$$(1-\eta)[W_t(a_t) - U_t] = \eta\left(J_t(a_t) + \Phi_t + \rho_t \frac{\partial \Phi_t}{\partial \rho_t}\right) \tag{1.64}$$

or equivalently:

$$J_t(a_t)+\Phi_t+\rho_t\frac{\partial\Phi_t}{\partial\rho_t}=(1-\eta)\Omega_t\Rightarrow E_t\left(J_{t+1}(a_{t+1})+\Phi_{t+1}+\rho_{t+1}\frac{\partial\Phi_{t+1}}{\partial\rho_{t+1}}\right)=E_t\left((1-\eta)\Omega_{t+1}\right) \tag{1.65}$$

where

$$\Omega_t=W(a_t)+U_t+J(a_t)+\Phi_t+\rho_t\frac{\partial\Phi_t}{\partial\rho_t}-V_t \tag{1.66}$$

is the total surplus of a job. Proceeding with the same reasoning as in the linear firing cost model, the expression for the wage becomes (where $\Phi'_t=\frac{\partial\Phi_t}{\partial\rho_t}$):

$$\begin{aligned}w(a_t)=\ &\eta\left[\varphi_tA_ta_t-b+(\Phi_t+\rho_t\Phi'_t)\right]+\eta\theta_tq(\theta_t)E_t\left[\frac{c}{q(\theta_t)}+\beta_{t+1}(\Phi_{t+1}+\rho_{t+1}\Phi'_{t+1})-\beta_{t+1}\rho^2_{t+1}\Phi'_{t+1}\right]+b\\&-\eta E_t\left(\beta_{t+1}(\Phi_{t+1}+\rho_{t+1}\Phi'_{t+1})\right)+E_t\left(\eta\rho^2_{t+1}\beta_{t+1}\Phi'_{t+1}\right)\end{aligned} \tag{1.67}$$

where $\frac{\partial\Phi_t}{\partial\rho_t}=\Phi'_t$. If ρ was constant over time, $\Phi_t=\Phi_{t+1}=\Phi'_t=0$, and equation (1.67) would reduce to the same expression as equation (1.48) for $\delta=0$. Compared to the linear firing costs case, there is now an additional term in the expression for wages which is quadratic in the separation rate. This arises because the decision to fire now has an impact on the value of all other employment relationships within the firm, and this is reflected in the bargaining power of the workers.

The expression for threshold productivity is given by:

$$\tilde{a}_t = \left[b - \frac{1-\eta\theta q(\theta_t)}{1-\eta}\left(\frac{c}{q(\theta_t)}\right) - (\Phi_t + \rho_t\Phi'_t) - \frac{\eta}{1-\eta}(1-\theta_t q(\theta_t))E_t\left(\beta_{t+1}(\Phi_{t+1} + \rho_{t+1}\Phi'_{t+1})\right)\right.$$
$$\left. + \frac{\eta}{1-\eta}E_t\left(\rho^2_{t+1}(1-\theta_t q(\theta_t))\beta_{t+1}\Phi'_{t+1}\right)\right]\frac{1}{\varphi_t A_t} \tag{1.68}$$

This expression, like the wage equation, also depends positively on a term that includes the separation rate squared and marginal firing costs. This term expresses the fact that if the firm anticipates that it will increase its separation rate and consequently the firing costs level in the next period, it will have incentives to increase the threshold productivity level (and hence the separation rate) today, in order to smooth that transition, because abrupt changes in separation imply higher costs than subtle ones due to the convexity of the linex function.

1.4.2 Business Cycle Properties Analysis

Impulse Response Functions

In the formulation assumed for the firing costs, the penalization of separations is only present when there are deviations from the steady-state. Therefore the effects of firing costs in this extension of the model are only transitional. This assumption is due to simplicity and clarity of the analysis, given that the model could be easily extended to feature a combination of linear and non-linear firing costs in order to generate a steady-state impact similar to the one described in Section 1.3.

The response of this model to shocks was obtained through a second order approximation of the non-linearized model using perturbation methods as implemented in *Dynare* (see Juillard (1996), Griffoli (2007-2008) and references herein). The pruning algorithm developed by Kim, Kim, Schaumburg and Sims (2008) and implemented in *Dynare* was also used. This algorithm eliminates the values of the simulations that lead the model to explosive paths. The parameter concerning the convexity of the linex function, ψ, was calibrated to 500, as in Fahr and Smets (2010), while the parameter ϕ, that determines the degree of asymmetry, i.e, the size of the penalty from increasing the separation rate relatively to the benefit of decreasing it, is set to 0.05, the average of the range used previously to evaluate linear firing costs.

The results of this analysis are shown in Figures (1.5) and (1.6). A positive shock corresponds to an increase in productivity or in money growth. The asymmetry of the responses is more visible in the monetary shock than in the technology shock (apart from some initial irregularities possibly induced by the pruning algorithm), a feature possibly related to the fact that in the baseline, the separation rate responds much significantly to a monetary shock, given that decreasing the number of separations is the only mechanism to increase real production in the period of impact of the shock. In the case of a negative monetary shock, output volatility is lower than in a positive shock, while the response of inflation remains almost unchanged. In line with the output response, the reaction in the number of searchers is also weaker in the case of a negative shock. In the case of the positive shock, the sign of the response of vacancies continues to be identical to that of searchers. However, in the case of the negative shock the number of vacancies decreases, in order to generate the decline in labour market tightness required to satisfy the job creation condition, given that separations increase initially as would happen with linear firing costs but then quickly revert part of that increase to avoid increasingly costly dismissals.

Moments

Table (1.4) shows the results of the computation of moments for the model with asymmetrical firing costs. As mentioned before, these moments were computed using a second order approximation to the model and a pruning algorithm to eliminate explosive paths, which may lead to changes in the cyclical properties of the model. Therefore, the results for the baseline and wage rigidity models of section (1.3.3) are presented, computed with the algorithms used in this section in order to isolate the impact of the second order approximation in the moments, namely on the standard deviations of the data.[9] Although the standard deviation of the variables has changed somewhat, namely the volatility of output as well of the relative volatility of the majority of variables has decreased, most of the comparative results between the baseline and wage rigidity model remain unchanged from section 1.3.3. The last panel of Table 1.4 shows the results for the model with asymmetrical firing costs. Results show the existence of a Beveridge curve to a degree similar to the one observed in the data, although only when considering unemployed workers, given that the behavior of searchers and unemployed appears to be now more detached. Moreover, for the combined effect of the supply and demand shock, the volatility of the simulations resembles that portrayed in the data for many of the variables. However, some undesirable features of the results with linear firing costs are still present, namely a strong positive correlation between job creation and destruction rates. Moreover, there is a negative correlation of inflation and output under monetary shocks. This probably reflects to some extent the erratic behavior of the first period response of inflation to a positive shock, namely an initial decrease in price growth, which does not happen in the case of the linear firing costs.

[9] Note that with a second order approximation a change in the standard deviation of the shocks does not represent merely a rescaling. Therefore the standard deviations of the shocks described in subsection 2.1 conducted the model to explosive paths, which when eliminated with pruning generated impulse response functions too erratic. Therefore the standard deviations of the shocks considered were those included in Krause and Lubik (2007), namely 0.0049 for the productivity shock and 0.00623 for the monetary shock. The resulting standard deviation of output was scaled to resemble the one obtained with linear firing costs so that the results would be more comparable.

1.5 Conclusion

The present work was based on Krause and Lubik (2007) and their conclusion that wage rigidity improves some of the business cycle properties of a New Keynesian model with a labour market characterized by search and matching frictions as a starting point. This work proceeds by adding to that framework both linear and non-linear firing costs, in order to analyze the impact of this observable and in many countries very relevant labour market institution. This objective can put in perspective the demanding assumption of full wage rigidity assumed by Krause and Lubik (2007). We conclude that the inclusion of firing costs leads the model to replicate some of the empirical regularities of the labour market, and in the case of non-linear firing costs provide in addition a reasonable approximation to actual data volatilities. Actually, the fact that the model that globally shows better empirical properties (despite excessive output volatility) combines both firing costs and wage rigidity suggests that an avenue for future investigation may be the interaction between different labour market institutions (for instance as in Bertola and Rogerson (1997)). Other margins for improvement of the current work comprise the introduction in the model of an intensive margin for labour (a factor that Christoffel et al. (2009) claim is the reason for the difference in their conclusions about wage rigidity from those of Krause and Lubik (2007)) and the inclusion of physical capital.

Appendices

1..1 Derivation of the demand function for intermediate good *i* (equation (1.15))

The profit maximization problem for the final goods firm is given by:

$$\begin{aligned}
&\max_{y_{it}} \Pi_t = P_t Y_t - \int_0^1 P_{it} y_{it} di \Leftrightarrow \\
&\max_{y_{it}} P_t \left[\left(\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}} \right] - \int_0^1 P_{it} y_{it} di
\end{aligned} \tag{1.69}$$

The first order condition of this problem is given by:

$$\begin{aligned}
&\frac{\partial \Pi_t}{\partial y_{it}} = P_t \frac{\varepsilon}{\varepsilon - 1} \underbrace{\left(\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{1}{\varepsilon-1}}}_{Y_t^{1/\varepsilon}} \left[y_{it}^{\frac{\varepsilon-1}{\varepsilon}} \Big|_0^1 \right] \frac{\varepsilon - 1}{\varepsilon} y_{it}^{\frac{-1}{\varepsilon}} - \left[P_{it} y_{it} \Big|_0^1 \right] P_{it} = 0 \Leftrightarrow \\
&P_t {Y_t}^{1/\varepsilon} y_{it}^{-\frac{1}{\varepsilon}} = P_{it} \Leftrightarrow \\
&y_{it} = \left(\frac{P_t}{P_{it}} \right)^{\varepsilon} Y_t
\end{aligned} \tag{1.70}$$

which is the demand for good *i*.

Replacing (1.70) in the aggregator described in equation (1.14) we obtain the expression for the general price level P_t:

$$Y_t = \left(\int_0^1 \left[\left(\frac{P_t}{P_{it}} \right)^{\varepsilon} Y_t \right]^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}} \Leftrightarrow Y_t = Y_t P_t^{\varepsilon} \left[\int_0^1 \frac{1}{P_{it}} di \right]^{\frac{\varepsilon}{\varepsilon-1}} \Leftrightarrow P_t = \left[\int_0^1 P_{it}^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}} \tag{1.71}$$

Additionally, given that the market for final goods is perfectly competitive, firms in this market have nil profits:

$$P_t Y_t = \int_0^1 P_{it} y_{it} di \tag{1.72}$$

1..2 Derivation of the job destruction condition and the New Keyneasian Philips curve

The Lagrangian function for profit maximization problem of the intermediate goods firms is given by:

$$\mathscr{L}(\tilde{a}_{it}, n_{it}, v_{it}, P_{it}, y_{it}, \xi_{it}, \varphi_{it}, \zeta_{it}) = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \Bigg\{ \frac{P_{it}}{P_t} y_{it} - w_{it}(1-\rho_{it}) n_{it-1} - v_{it} c$$

$$- \frac{\psi}{2} \left(\frac{P_{it}}{P_{it-1}} - \pi \right)^2 Y_t - \rho_{it} n_{it-1} \delta - \xi_{it} [n_{it} - (1-\rho_{it})(n_{it-1}) - v_{it} q(\theta_t)]$$

$$- \varphi_{it} \left[y_{it} - A_t (1-\rho_{it}) n_{it-1} H(\tilde{a}_{it}) \right] - \zeta_{it} \left[y_{it} - \left(\frac{P_t}{P_{it}} \right)^{\varepsilon} Y_t \right] \Bigg\}$$

The first order condition for $\tilde{a}_{it}$ is given by:

$$\frac{\partial \mathscr{L}}{\partial \tilde{a}_{it}} = 0 \Leftrightarrow \left[\xi_{it} - w_{it} + \varphi_{it} A_t H(\tilde{a}_{it}) + \delta \right] \frac{\partial \rho_{it}}{\partial \tilde{a}_{it}} = \left[\varphi_{it} A_t \frac{\partial H(\tilde{a}_{it})}{\partial \tilde{a}_{it}} - \frac{\partial w(H(\tilde{a}_{it}))}{\partial \tilde{a}_{it}} \right] (1-\rho_{it}) \tag{1.73}$$

Auxiliary calculations:

$$\frac{\partial \rho_{it}(\tilde{a}_{it})}{\tilde{a}_{it}} = (1-\rho^x) f(\tilde{a}_{it})$$

$$1-\rho_{it} = (1-\rho^x) - (1-\rho^x)F(\tilde{a}_{it}) = (1-\rho^x)(1-F(\tilde{a}_{it}))$$

$$w(H(\tilde{a}_{it})) = \int_{\tilde{a}_{it}}^{\infty} w(a)\frac{f(a)}{1-F(\tilde{a}_{it})}da = \frac{1}{1-F(\tilde{a}_{it})}\int_{\tilde{a}_{it}}^{\infty} w(a)f(a)da$$

$$\frac{\partial w(H(\tilde{a}_{it}))}{\partial \tilde{a}_{it}} = \frac{f(\tilde{a}_{it})}{(1-F(\tilde{a}_{it}))^2}\int_{\tilde{a}_{it}}^{\infty} w(a)f(a)da + \frac{1}{(1-F(\tilde{a}_{it}))}[-w(\tilde{a}_{it})f(\tilde{a}_{it})]$$

$$= \frac{f(\tilde{a}_{it})}{(1-F(\tilde{a}_{it}))}\left[\int_{\tilde{a}_{it}}^{\infty} \frac{w(a)f(a)da}{(1-F(\tilde{a}_{it}))} - w(\tilde{a}_{it})\right]$$

$$\frac{\partial H(\tilde{a}_{it})}{\partial \tilde{a}_{it}} = \frac{f(\tilde{a}_{it})}{(1-F(\tilde{a}_{it}))^2}\int_{\tilde{a}_{it}}^{\infty} af(a)da - \frac{f(\tilde{a}_{it})}{(1-F(\tilde{a}_{it}))}\tilde{a}_{it} = \frac{f(\tilde{a}_{it})}{(1-F(\tilde{a}_{it}))}\left[\underbrace{\int_{\tilde{a}_{it}}^{\infty} \frac{af(a)da}{(1-F(\tilde{a}_{it}))}}_{H(\tilde{a}_{it})} - \tilde{a}_{it}\right]$$

Replacing these auxiliary calculations in equation (1.30), we obtain equation (1.35), the job destruction condition:

$$\begin{aligned}
&[\xi_{it} - w_{it} + \varphi_{it}A_t H(\tilde{a}_{it}) + \delta]\, f(\tilde{a}_{it})(1-\rho^x) = \\
&[\varphi_t A_t(H(\tilde{a}_{it}) - \tilde{a}_{it}) - (w(H(\tilde{a}_{it})) - w(\tilde{a}_{it}))]\,(1-\rho_{it})\frac{f(\tilde{a}_{it})}{1-F(\tilde{a}_{it})} \Leftrightarrow \\
&\varphi_{it}A_t\tilde{a}_{it} - w(\tilde{a}_{it}) + \delta + \frac{c}{q(\theta_t)} = 0
\end{aligned} \tag{1.74}$$

The first order condition for the price level P_{it} in the same problem is given by:

$$\frac{\partial \mathscr{L}}{\partial P_{it}} = 0 \Leftrightarrow \frac{1}{P_t} y_{it} - \psi\left(\frac{P_{it}}{P_{it-1}} - \pi\right)\frac{1}{P_{it-1}} Y_t - \psi\beta_{t+1}\left(-\frac{P_{it+1}}{P_{it}^2}\right)\left(\frac{P_{it+1}}{P_{it}} - \pi\right) Y_{t+1}$$
$$- \varepsilon\zeta_{it}\left(\frac{P_t}{P_{it}^2}\right)\left(\frac{P_t}{P_{it}}\right)^{\varepsilon-1} Y_t = 0 \tag{1.75}$$

Using the definition $\frac{P_{it}}{P_{it-1}} = \pi_{it}$, multiplying by P_{it} and dividing by Y_t, equation (1.75) becomes:

$$\frac{P_{it}}{P_t}\frac{y_{it}}{Y_t} - \psi\left(\pi_{it} - \pi\right)\pi_{it} + E_t\left[\psi\beta_{t+1}\left(\pi_{it+1} - \pi\right)\pi_{it+1}\frac{Y_{t+1}}{Y_t}\right] - \varepsilon\zeta_{it}\left(\frac{P_t}{P_{it}}\right)^{\varepsilon} = 0$$

Replacing equations (1.32) and (1.70) in this expression, we obtain:

$$\Leftrightarrow \frac{P_t}{P_{it}}^{\varepsilon-1} - \psi\left(\pi_{it} - \pi\right)\pi_{it} + E_t\left[\psi\beta_{t+1}\left(\pi_{it+1} - \pi\right)\pi_{it+1}\frac{Y_{t+1}}{Y_t}\right] - \varepsilon\left(\frac{P_t}{P_{it}}\right)^{\varepsilon-1} + \varepsilon\varphi_{it}\left(\frac{P_t}{P_{it}}\right)^{\varepsilon} = 0 \tag{1.76}$$

Given that all intermediate goods' firms face the same profit maximization problem and constraints and that they are all free to adjust their prices at any moment (albeit at a cost), in equilibrium they should all set the same price. If P_{it}=P_{jt}=P_t, $\forall i, j$, we have:

$$P_{it} = P_t \Leftrightarrow P_{it}^{1-\varepsilon} = P_t^{1-\varepsilon} \Leftrightarrow \int_0^1 P_{it}^{1-\varepsilon} di = \int_0^1 P_t^{1-\varepsilon} di \Leftrightarrow \left(\int_0^1 P_{it}^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}} = \left(\int_0^1 P_t^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}}$$
$$\Leftrightarrow \left(\int_0^1 P_{it}^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}} = P_t\left(\int_0^1 1 di\right)^{\frac{1}{1-\varepsilon}} \Leftrightarrow \left(\int_0^1 P_{it}^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}} = P_t$$

which is an identity, as defined before. Given that the demand for each intermediate good only varies across firms in as much as their prices differ, we can also conclude that y_{it}=y_{jt}=Y_t, $\forall i, j$.

From this results that:

$$\int_0^1 P_{it}Y_{it}di = \int_0^1 P_tY_tdi \Leftrightarrow \int_0^1 P_{it}Y_{it}di = P_tY_t\int_0^1 1di \Leftrightarrow \int_0^1 P_{it}Y_{it}di = P_tY_t[i|_0^1] \Leftrightarrow \int_0^1 P_{it}Y_{it}di = P_tY_t$$

which satisfies equation (1.72). Using these results, equation (1.76) becomes:

$$1 - \psi\Big(\pi_t - \pi\Big)\pi_t + E_t\left[\psi\beta_{t+1}\Big(\pi_{t+1} - \pi\Big)\pi_{t+1}\frac{Y_{t+1}}{Y_t}\right] = \varepsilon(1 - \varphi_t) \tag{1.77}$$

1..3 Derivation of the value of the net surplus from employment for the household ($W(a_t) - U_t$)

Employment in a given period *t* is determined after separations have taken place, and thus is given by:

$$e_t = (1 - \rho_t)n_{t-1} \tag{1.78}$$

where n_{t-1} is the number of employment relationships in place in the beginning of period *t*. Therefore, the law of motion for jobs (equation (1.25)) can be rewritten in terms of employment as:

$$e_{t+1} = (1 - \rho_{t+1})e_t + (1 - \rho_{t+1})\theta_t q(\theta_t)(1 - e_t) \tag{1.79}$$

where we are also using the fact that $s_t = 1 - e_t$. The household problem can be expressed in terms of the Bellman equation for the value function $\Gamma_t(e_t)$:

$$\Gamma(e_t) = \max \left\{ u(c_t, m_t) + E_t(\beta \Gamma(e_{t+1})) \right\} \tag{1.80}$$

subject to the constraints given by equation (1.79 and (1.2) where $u(c_t, m_t)$ is period *t* utility. The value for a member of the household of shifting from unemployment to employment is given by the corresponding change in the household utility function. The imposition of the restriction that the labour force equals unity allowed to express the whole problem in terms of employment only.

The problem may be formalized as:

$$\begin{aligned}\Gamma(e_t) = &\max_{e_{t+1}} \min_{\lambda_1, \lambda_2} \Bigg\{ u(c_t, m_t) + E_t(\beta \Gamma(e_{t+1})) + \lambda_1 \left[(1-\rho_{t+1}) e_t + (1-\rho_{t+1}) \theta_t q(\theta_t)(1-e_t) - e_{t+1} \right] \\ &+ \lambda_2 \left[\left(w_t e_t + \frac{M_{t-1}}{P_t} + i_{t-1} \frac{B_{t-1}}{P_t} + b(1-e_t) + \frac{Prof_t}{P_t} + \frac{T_t}{P_t} \right) - c_t - \frac{M_t}{P_t} - \frac{B_t}{P_t} \right] \Bigg\}\end{aligned} \tag{1.81}$$

The first order and envelope conditions yield:

$$\beta E_t \frac{\partial \Gamma(e_{t+1})}{\partial e_{t+1}} = \lambda_1 \tag{1.82}$$

$$\frac{\partial \Gamma(e_t)}{\partial e_t} = \lambda_2 w_t - \lambda_2 b + E_t \left[(1-\rho_{t+1})(1 - q(\theta_t)\theta_t) \lambda_1 \right] \tag{1.83}$$

And the transversality condition is given by:

$$\lim_{t\to\infty} \beta^t \Gamma(e_t) = 0 \tag{1.84}$$

Equations (1.82) and (1.83) yield the law of motion for the the marginal surplus of a job to the household, which is the marginal value for a member of the household of going from unemployment to employment:

$$\frac{\partial \Gamma_t}{\partial e_t} = \tilde{W}_t(a_t) - \tilde{U}_t = \lambda_2 w(a_t) - \lambda_2 b + E_t\left[\beta\left(\frac{\partial \Gamma_{t+1}}{\partial e_{t+1}}\right)(1-\rho_{t+1})(1-\theta_t q(\theta_t))\right] \tag{1.85}$$

In period $t+1$ employment will only have value if the match is not dismissed before it is used in production, which happens if $a_{t+1} < \tilde{a}_{t+1}$, this expression becomes:

$$\tilde{W}_t(a_t) - \tilde{U}_t = \lambda_2 w(a_t) - \lambda_2 b + E_t\left[\beta(1-\rho_{t+1})(1-\theta_t q(\theta_t))\int_{\tilde{a}_{t+1}}^{\infty}\left(\frac{\tilde{W}_t(a_{t+1})}{1-F(\tilde{a}_{t+1})} - \frac{\tilde{U}_{t+1}}{1-F(\tilde{a}_{t+1})}\right) f(a)da\right] \tag{1.86}$$

And defining

$$W_t(a_t) - U_t = \frac{\tilde{W}_t(a_t) - \tilde{U}_t}{\lambda_2} \tag{1.87}$$

as the value of employment in units of final consumption goods, given that λ_2 equals the marginal utility of consumption, we obtain:

$$W_t(a_t)-U_t = w(a_t)-b+E_t\left[\beta_{t+1}(1-\rho_{t+1})(1-\theta_t q(\theta_t))\int_{\tilde{a}_{t+1}}^{\infty}\left(\frac{W_t(a_t)}{1-F(\tilde{a}_{t+1})}-\frac{U_t}{1-F(\tilde{a}_{t+1})}\right)f(a)da\right] \tag{1.88}$$

which is identical to the expression obtained from subtracting equation (1.38) from equation (1.37).

1..4 Derivation of the value of the net surplus of employment for the firm ($J(a_t) - V_t$)

The Bellman equation defining the marginal surplus of a job to the firm (for a given worker) depends on the future value of the value function in the case the employment relationship is maintained. In the case the job is severed, there is a negative value associated with the separation costs:

$$\Upsilon_t(e_t, v_t) = \varphi_t A_t a_t e_t - w_t e_t - c v_t + E_t\left(\beta_{t+1}\Upsilon_{t+1}(e_{t+1}, v_{t+1}) - \delta\beta_{t+1}\rho_{t+1}(e_t + v_t q(\theta_t))\right) \tag{1.89}$$

This expression already incorporates the fact that φ_t is the optimal marginal revenue per each unit of output produced and is expressed in consumption units. Given that the employment level is determined only after the idiosyncratic shocks to productivity have taken place, we assume that the value function is evaluated after a_t is known for each worker and therefore the relevant separation decisions have been made and their associated firing costs have been paid. Therefore the latter affect the value of employment in prospective terms only.

The problem can be formalized as:

$$\Upsilon_t(e_t, v_t) = max_{e_{t+1}, v_{t+1}} min_\lambda \Big\{ \varphi_t A_t a_t e_t - w_t e_t - cv_t + E_t \left(\beta_{t+1} \Upsilon_{t+1}(e_{t+1}, v_{t+1}) - \delta \beta_{t+1} \rho_{t+1}(e_t + v_t q(\theta_t)) \right)$$
$$+ \lambda[(1 - \rho_{t+1})e_t + (1 - \rho_{t+1})q(\theta_t)v_t - e_{t+1}] \Big\} \tag{1.90}$$

The first order and envelope conditions are given by:

$$E_t \left[\beta_{t+1} \frac{\partial \Upsilon_{t+1}(e_{t+1}, v_{t+1})}{\partial e_{t+1}} \right] = \lambda \tag{1.91}$$

$$\frac{\partial \Upsilon_t(e_t, v_t)}{\partial e_t} = \varphi_t A_t a_t - w_t - E_t \left[\delta \beta_{t+1} \rho_{t+1} + \lambda(1 - \rho_{t+1}) \right] \tag{1.92}$$

$$E_t \left[\beta_{t+1} \frac{\partial \Upsilon_{t+1}(e_{t+1}, v_{t+1})}{\partial v_{t+1}} \right] = 0 \tag{1.93}$$

$$\frac{\partial \Upsilon_t(e_t, v_t)}{\partial v_t} = -c - E_t \left[\delta \beta_{t+1} \rho_{t+1} q(\theta) + \lambda(1 - \rho_{t+1}) q(\theta) \right] \tag{1.94}$$

Combining these equations yields:

$$\frac{\partial \Upsilon_t}{\partial e_t} - \frac{\partial \Upsilon_t}{\partial v_t} = \varphi_t A_t a_t - w(a_t) + c$$
$$+ E_t\left[\beta_{t+1}(1-\rho_{t+1})(1-q(\theta_t))\left(\frac{\partial \Upsilon_{t+1}}{\partial e_{t+1}} - \frac{\partial \Upsilon_{t+1}}{\partial v_{t+1}}\right) - \delta\beta_{t+1}\rho_{t+1}(1-q(\theta_t))\right] \tag{1.95}$$

Considering, as in the previous derivation, that a job only has marginal value for the firm in period t+1 if it is not severed, the expression becomes:

$$J(a_t) - V_t = \varphi_t A_t a_t - w(a_t) + E_t\left[\beta_{t+1}(1-\rho_{t+1})(1-q(\theta_t))\int_{\tilde{a}_{t+1}}^{\infty}\left(\frac{J(a_{t+1})}{1-F(\tilde{a}_{t+1})} - \frac{V_{t+1}}{1-F(\tilde{a}_{t+1})}\right) f(a)da\right]$$
$$- E_t\left[\beta_{t+1}(1-q(\theta_t))\rho_{t+1}\delta\right] + c \tag{1.96}$$

which is identical to the expression obtained by subtracting equation (1.40) from (1.39).

1..5 Derivation of the Nash Bargaining wage

The problem of wage bargaining is given by:

$$\max_{w(a_t)} \left(W_t(a_t) - U_t\right)^{\eta}\left(J_t(a_t) - V_t + \delta\right)^{(1-\eta)} \tag{1.97}$$

The first order condition of this problem is:

$$\eta(W(a_t)-U_t)^{\eta-1}\Bigg(\underbrace{\frac{\partial W(a_t)}{\partial w(a_t)}}_{=1}-\underbrace{\frac{\partial U}{\partial w(a_t)}}_{=0}\Bigg)(J(a_t)-V_t+\delta)^{1-\eta}$$
$$+(1-\eta)(J(a_t)-V_t+\delta)^{-\eta}(W(a_t)-U_t)^{\eta}\underbrace{\frac{\partial J(a_t)}{\partial w(a_t)}}_{=-1}=0 \Leftrightarrow \tag{1.98}$$
$$(1-\eta)[W_t(a_t)-U_t]=\eta(J_t(a_t)+\delta)$$

1..6 Derivation of the value of the joint surplus of a match

$$\frac{c}{q(\theta_t)}=E_t\left\{\beta_{t+1}(1-\rho_{t+1})\Bigg(\int_{\tilde{a}_{t+1}}^{\infty}J_{t+1}\frac{f(a)}{1-F(\tilde{a}_{t+1})}da\Bigg)-\rho_{t+1}\beta_{t+1}\delta\right\}\Leftrightarrow$$
$$\frac{c}{q(\theta_t)}=E_t\left\{\beta_{t+1}(1-\rho_{t+1})\Bigg(\int_{\tilde{a}_{t+1}}^{\infty}J_{t+1}\frac{f(a)}{1-F(\tilde{a}_{t+1})}da\Bigg)+\beta_{t+1}(1-\rho_{t+1})\delta-\beta_{t+1}\delta\right\}\Leftrightarrow \tag{1.99}$$

Given that: $\delta=\frac{\delta}{1-F(\tilde{a}_{t+1})}\int_{\tilde{a}_{t+1}}^{1}f(a)da=\int_{\tilde{a}_{t+1}}^{1}\frac{\delta}{1-F(\tilde{a}_{t+1})}f(a)da$, we can write:

$$\frac{c}{q(\theta_t)} = E_t \left\{ \beta_{t+1}(1-\rho_{t+1}) \left(\int_{\tilde{a}_{t+1}}^{\infty} \left(\frac{J_{t+1}}{1-F(\tilde{a}_{t+1})} + \frac{\delta}{1-F(\tilde{a}_{t+1})} \right) f(a)da \right) - (\beta_{t+1}\delta) \right\} \Leftrightarrow$$

$$\frac{c}{q(\theta_t)} = E_t \left\{ \beta_{t+1} \left[(1-\rho^x) \left(\int_{\tilde{a}_{t+1}}^{\infty} (J_{t+1}+\delta) f(a)da \right) \right] - \delta \right\} \Leftrightarrow$$

$$\frac{c}{q(\theta_t)} = E_t \left\{ \beta_{t+1} \left[(1-\rho^x) \left(\int_{\tilde{a}_{t+1}}^{\infty} (1-\eta)\, \Omega_{t+1} f(a)da \right) - \delta \right] \right\} \Leftrightarrow$$

$$E_t \left\{ \left(\frac{c}{q(\theta_t)} + \beta_{t+1}\delta \right) \frac{1}{\beta_{t+1}(1-\rho^x)(1-\eta)} \right\} = E_t \left\{ \left(\int_{\tilde{a}_{t+1}}^{\infty} \Omega_{t+1} f(a)da \right) \right\}$$

1..7 Determination of threshold productivity level

At the threshold level of productivity we have:

$$W(\tilde{a}_t) - U(\tilde{a}_t) = 0$$

which implies:

$$w(\tilde{a}_t) + (1-\theta_t q(\theta_t)) \frac{\eta}{1-\eta} \left[\frac{c}{q(\theta_t)} + E_t\left(\beta_{t+1}\delta\right) \right] - b = 0 \tag{1.100}$$

And using equation (1.48) evaluated at $\tilde{a}_t$ to replace $w(\tilde{a}_t)$ we have:

$$b-(1-\theta_t q(\theta_t))\frac{\eta}{1-\eta}\left[\frac{c}{q(\theta_t)}+E_t(\beta_{t+1}\delta)\right]=$$

$$\eta\varphi_t A_t\tilde{a}_t+\eta\theta_t q(\theta)\left[\frac{c}{q(\theta_t)}\right]+\left[1-(1-\theta_t q(\theta_t))E_t(\beta_{t+1})\right]\eta\delta+(1-\eta)b\Leftrightarrow \tag{1.101}$$

$$\tilde{a}_t=\left[b-\frac{1-\eta\theta q(\theta_t)}{1-\eta}\left(\frac{c}{q(\theta_t)}\right)-\delta-\frac{\eta}{1-\eta}\delta(1-\theta_t q(\theta_t))E_t(\beta_{t+1})\right]\frac{1}{\varphi_t A_t}$$

According to equation (1.74), the maximization of profit for firms implies:

$$-\xi_t=[\varphi_t A_t\tilde{a}_t-w(\tilde{a}_t)+\delta]$$

Using equation (1.48) to substitute the threshold wage rate we have:

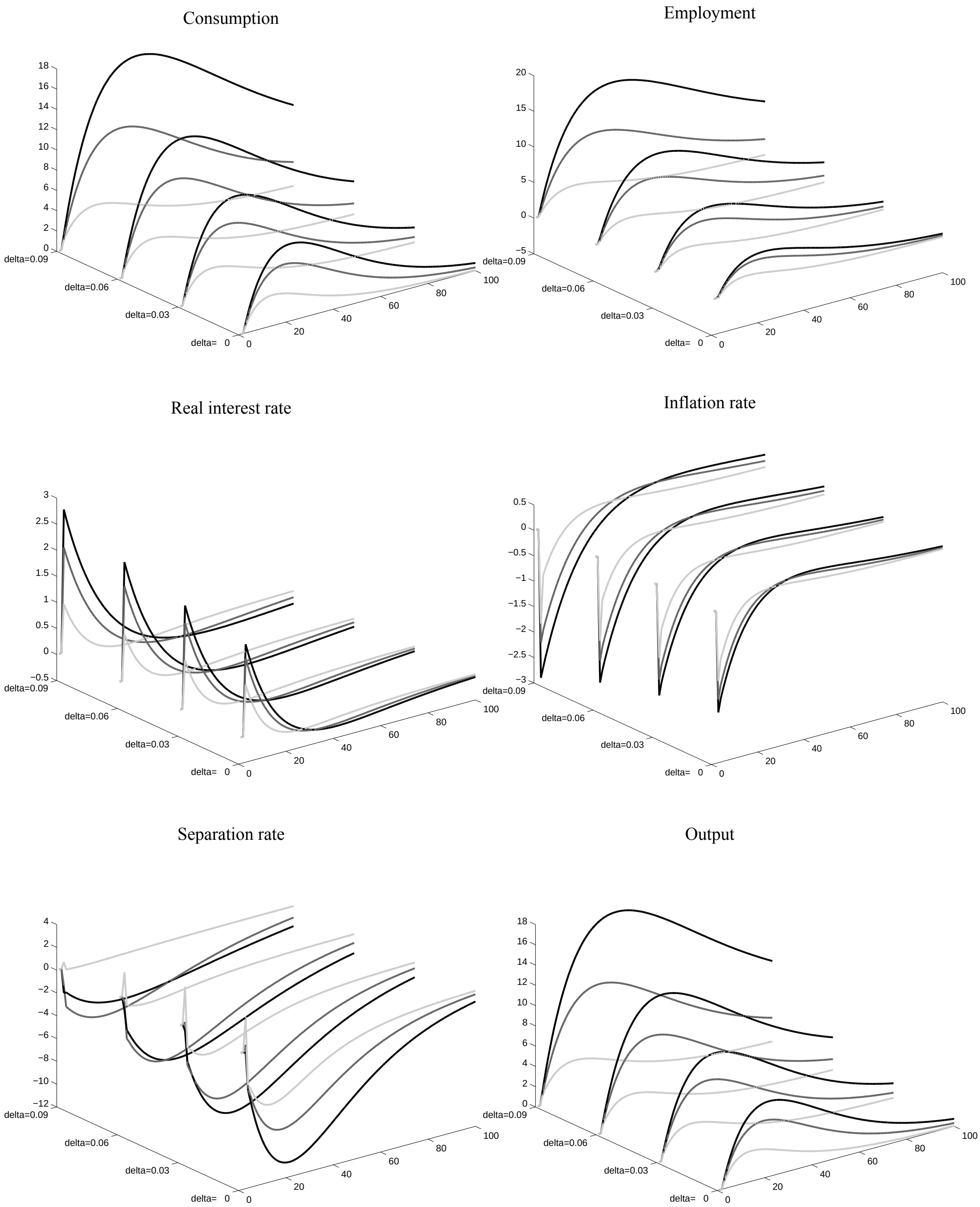
$$-\xi_t=(1-\eta)\varphi_t\tilde{a}_t-(1-\eta)b-\eta c\theta_t-\eta\delta[1-(1-\theta_t q(\theta_t))E_t(\beta_{t+1})]+\delta\Leftrightarrow$$

$$\xi_t=\frac{c}{q(\theta_t)}$$

which is the first order condition for the posting of vacancies. Therefore the threshold level of productivity that arises from the Nash bargaining process satisfies the optimality conditions of the firm.

Figure 1.3: Impulse response functions to a 1% technology shock and different degrees of wage rigidity and firing costs

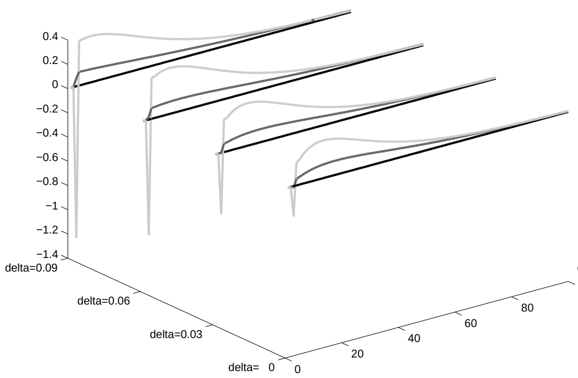
Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)



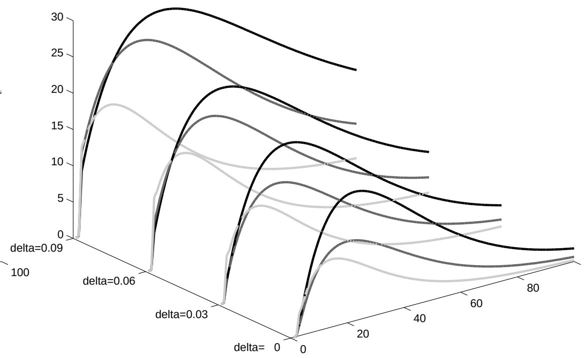
Impulse response functions to a 1% technology shock and different degrees of wage rigidity and firing costs

Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)

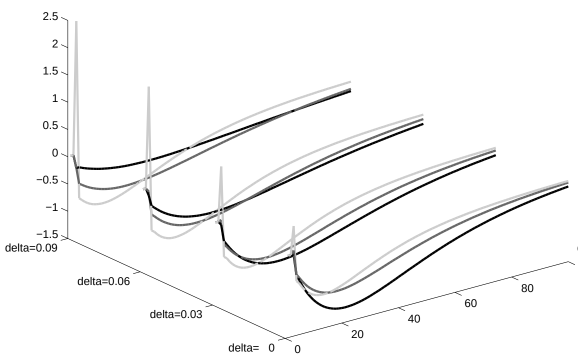
Wage



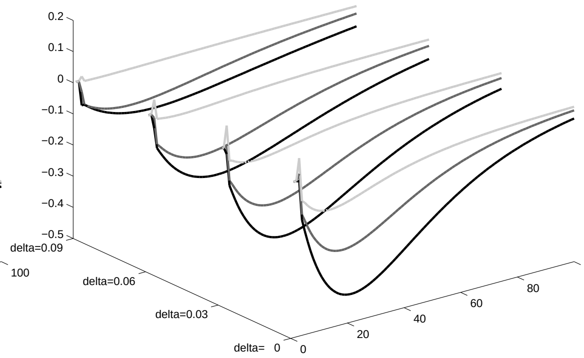
Labour market tightness



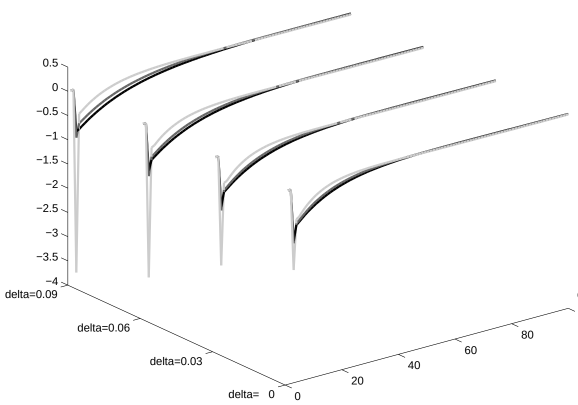
Treshold productivity



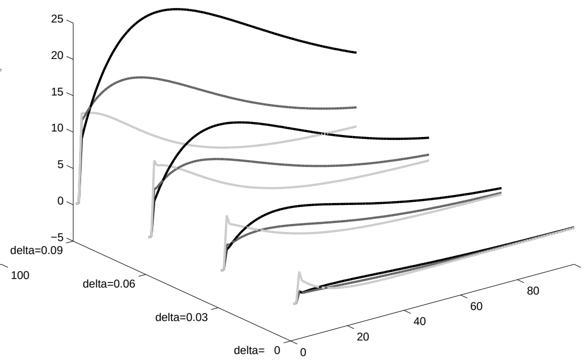
Average productivity



Real marginal cost



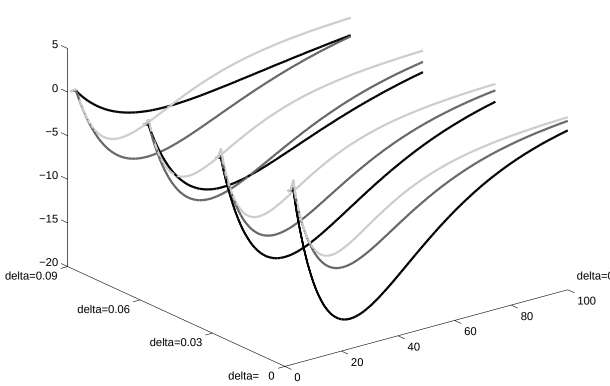
Vacancies



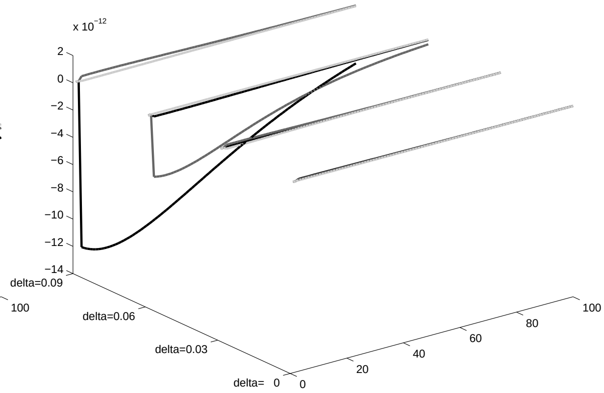
Impulse response functions to a 1% technology shock and different degrees of wage rigidity and firing costs

Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)

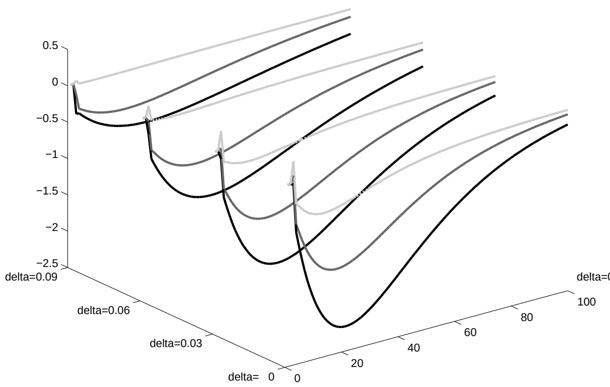
Job searchers



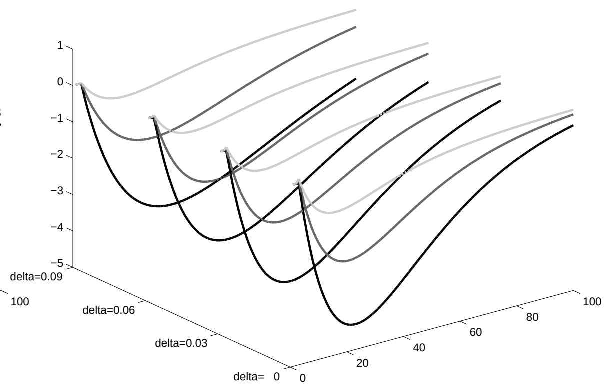
Nominal interest rate



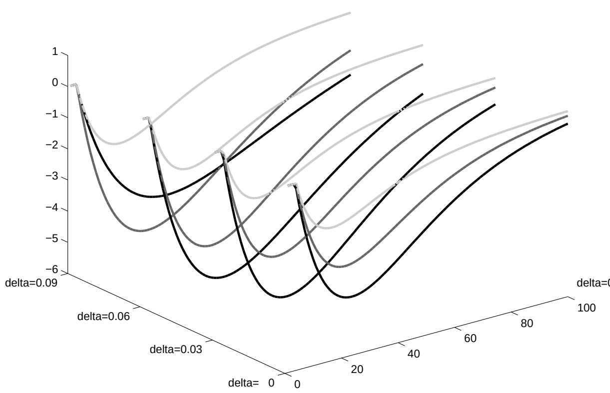
Job destruction



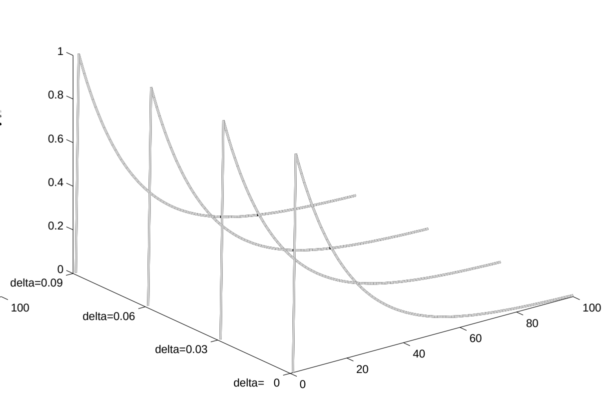
Job creation



Unemployment rate (in percentage points)



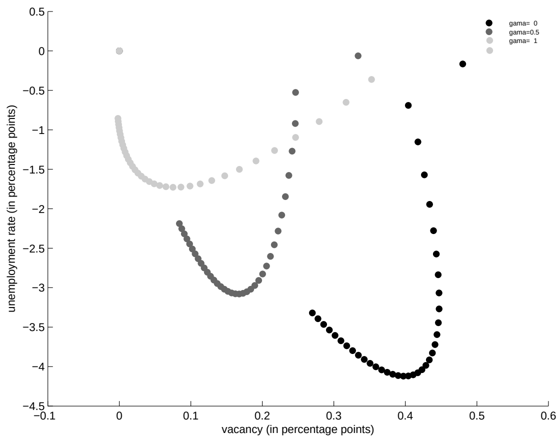
Productivity shock



Impulse response functions to a 1% technology shock and different degrees of wage rigidity and firing costs

Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)

Beveridge curve for $\delta = 0$



Beveridge curve for $\delta = 0.09$

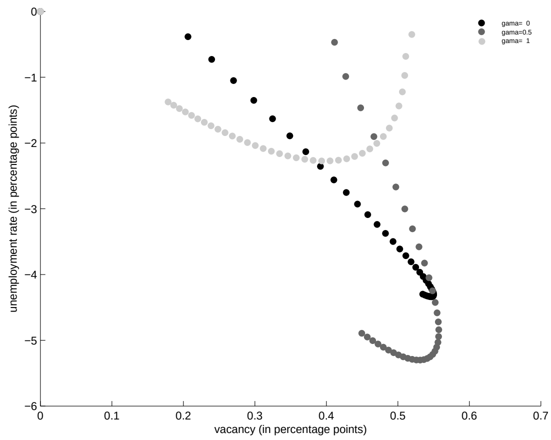
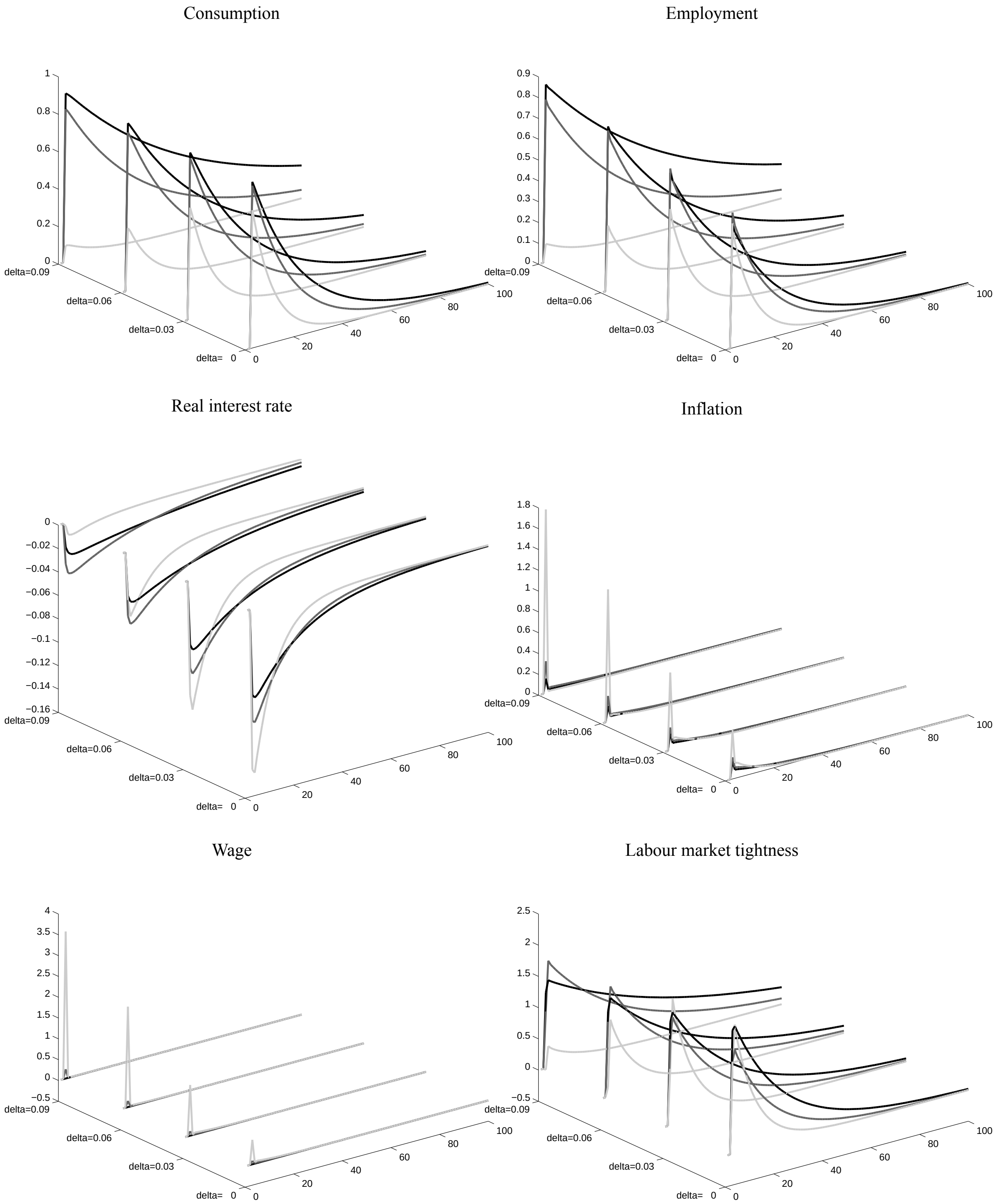


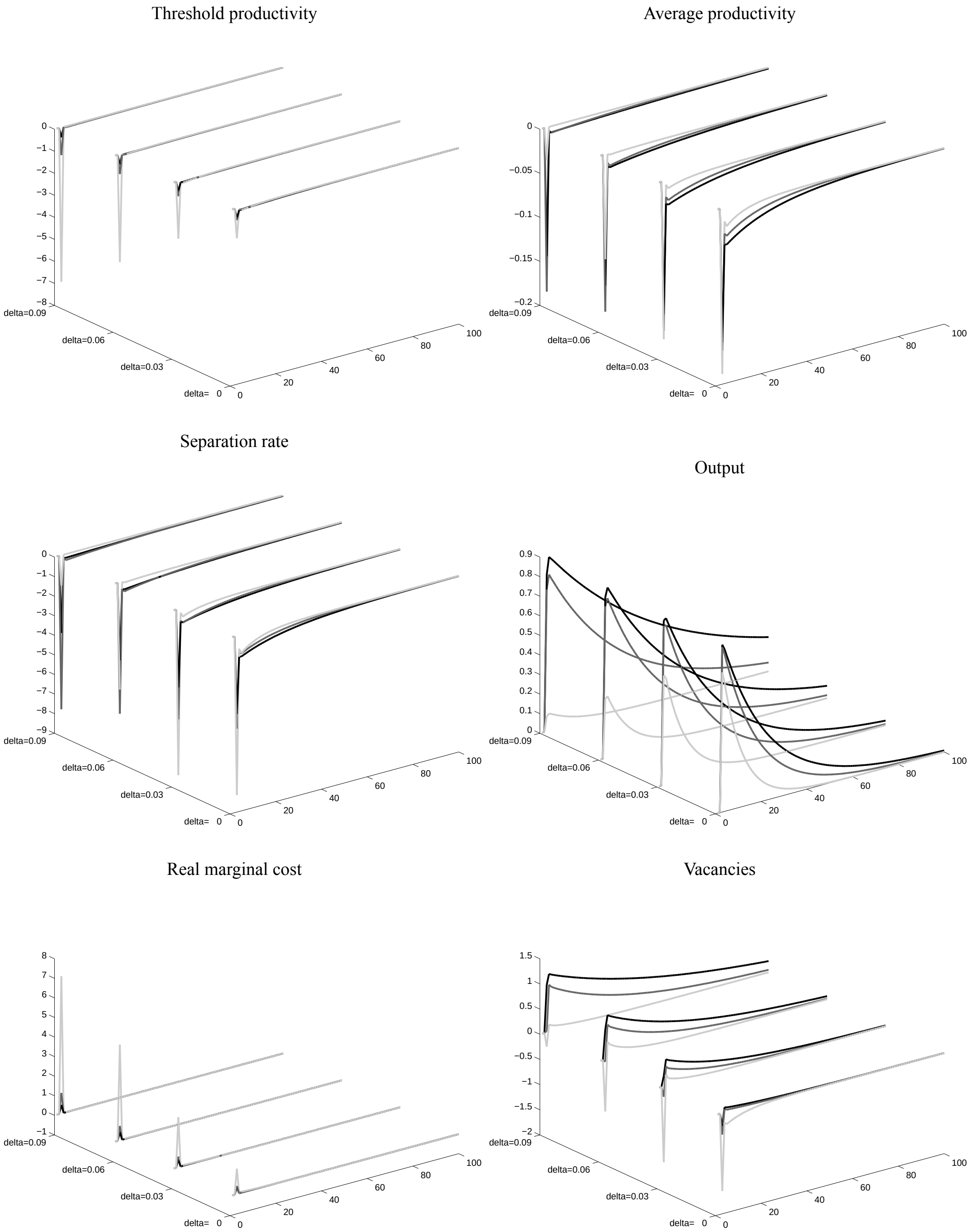
Figure 1.4: Impulse response functions to a 1% monetary shock and different degrees of wage rigidity and firing costs

Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)



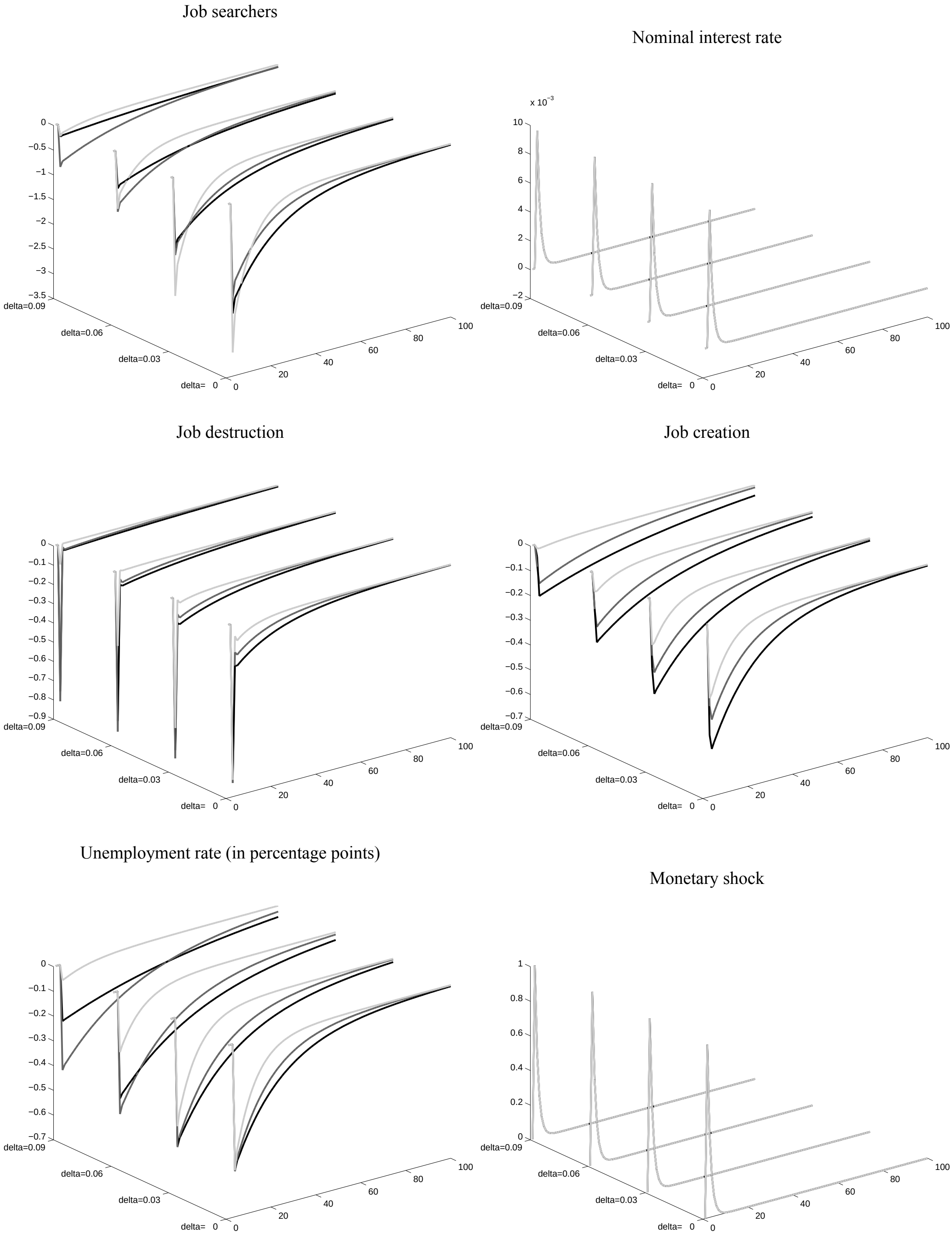
Impulse response functions to a 1% monetary shock and different degrees of wage rigidity and firing costs

Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)



Impulse response functions to a 1% monetary shock and different degrees of wage rigidity and firing costs

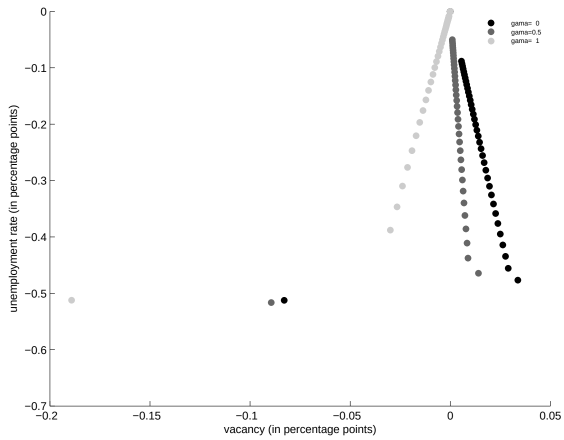
Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)



Impulse response functions to a 1% monetary shock and different degrees of wage rigidity and firing costs

Legend: $\gamma = 1$ (full wage flexibility) $\gamma = 0.5$ $\gamma = 0$ (full wage rigidity)

Beveridge curve for $\delta = 0$



Beveridge curve for $\delta = 0.09$

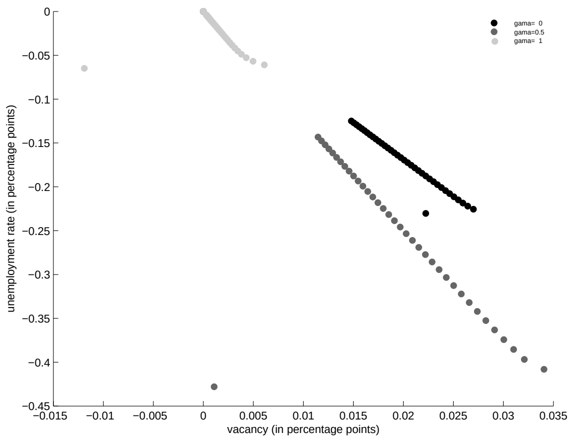
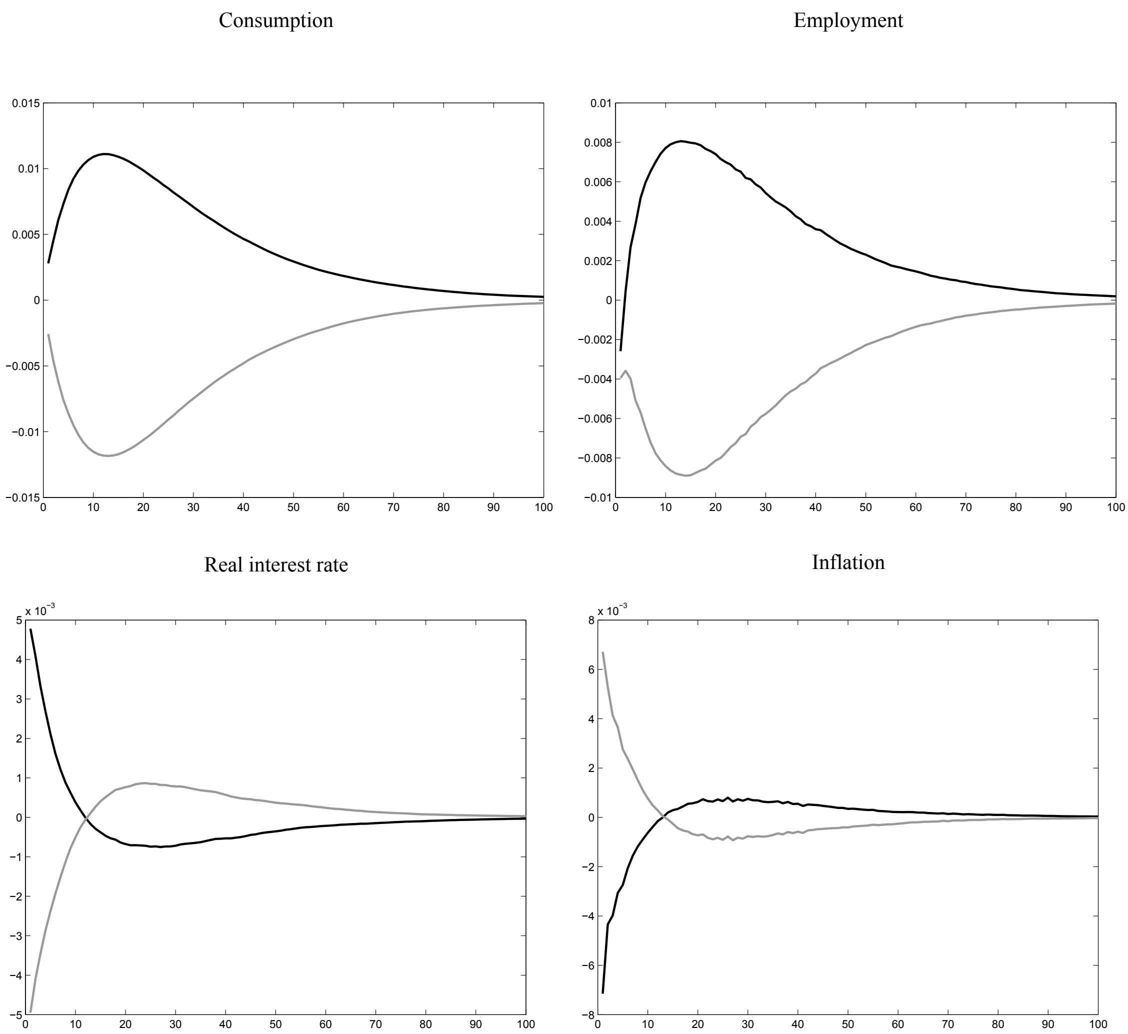


Figure 1.5: Impulse response functions to a 1 standard deviation productivity shock with asymmetrical firing costs

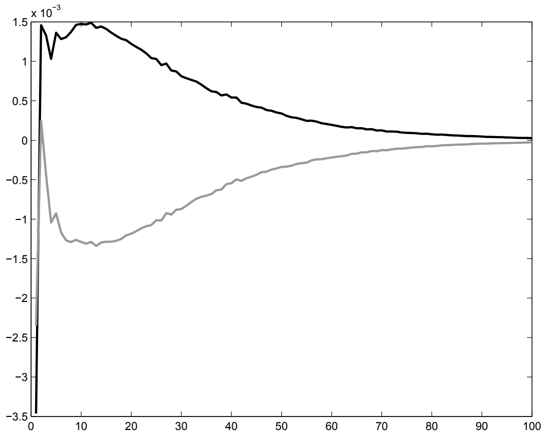
Legend: negative shock positive shock



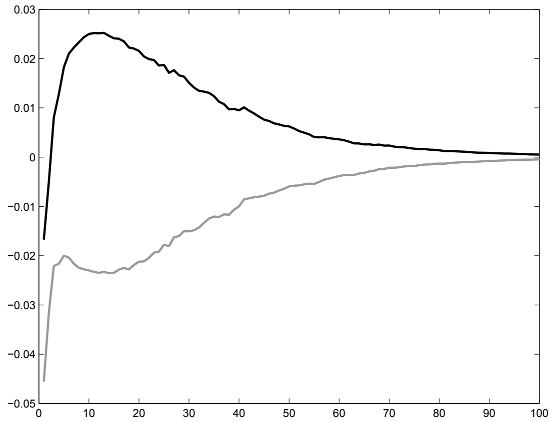
Impulse response functions to a 1 standard deviation productivity shock with asymmetrical firing costs

Legend: negative shock positive shock

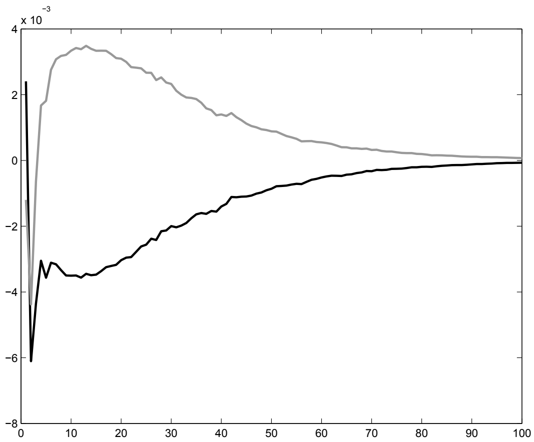
Wage



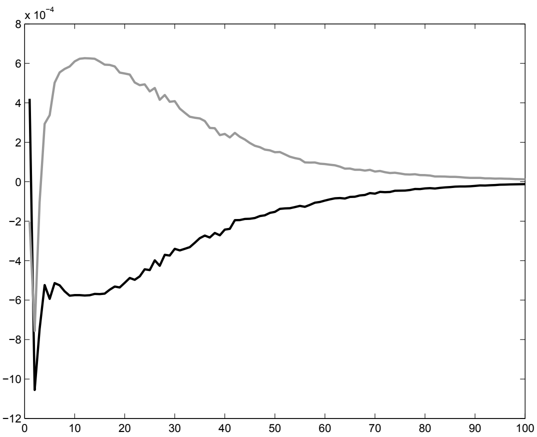
Labour market tightness



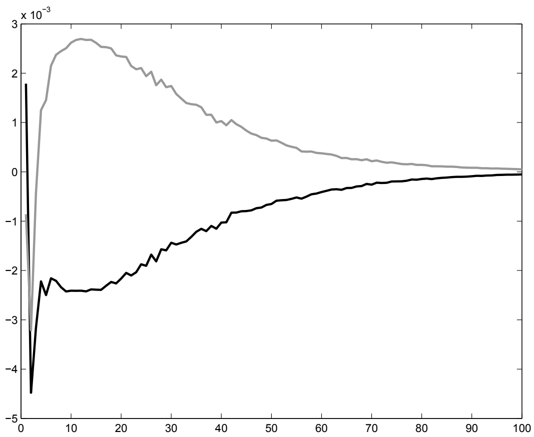
Threshold Productivity



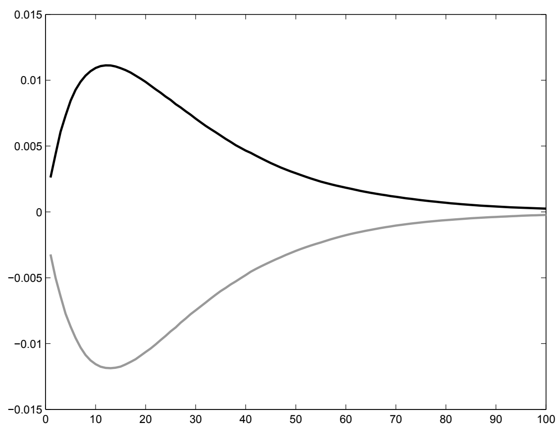
Average Productivity



Separation rate



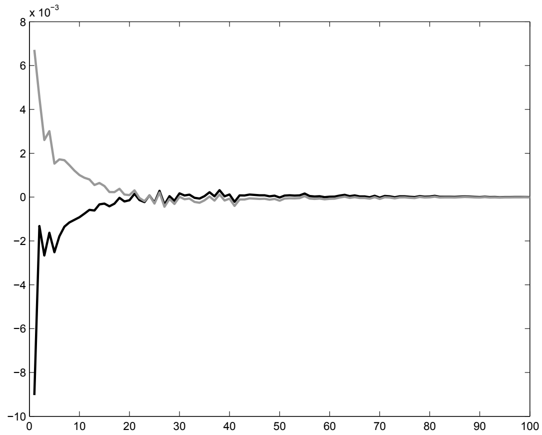
Output



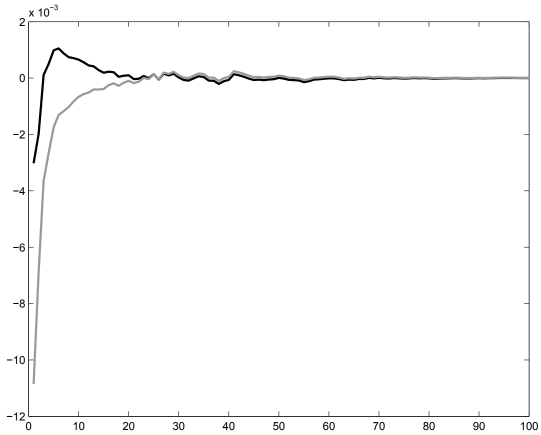
Impulse response functions to a 1 standard deviation productivity shock with asymmetrical firing costs

Legend: negative shock positive shock

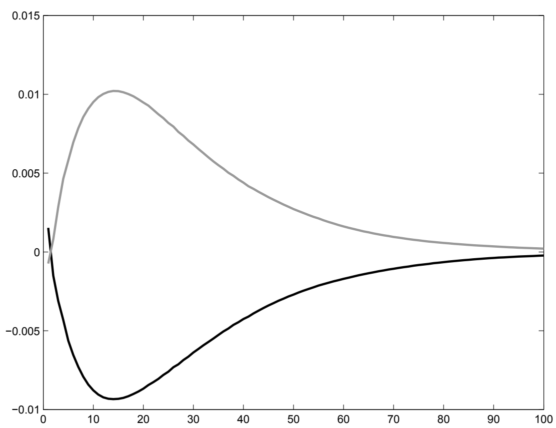
Real marginal costs



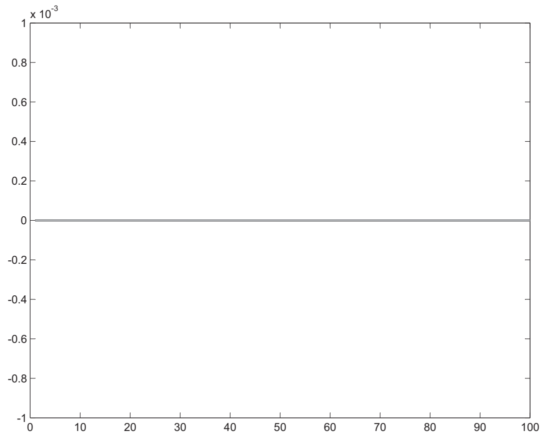
Vacancies



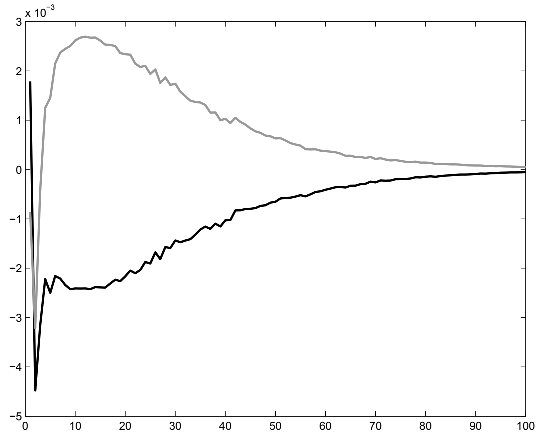
Searchers



Nominal interest rate



Job destruction rate



Job creation rate

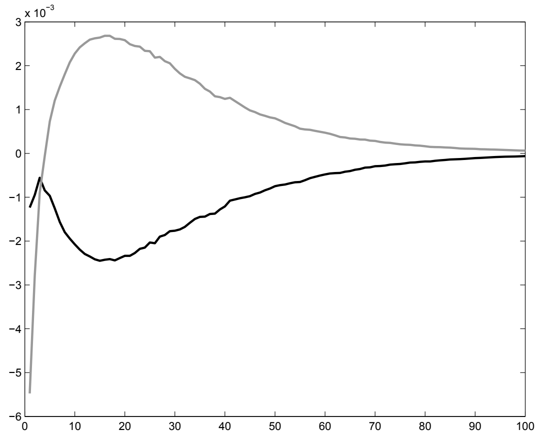
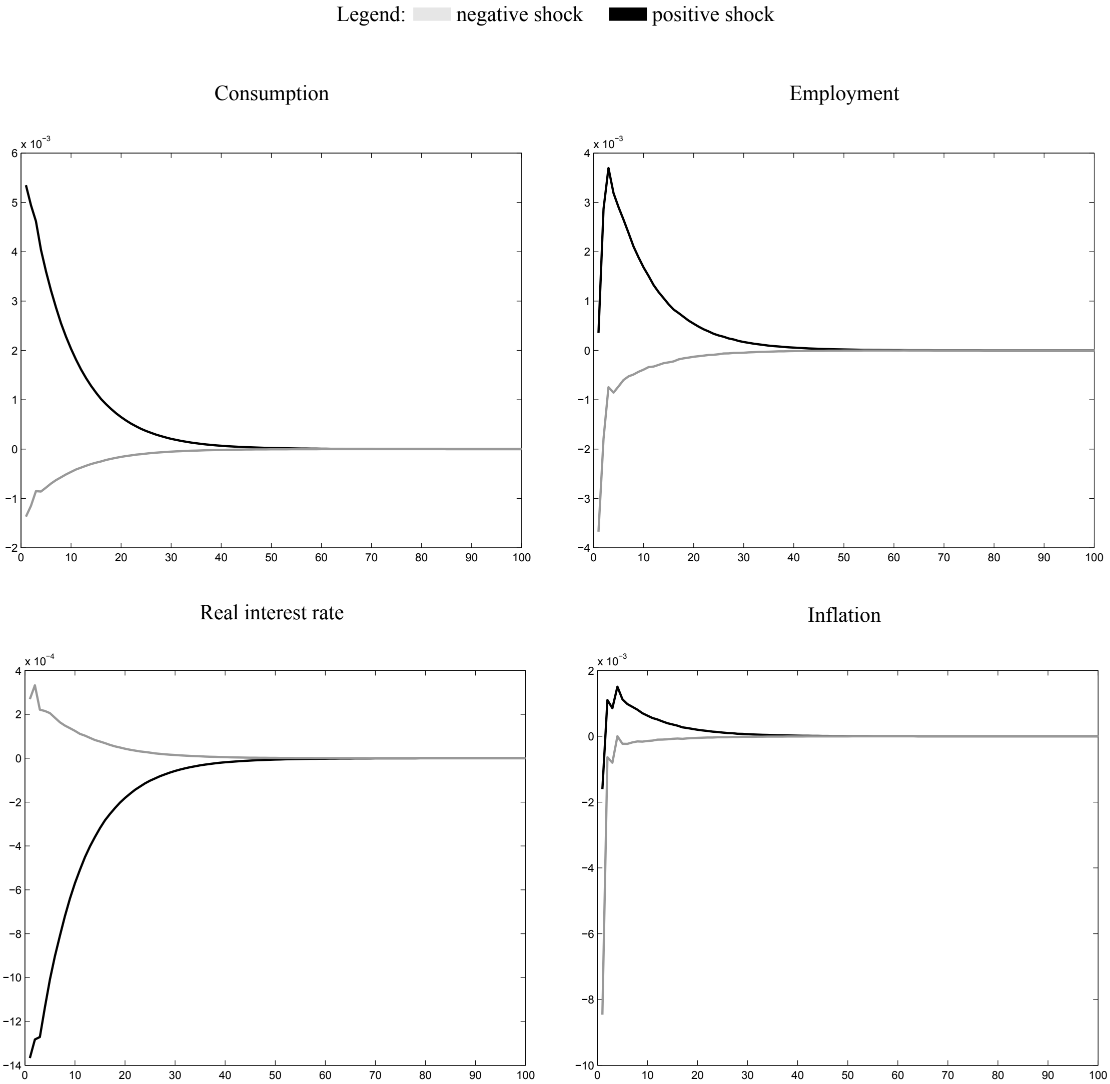
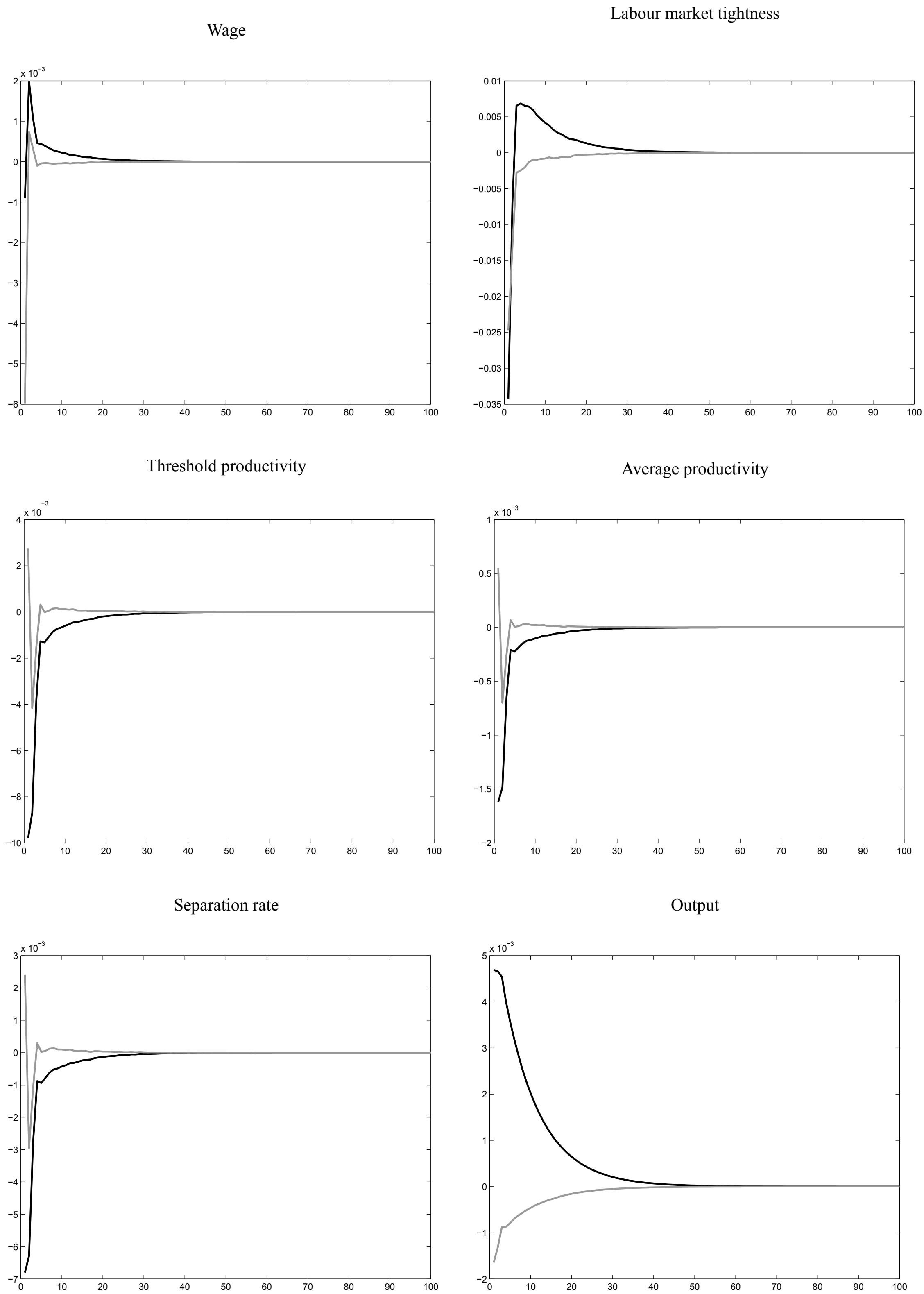


Figure 1.6: Impulse response functions to a 1 standard deviation monetary shock with asymmetrical firing costs



Impulse response functions to a 1 standard deviation monetary shock with asymmetrical firing costs

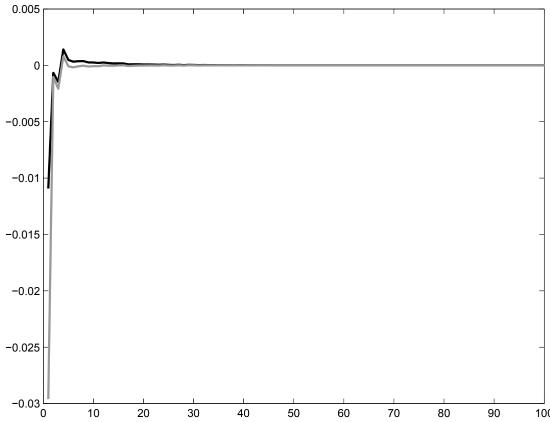
Legend: negative shock positive shock



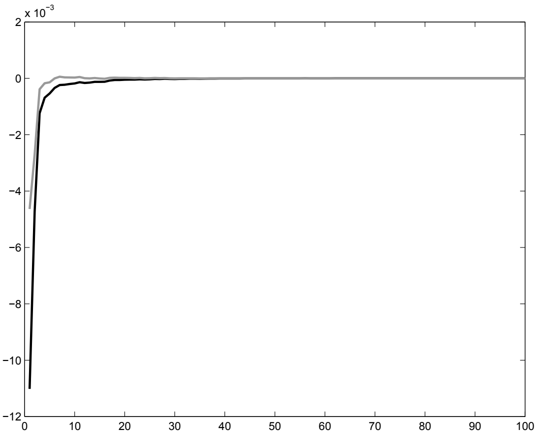
Impulse response functions to a 1 standard deviation monetary shock with asymmetrical firing costs

Legend: negative shock positive shock

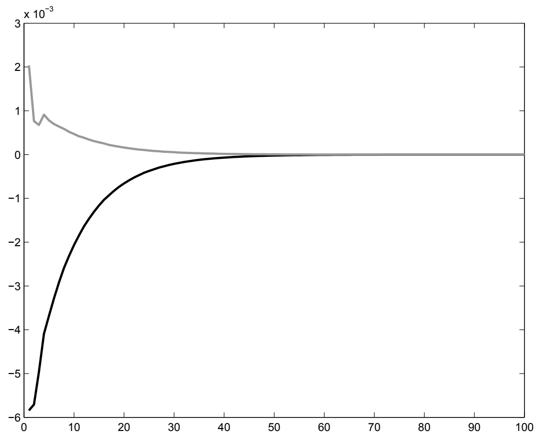
Real marginal cost



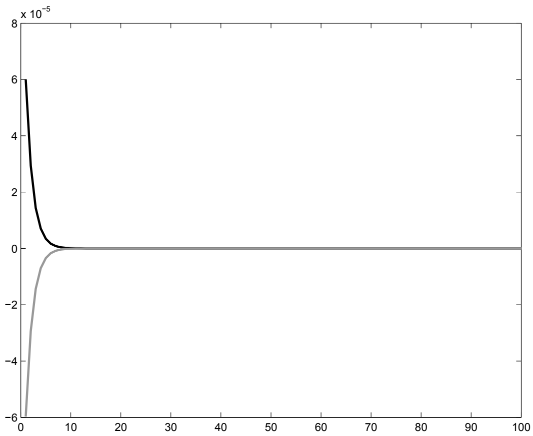
Vacancies



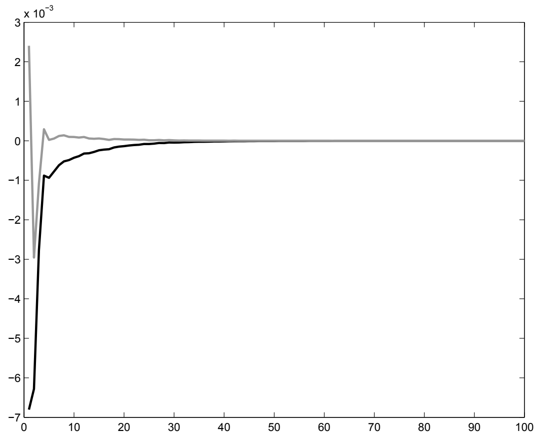
Separation rate



Nominal interest rate



Job destruction rate



Job creation rate

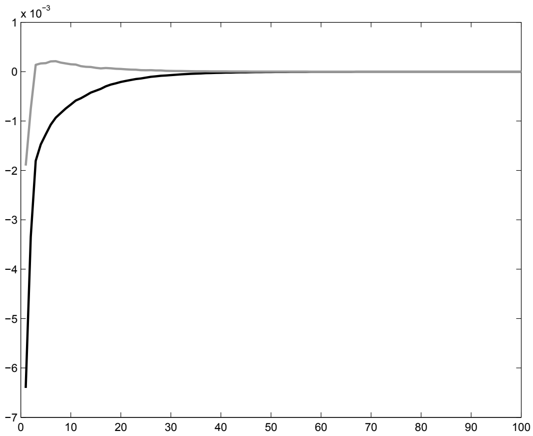


Table 1.2: U.S. Business Cycle Data - Sources and Descriptive Statistics

Variable	Standard Deviation (×100)	Standard Deviation (relative to Y)	First Order Autocorrelation	Original Unit	Variable Transformation	Description	Source
Output	1.59	1.00	0.87	Billions of chained 2005 dollars	ln	sa	US Bureau of Economic Analysis
Vacancies	13.29	8.37	0.92	Index, 1987=100	ln	nsa	Conference Board via Thomson Financial Datastream (Reuters)
Unemployment	10.92	6.87	0.91	Number in thousands	ln	16 years and over, sa	US Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey (LNS13000000Q)
Wages	1.15	0.72	0.91	Average Hourly Earnings, 1982 Dollars	ln	sa	US Bureau of Labor Statistics, Employment, Hours, and Earnings from the Current Employment Statistics survey (National) (CES0500000032)
Inflation rate	1.79	1.12	0.56	Index, 1982-84=100	q-o-q annualized rate of change, ln	sa	US Bureau of Labor Statistics, Consumer Price Index - All Urban Consumers (CUSR0000SA0)
Employment	1.30	0.82	0.94	Number in thousands	ln	sa	US Bureau of Labor Statistics, Employment, Hours, and Earnings from the Current Employment Statistics survey (National) (CES0000000001)
Labour market tightness	23.88	15.03	0.92	-	ln	sa	Authors' calculations
Labour productivity	0.92	0.58	0.76	-	ln	-	Authors' calculations
Job creation rate	2.52	1.59	0.42	-	ln	sa	US Bureau of Labor Statistics, Business Employment Dynamics (BDS0000000000000000110001LQ5) and authors' calculations, based on Cole and Rogerson (1996) methodology.
Job destruction rate	2.93	1.84	0.61	-	ln	sa	US Bureau of Labor Statistics, Business Employment Dynamics (BDS0000000000000000110004LQ5) and authors' calculations, based on Cole and Rogerson (1999) methodology.

Notes: All data is quarterly or converted to quarterly frequency and refers to the period 1964Q1 to 2002Q4, with the exception of job creation and destruction statistics, which range from 1992Q3 to 2002Q4. The trend component of the series was removed using the HP-filter with λ=1600. In the case of job creation and destruction, due to the reduced time span of the series, a longer sample, up to 2008Q4 was used to extract the trend. sa - seasonally adjusted. nsa - not seasonally adjusted.

Table 1.3: Business cycle properties of US economy and model economy: linear firing costs

	US Economy	Baseline Model			Rigid Wage Model			Firing Costs Model			Firing Costs and Rigid Wage Model		
		M&R	Money	Real	M&R	Money	Real	M&R	Money	Real	M&R	Money	Real
Standard deviations (in %)													
Output	1.59	2.14	0.75	1.27	3.69	0.98	3.84	1.61	0.10	1.27	5.63	0.89	5.32
Inflation	1.12	0.63	0.50	0.87	0.48	0.14	0.53	1.16	13.09	0.91	0.50	0.11	0.57
Real wage	0.72	0.27	0.64	0.23	0.00	0.00	0.00	1.88	26.25	0.76	0.00	0.00	0.00
Searchers		3.16	3.81	3.09	3.04	3.25	3.01	2.50	3.37	2.49	0.38	0.39	0.37
Vacancies	8.37	1.82	1.66	2.51	0.88	0.64	0.95	2.20	0.96	2.41	4.98	3.39	5.41
Tightness	15.03	3.07	2.76	3.15	4.70	4.79	4.68	1.80	0.93	1.92	4.07	3.08	4.37
JCR	1.59	7.81	8.48	8.82	9.36	9.45	9.32	8.18	4.32	9.15	6.14	3.60	6.90
JDR	1.84	12.02	27.43	10.51	10.81	18.16	9.98	1.77	24.66	0.73	4.18	20.43	2.74
For reference:													
Unemployment	6.87	4.12	4.73	3.93	3.60	3.77	3.57	8.70	10.35	8.60	5.29	5.43	5.28
Correlations													
S, V		0.34	0.76	0.38	-0.31	-0.01	-0.32	-0.21	0.06	-0.14	-0.68	-0.99	-0.63
JCR, JDR	-0.53	0.60	0.72	0.60	0.84	0.66	0.87	0.10	0.87	0.37	-0.46	-0.83	-0.71
Y, inflation	0.38	-0.05	0.81	-0.25	-0.09	0.91	-0.14	-0.10	0.33	-0.24	-0.09	0.58	-0.13
For reference:													
U, V	-0.94	0.19	0.71	0.18	-0.37	-0.05	-0.38	-0.51	-0.06	-0.47	-0.79	-0.99	-0.77
Autocorrelations													
Output	0.87	0.91	0.65	0.90	0.95	0.80	0.97	0.92	0.83	0.89	0.96	0.78	0.96
Inflation	0.56	0.63	0.06	0.57	0.73	0.47	0.81	0.06	-0.09	0.26	0.72	0.06	0.77

Table 1.4: Business cycle properties of US economy and model economy: asymmetrical firing costs

	US	Baseline Model			Rigid Wage Model			Firing Costs Model		
	Economy	M&R	Money	Real	M&R	Money	Real	M&R	Money	Real
Standard deviations (in %)										
Output	1.59	0.82	0.46	0.85	1.14	0.48	1.31	1.28	0.74	1.02
Inflation	1.12	0.90	0.64	0.96	1.01	0.20	0.91	1.47	1.82	0.75
Real wage	0.72	0.46	0.74	0.24	0.00	0.00	0.00	1.04	1.32	0.38
Searchers		0.98	1.12	0.89	1.30	1.42	1.32	1.42	1.62	1.17
Vacancies	8.37	0.32	0.26	0.33	0.99	0.33	1.00	6.38	7.52	2.34
Tightness	15.03	2.19	1.89	2.24	8.01	7.10	8.71	19.93	22.06	8.77
JCR	1.59	0.34	0.35	0.32	1.77	1.76	1.83	5.01	6.12	2.01
JDR	1.84	0.69	1.11	0.39	2.37	3.65	1.91	6.13	7.44	2.33
For reference:										
Unemployment	6.87	4.68	5.17	4.38	4.32	4.56	4.42	6.43	6.28	4.60
Correlations										
S, V		0.41	0.76	0.25	-0.05	0.10	-0.10	0.27	0.49	0.01
JCR, JDR	-0.53	0.61	0.71	0.61	0.70	0.64	0.80	0.52	0.61	0.40
Y, inflation	0.38	0.05	0.81	-0.23	-0.23	0.90	-0.10	-0.11	-0.22	-0.16
For reference:										
U, V	-0.94	0.26	0.71	0.07	-0.25	0.05	-0.32	-0.66	-0.61	-0.44
Autocorrelations										
Output	0.87	0.86	0.66	0.93	0.88	0.75	0.95	0.85	0.73	0.95
Inflation	0.56	0.40	0.14	0.59	0.64	0.39	0.73	0.01	-0.06	0.54

1..8 Steady-state of the model with linear firing costs

Demand for money

$$m = \chi \frac{i}{i-1} c^{\sigma}$$

Nominal interest rate

$$i_t = \left(\pi \frac{1}{\beta} \right)$$

Marginal utility of consumption

$$c^{-\sigma} = \lambda$$

Phillips curve

$$1 = \varepsilon(1 - \varphi)$$

Resource constraint

$$y = c + cv + \delta \rho n$$

Market clearing

$$Y = AeH(\tilde{a})$$

Matching function

$$m(s, v) = ms^{\mu} v^{1-\mu}$$

Transition probabilities

$$\frac{m(s, v)}{v} = q(\theta)$$

$$\frac{m(s, v)}{s} = q(\theta)\theta$$

Labour market tightness

$$\theta = \frac{v}{u}$$

Jobs (Employment relationships prior to separation)

$$n = (1-\rho)n + vq(\theta)$$

Employment

$$e = (1-\rho)(e + vq(\theta)) = (1-\rho)n$$

Searching workers

$$s = 1 - (1-\rho)n$$

Unemployment

$$u = 1 - n$$

Vacancy posting condition

$$c = q(\theta)\left[\beta(1-\rho)\left[\varphi AH(\tilde{a}) - w + \frac{c}{q(\theta)}\right] - \beta\rho\delta\right]$$

Job destruction condition

$$\varphi A\tilde{a} - w(\tilde{a}) + \frac{c}{q(\theta)} = -\delta$$

Job creation rate

$$jcr = \frac{m}{n} - \rho^x$$

Job destruction rate

$$jdr = \rho - \rho^x$$

Separation rate

$$\rho = \rho^x + (1-\rho^x)F(\tilde{a})$$

Wage rate

$$w = \eta\varphi AH(\tilde{a}) + \eta\theta c + (1-\eta)b + \eta\delta[1 - (1-\theta q(\theta))(\beta)]$$

Bibliography

Arpaia, A. and Mourre, G. (2012), 'Institutions And Performance In European Labour Markets: Taking A Fresh Look At Evidence', *Journal of Economic Surveys, Wiley Blackwell* **26**(1), 1–41.

Bertola, G. and Rogerson, R. (1997), 'Institutions and labor reallocation', *European Economic Review, Elsevier* **41**(6), 1147–1171.

Bewley, T. F. (1995), 'A Depressed Labor Market as Explained by Participants', *American Economic Review, American Economic Association* **85**(2), 250–254.

Blanchard, O. and Galí, J. (2010), 'Labor Markets and Monetary Policy: A New Keynesian Model with Unemployment', *American Economic Journal: Macroeconomics, American Economic Association* **2**(2), 1–30.

Blanchard, O. and Portugal, P. (2001), 'What Hides Behind an Unemployment Rate: Comparing Portuguese and U.S. Labor Markets', *American Economic Review, American Economic Association* **91**(1), 187–207.

Cahuc, P. and Zylberberg, A. (1999), Job Protection, Minimum Wage and Unemployment, IZA Discussion Papers 95, Institute for the Study of Labor (IZA).

Calvo, G. A. (1983), 'Staggered prices in a utility-maximizing framework', *Journal of Monetary Economics, Elsevier* **12**(3), 383–398.

Cassorla, C. S. (2010), The interaction of minimum wage and severance payments in a frictional labor market: theory and estimation, Working Papers. Serie AD, Instituto Valenciano de Investigaciones Económicas, S.A. (Ivie) 2010-22.

Christoffel, K., Costain, J., de Walque, G., Kuester, K., Linzert, T., Millard, S. and Pierrard, O. (2009), Inflation dynamics with labour market matching: assessing alternative specifications, Bank of England working papers, Bank of England 375, Bank of England.

Cole, H. L. and Rogerson, R. (1999), 'Can the Mortensen-Pissarides Matching Model Match the Business-Cycle Facts?', *International Economic Review, Department of Economics, University of Pennsylvania and Osaka University Institute of Social and Economic Research Association* **40**(4), 933–959.

den Haan, W. J., Ramey, G., and Watson, J. (2000), 'Job Destruction and Propagation of Shocks', *American Economic Review, American Economic Association* **90**(3), 482–498.

Di Tella, R. and MacCulloch, R. (2005), 'The consequences of labor market flexibility: Panel evidence based on survey data', *European Economic Review, Elsevier* **49**(5), 1225–1259.

Emerson, M. (1988), 'Regulation or deregulation of the labour market : Policy regimes for the recruitment and dismissal of employees in the industrialised countries', *European Economic Review, Elsevier* **32**(4), 775–817.

Fahr, S. and Smets, F. (2010), 'Downward Wage Rigidities and Optimal Monetary Policy in a Monetary Union', *Scandinavian Journal of Economics, Wiley Blackwell* **112**(4), 812–840.

Garibaldi, P. and Violante, G. (2005), 'The Employment Effects of Severance Payments with Wage Rigidities', *The Economic Journal* **115**(506), 799–832.

Griffoli, T. (2007-2008), 'Dynare User Guide: An Introduction to the Solution & Estimation of DSGE Models', *Manuscript, http://www.cepremap.cnrs.fr/dynare* .

Hall, R. E. (2005), 'Employment Fluctuations with Equilibrium Wage Stickiness', *American Economic Review, American Economic Association* **95**(1), 50–65.

Hamermesh, D. and Pfann, G. (1996), 'Adjustment costs in factor demand', *Journal of Economic Literature* **34**(3), 1264–1292.

Hornstein, A., Krusell, P. and Violante, G. L. (2005), 'Unemployment and vacancy fluctuations in the matching model: inspecting the mechanism', *Economic Quarterly, Federal Reserve Bank of Richmond* **91**(3), 19–51.

Juillard, M. (1996), Dynare: a program for the resolution and simulation of dynamic models with forward variables through the use of a relaxation algorithm, CEPREMAP Working Papers (Couverture Orange) 9602, CEPREMAP.

Kim, J., Kim, S., Schaumburg, E. and Sims, C. A. (2008), 'Calculating and using second-order accurate solutions of discrete time dynamic equilibrium models', *Journal of Economic Dynamics and Control, Elsevier* **32**(11), 3397–3414.

Kim, J. and Ruge-Murcia, F. J. (2009), 'How much inflation is necessary to grease the wheels?', *Journal of Monetary Economics, Elsevier* **56**(3), 365–377.

Kramarz, F. and Michaud, M.-L. (2010), 'The shape of hiring and separation costs in France', *Labour Economics, Elsevier* **17**(1), 27–37.

Krause, M. and Lubik, T. (2003), 'The (ir) relevance of real wage rigidity in the new keynesian model with search frictions', *CentER Discussion Paper* (2003-113), 1–44.

Krause, M. U. and Lubik, T. A. (2007), 'The (ir)relevance of real wage rigidity in the New Keynesian model with search frictions', *Journal of Monetary Economics, Elsevier* **54**(3), 706–727.

Lazear, E. P. (1990), 'Job Security Provisions and Employment', *The Quarterly Journal of Economics, MIT Press* **105**(3), 699–726.

Ljungqvist, L. (2002), 'How Do Lay–off Costs Affect Employment?', *Economic Journal, Royal Economic Society* **112**(482), 829–853.

Ljungqvist, L. and Sargent, T. J. (2005), Jobs and Unemployment in Macroeconomic Theory: A Turbulence Laboratory, C.E.P.R. Discussion Papers 5340.

McCandless, G. (2008), *The ABCs of RBCs: an introduction to dynamic macroeconomic models*, Harvard University Press.

Mortensen, D. T. and Pissarides, C. A. (1994), 'Job Creation and Job Destruction in the Theory of Unemployment', *Review of Economic Studies, Wiley Blackwell* **61**(3), 397–415.

Petrongolo, B. and Pissarides, C. A. (2001), 'Looking into the Black Box: A Survey of the Matching Function', *Journal of Economic Literature, American Economic Association* **39**(2), 390–431.

Pfann, G. A. and Palm, F. C. (1993), 'Asymmetric Adjustment Costs in Non-linear Labour Demand Models for the Netherlands and U.K. Manufacturing Sectors', *Review of Economic Studies, Wiley Blackwell* **60**(2), 397–412.

Rotemberg, J. J. (1982), 'Monopolistic Price Adjustment and Aggregate Output', *Review of Economic Studies, Wiley Blackwell* **49**(4), 517–31.

Thomas, C. (2006), Firing costs, labor market search and the business cycle, Technical report, London School of Economics, mimeo.

Thomas, C. and Zanetti, F. (2009), 'Labor market reform and price stability: An application to the Euro Area', *Journal of Monetary Economics, Elsevier* **56**(6), 885–899.

Trigari, A. (2006), The Role of Search Frictions and Bargaining for Inflation Dynamics, Working Papers, IGIER (Innocenzo Gasparini Institute for Economic Research), Bocconi University 304.

Uhlig, H. (2001), A Toolkit for Analysing Nonlinear Dynamic Stochastic Models Easily, *in* R. Marimon and A. Scott, eds, 'Computational Methods for the Study of Dynamic Economies', number 9780199248278 *in* 'OUP Catalogue, Oxford University Press', Oxford University Press, chapter 3.

Uhlig, H. (2006), Approximate Solutions to Dynamic Models - Linear Methods, SFB 649 Discussion Papers SFB649DP2006-030, Sonderforschungsbereich 649, Humboldt University, Berlin, Germany.

Varian, H. (1974), A Bayesian approach to real estate assessment, *in* S. Feinberg and A. Zellner, eds, 'Studies in Bayesian Econometrics and Statistics in Honor of L. J. Savage', North-Holland, Amsterdam, pp. 195–208.

Venn, D. (2009), Legislation, Collective Bargaining and Enforcement: Updating the OECD Employment Protection Indicators, OECD Social, Employment and Migration Working Papers 89, Organisation for Economic Co-operation and Development (OECD).

Walsh, C. E. (2003), Labour Market Search and Monetary Shocks, *in* S. Altug, J. S. Chadha and C. Nolan, eds, 'Dynamic Macroeconomic Analysis: Theory and Policy in General Equilibrium', Cambridge, UK: Cambridge University Press, p. 451□487.

Wesselbaum, D. (2009), Firing Costs in a New Keynesian Model with Endogenous Separations, Kiel Working Papers 1550, Kiel Institute for the World Economy.

Yashiv, E. (2007), 'Labor search and matching in macroeconomics', *European Economic Review, Elsevier* **51**(8), 1859–1895.

Zanetti, F. (2011), 'Labor market institutions and aggregate fluctuations in a search and matching model', *European Economic Review, Elsevier* **55**(5), 644–658.

Chapter 2

Interaction of skills and training in a segmented labour market

Abstract

This paper aims at analyzing the interaction of labour market segmentation within a search and matching model with a so far relatively neglected channel: training and its externalities as regards the skill composition of the economy. In this setup, a reform of the type that took place in several European countries over the 80's and 90's, namely a reduction in employment protection for temporary contracts while leaving it virtually unchanged for open-ended contracts, can actually increase employment, but at the cost of limiting investments in training, thus damaging career prospects for unskilled workers. Given that human capital can be a determinant factor for economic growth, the impact of labour market policies on general skill accumulation cannot be disregarded. A policy along the spirit of the single contract proposal, that approximates firing costs levels in temporary and permanent contracts, can have beneficial effects for the economy in terms of unemployment, skill level and production. Moreover, these beneficial effects are extensive to every worker segment, decreasing wage premiums. Alternative measures where full training is achieved by subsidizing training to compensate for high levels of employment protection imply higher unemployment and a lower value of production than a policy mix with higher training costs and lower firing costs, given that the latter affect job creation more strongly.

JEL Classification: E24, J24, , J63, J64.

Keywords: Search and matching; Labour market institutions; General human capital; work-related training; fixed-term contracts.

2.1 Introduction

Temporary contracts have been on an upward trend since the mid 80's in Europe. According to data from the Organisation for Economic Cooperation and Development (OECD) based on labour force surveys, temporary employment as a share of overall employees in the European Union (EU) has increased steadily from about 8 per cent in the mid 80's to about 14 per cent in 2012 (with a maximum of 15 per cent in 2007). The stabilization if this indicator in more recent years reflects to a large extent the decline in Spain (to close to 24 per cent in 2012). Notwithstanding, this country still had the second highest incidence of temporary contracts in the EU in 2012 (along with Poland (27 per cent) and Portugal (21 per cent)), while in some of the more recent member states it is less than 5 per cent.

Temporary jobs comprise several types of contractual arrangements, from seasonal work to temporary working agencies, but fixed-term contracts are the majority (OECD (2002)), and the two concepts are used almost interchangeably henceforth.[1] Fixed-term contracts represent a higher share of employment in the primary and construction sectors, but have also high incidence in some specific service sectors (personal services)(OECD (2001)). As regards worker characteristics, these contracts are heavily concentrated among young agents (European Commission (2005)), as this is the main entry gate of school-leavers into the labour market (along with part-time work) (OECD (1998)). Additionally, temporary contracts are associated with less skilled workers, given that the proportion of employees with this type of working arrangement is highest for the lowest education level (European Commission (2005)).[2] Moreover, within temporary jobs there is also heterogeneity as regards skills, given that higher educated workers with this type of contract have better prospects of moving into permanent jobs, having longer temporary contracts and receiving

[1] In addition, henceforth the term "permanent employment" is also often used for simplicity in alternative to "employment in and open-ended contract", by opposition to the term "temporary employment".

[2] "Skill" is used throughout the paper as a shorthand reference to formal qualification, not actual ability.

training (OECD (2002)). In fact, the incidence of continuous vocational training is lower among low-skilled and temporary workers (OECD (2003)). Arulampalam, Booth and Bryan (2004) find for several European countries that being in a fixed-term contract reduces the probability of receiving training by about 10 per cent. Albert, García-Serrano and Hernanz (2004) conclude, in a study of the Spanish economy, that workers with temporary contracts not only are less likely to be employed in training firms but, once in those firms, they also have a lower probability of being chosen to participate in firm-provided training activities. These authors find that the decision of a firm not to train is likely to be associated to productive and technology characteristics (low degree of technological progress and/or a high proportion of small and medium-sized firms in the industry) and these features also determine a higher propensity to hire under temporary contracts. Along with the contract type, training also appears to have an impact in both subjective and objective measures of employment security, in particular in the case of older and low-skilled workers (OECD (2004)). Possibly related to this, a large share of temporary workers is however unsatisfied with their work status, reporting it to be involuntary or unwanted (European Commission (2005)), an assessment that may be related with the perception of job insecurity in these contracts (OECD (2002)). This context can lead to detrimental impacts in productivity (Dolado and Stucchi (2008), Blanchard and Landier (2002)).

In some countries the incidence of temporary employment has increased substantially (particularly for some specific population groups) following reforms driven by the objective of improving labour market flexibility (Blanchard and Landier (2002), Dolado, García-Serrano and Jimeno (2002)). These reforms assumed in many cases a partial nature, since the change in regulation was confined to a subset of the potentially eligible population, or its complete phasing was protracted in time (Boeri (2011)). These policies may create two-tier systems, generating persistent asymmetries between the subset affected by the reform and the remaining population. Among these reforms are

Employment Protection Legislation (EPL) reforms carried out in several European countries with the aim of expanding the scope or otherwise reducing the strictness of employment protection for temporary contracts while leaving the open-ended contracts legislation unchanged. This type of reform was adopted for example in Spain, France and Germany in the mid 80's (OECD (1993)) and in Italy in 1997-2003 (Boeri (2011)). This was the main channel for the convergence of EPL strictness indexes that has taken place since the beginning of the 90's in OECD countries (OECD (2004)). The fact that a reform is two-tier does not necessarily imply an increase in asymmetries in regulatory regimes. However, this appears to have been the case for the large majority of European labour market reforms (Boeri (2011)).

These institutional reforms and the creation or reinforcement of two-tier systems had an impact in labour market flows and stocks. There is evidence that countries with large shares of temporary contracts tend to have worker turnover rates much higher than job turnover rates, implying large job-to-job movements (García Serrano (1998), Bassanini and Marianna (2009)). In a study for Spain, García-Serrano and Jimeno (1999) find that since the mid 80's, the rate of worker turnover (hiring plus separations) increased significantly, while job turnover (creation plus destruction) has remained relatively stable. This has taken place through an increase in short employment and unemployment spells, implying also a reduction in job tenure and unemployment duration. These labour movements are largely concentrated in hirings and separations associated with temporary contracts. Centeno and Novo (2012) arrive at similar conclusions regarding worker turnover in a natural experience for Portugal following an increase in the protection of open-ended contracts, which raised the incidence of fixed-term contracts and the rate of churning among them. These developments have lead to an increase in employment and unemployment volatility in countries with this type of employment structure (Boeri (2011)), the consequences of which have been clear during the Great Recession. In fact, in 2008-2009, some countries, in particular Spain and Portugal, recorded sharp adjustments in employment, which were actually faster than in previous recessions (OECD (2010)).[3] The decrease in employment in the EU was largely concentrated in jobs with temporary contracts (OECD (2010)) and the groups that recorded the largest drop in employment over 2008-2009 were young workers (15-24 years) and low-skilled workers, while for high-skilled workers there was actually an increase in employment over this period (European Commission – DG ECFIN (2010)). This result is not surprising given the overrepresentation of young and low skilled workers in temporary employment. In tandem with this evolution, temporary contracts also recovered from the beginning of 2010 onwards, while permanent employment declined less, but in a more persistent way. This may be related with the weight of temporary contracts on new hires, which can be as high as 90 per cent in countries with strict EPL on permanent contracts (Boeri (2011)).

As for labour market stocks, the impact in the overall employment level depends on whether temporary contracts act as complements or substitutes for permanent employment. If temporary contracts are used as a screening device, they can be seen as complements of permanent jobs, while if they act as a buffer to allow firms to accommodate shocks to their desired workforce level they have more of a substitution effect. According to Boeri and Garibaldi (2007), the substitution motive dominates, leading to a neutral effect of two-tier reforms in overall employment in the long-run. However, in the short-run, firms choose to concentrate their new hires on temporary workers, but due to high EPL costs, do not fire permanent workers, which are replaced only through a process of attrition. This leads to an increase in employment that lasts over the transition period, the so-called "honeymoon" effect. Therefore, in the short-run, institutional reforms liberalizing temporary contracts may lead to an increase in employment, while in the long-run the impact should be virtually nil. The empirical evidence on this topic is somewhat mixed. Kahn (2010) concludes that reforms that led to an increase in the use of fixed-term contracts had no impact on overall employ-

[3] In Spain, labour productivity actually increased in 2008-2009, despite a large reduction in GDP.

ment or actually contributed to decrease it in several European countries. European Commission (2004) confirms this result for the EU-12 as a whole. Portugal and Varejão (2010) conclude in a study for Portugal that the screening motive dominates hiring for temporary contracts, given that a majority of fixed-term contracts are converted into permanent before the end of the legal limit. Other motives for the use of the contracts restrict more to low-skilled workers, given that human capital intensive firms and/or training firms convert temporary contracts more often. Guell and Petrongolo (2007) find a spike in conversions of temporary contracts into open-ended after one year of job tenure and at the end of the legal limit for the duration of these contracts, whereas only the latter spike is relevant for low-skilled workers. This evidence suggests the coexistence of the two above mentioned types of relationship between temporary and permanent contracts, used both for screening (which would take about a year) and as a substitute for permanent employment (up to the maximum legal limit).

Independently of the moment of the duration of the temporary contract in which they take place, transitions of workers into open-ended contracts appear to be relatively limited. In fact, studies for Spain have found very low transition rates from temporary to permanent employment. In particular, Dolado and Stucchi (2008) find a transition rate of 12.7 per cent, fairly constant across firms, given that a large majority has conversion rates between 0 and 20 per cent, with only 3 per cent exhibiting rates above 50 per cent. Guell and Petrongolo (2007) find conversion rates generally below 10 per cent, while Portugal and Varejão (2010) estimate this transition rate to be 18.6 per cent per year in Portugal. European Commission (2010) conclude that the odds-ratio of temporary workers moving to a permanent contract vis-à-vis remaining in a temporary job depends negatively on a measure of segmentation (difference in EPL for temporary and permanent contracts). Younger, more skilled and experienced workers have a higher probability of moving into a permanent job after one or two years in a temporary contract (these findings are confirmed by the results in Chapter (3)). These determinants have an identical impact in transitions from low-paid employment, suggesting that both aspects are related. In fact, being in a temporary job substantially hinders the probability of moving out of low-pay employment.

Notwithstanding their low conversion rates, temporary contracts are in general found to be stepping stones and not traps, i.e, temporary employees do not generally enter a vicious circle according to which they cannot leave this type of employment (European Commission (2010)). However, some population groups (namely early school leavers) have a very long permanence in temporary contracts (up to five years after initial education), which suggests that they are trapped in a cycle of temporary contracts (OECD (2008)).

Regarding wages, two-tier labour markets (in some countries conjugated with centralized collective bargaining) strengthen the position of protected workers ("insiders") in wage bargaining, given that the burden of cyclical dismissals falls upon temporary workers. This translates into increases in permanent workers wages in tandem with increases in the share of temporary workers in the economy (Bentolila, Dolado and Jimeno (2008) and references herein). Additionally, there is a wage premium on permanent vis-à-vis temporary contracts, by a factor ranging from 10 to 20 per cent, even when controlling for workers characteristics (Boeri (2011), European Commission (2010)), a gap that can arise due to worker under classification. The fact that temporary workers receive less training may also accentuate this wage gap, given that training has an impact on wage growth for at least part of workers (young and highly skilled) (OECD (2004)).

Given the developments in European labour markets in recent years, a branch of the literature has developed, modelling segmented labour markets and their interaction with two-tier EPL reforms using extensions of the search and matching model by Mortensen and Pissarides (1994). Some of these models comprise a segmented labour market with temporary and permanent contracts, in which the latter have stricter EPL. In these models, temporary contracts are either the entry gate into the labour market for an unemployed worker or the initial affectation between temporary and permanent contracts is random (in the case of Cahuc and Postel-Vinay (2002) it is a policy parameter). Upon the expiry of a temporary contract, the worker can be dismissed or his contract converted into permanent. This conversion decision is in general the result of a random productivity draw, according to which workers above an endogenously determined threshold productivity level are converted. This literature includes Blanchard and Landier (2002) and Cahuc and Postel-Vinay (2002), which focus on steady state outcomes, and Sala, Silva and Toledo (2012) and Costain, Jimeno and Thomas (2010), which focus on business cycle results, particularly on unemployment volatility. Cao, Shao and Silos (2011) and Cahuc, Charlot and Malherbet (2012) focus, beyond the conversion decision, on the decision of the initial contract to be offered to a worker that fills a vacancy, and, in the case of Cahuc et al. (2012), also on the duration of the temporary contract to be offered. The majority of these studies conclude that an increase in the gap between firing costs in permanent and temporary contracts (either by decreasing them for temporary contracts or by increasing them for permanent jobs) leads to an increase in the share of temporary contracts. They also find that moving from an institutional setup where all jobs are protected to a segmented market increases worker turnover. Some studies conclude that these reforms may lead to unfavourable welfare developments (Blanchard and Landier (2002) and Cahuc and Postel-Vinay (2002)) or to an increase in wage inequality (Cao et al. (2011)). Sala et al. (2012) and Costain et al. (2010) are able to show that a two-tier EPL reform of the type that took place in many European countries leads to an increase on unemployment volatility. These studies obtain different results as regards the impact of these reforms on the unemployment level, and in some cases results are inconclusive, depending on model calibration (Cahuc and Postel-Vinay (2002)). It is worth mentioning that among these studies, only Cahuc et al. (2012) allow for the possibility of temporary contract renewal, concluding that in general it will be in the interest of firms to exploit that option to the legal limit.

These studies have in common the fact that workers are homogeneous (at least *a priori*) and their situation in the labour market becomes heterogenous due to institutional arrangements combined with random shocks to worker productivity that take place at the moment contractual decisions are made. There is however another branch of the literature, also within the search and matching framework, where different labour market outcomes arise from heterogeneity among workers (this segmentation can be observable *ex-ante* or *ex-post* the contract), or heterogeneity among firms. These papers focus mainly in welfare considerations, namely on the impacts of partial reforms in this heterogenous setup.

In particular, in Belot, Boone and Ours (2007) and Wasmer (2006), workers become heterogenous through the effort exerted in order to obtain additional skills. They conclude that in such a setup, increases in EPL create incentives to investments in specific skills. Although this may have welfare increasing effects for positive but low EPL levels (Belot et al. (2007)), it also implies higher costs after reallocation shocks, given that workers require retraining (Wasmer (2006)). In the same vein, Lamo, Messina and Wasmer (2011) analyse a setup in which the heterogeneity of workers depends on education, which can be concentrated in vocational or general skills. Results suggest that a labour force too concentrated in vocational skills (associated with a more traditional sector) can limit the economy's ability to adjust to structural shocks, implying a persistent increase in unemployment. Dolado, Jansen and Jimeno (2005) conclude that in an environment of heterogenous workers (skilled and unskilled), a partial reform targeted to one of the groups can be more welfare increasing than a complete one.

Other studies focus on heterogeneity arising from firms or matches. In particular, Kilponen and Vanhala (2009) assume that new jobs are less productive than old jobs, but their productivity is more responsive to shocks, while Silva and Toledo (2009) assume that new entrants in the labour market are less productive that incumbents due to the time they have to invest in on-the-job training. These features are able to improve the fit of these models to the data.

The main reference for this paper is Shintoyo (2008), which focuses on a search and matching framework where workers are heterogenous (skilled and unskilled), and after a match, firms must choose between training (which general skills) an unskilled worker or waiting to find a skilled worker in the unemployment pool, given that only a skilled agent can perform the task required. The firm will choose to train a worker when the incidence of skilled workers among unemployed is relatively low, implying a long waiting time to fill a vacancy with a skilled worker. The results show that the interaction of the search and matching framework with training decisions can have a dramatic impact on the results of policy changes in the labour market. In fact, a reduction in the costs of keeping an open vacancy can have a positive or a negative impact on unemployment depending on how it affects firms training decisions.

The present work combines the two branches of the literature, analysing within a search and matching framework a labour market where temporary and permanent contracts exist and workers are heterogenous (skilled and unskilled). This way, the impact of two-tier reforms in the labour market can be analysed also along the dimensions of their impact through the training channel in the average skill level of the working force. To the extent that human capital accumulation can be a source of economic growth, this is an important aspect to bear in mind. The model reflects some the above mentioned features of some European segmented labour markets, namely that hirings take place essentially through temporary contracts, that permanent workers have more access to training, are more productive and have higher employment protection than temporary workers.

The papers that resemble this the most are Tealdi (2011) and Faccini (2014), *inter alia* because they comprise the possibility of temporary contract renewal and permanent contracts have in equilibrium higher wages and productivity levels. In Tealdi (2011), as in the current paper, workers can be high-productivity (skilled) or low-productivity (unskilled), and up until the realization of a productivity shock, workers are inexperienced (firms do not know their skill level). In equilibrium only temporary contracts are offered to inexperienced workers, and therefore fulfill a screening role, but also to workers which have already revealed to be unskilled, whereas permanent contracts are only offered to skilled workers. This result is a particular case of the model of this paper, that arises when there is no training on-the-job. Tealdi (2011) concludes that as concerns lifetime income, less productive workers are worse off after a two-tier reform that gives rise to a segmented market, by opposition to a permanent contract only framework. On the other hand, more productive workers are better off, given that a more segmented market allows them to earn higher wages. In Faccini (2014), heterogeneity arises from match quality, which can be good or bad. Due to idiosyncratic productivity shocks, the quality of the match is observed with noise and can only be inferred over time. Temporary contracts are renewed until a non-renewability clause is activated, upon which they can be converted into permanent or dissolved. Therefore, temporary contracts play a screening role, in the sense that they allow the true quality of the match to be perceived trough the observation of repeated signals. An increase in the (policy driven) share of temporary contracts leads to and increase in job creation and output and a decline in unemployment. The welfare gains of an increase in the use of temporary contracts are nevertheless lower than those of an elimination of firing costs in permanent contracts. However, contrary to this paper, these models do not consider the role of training, i.e., there is no mechanism that captures the possibility of workers permanently increasing their productivity levels and the impact that this can have on their contractual arrangement and overall labour market results.

In order to solve the problems generated by dual labour markets, several proposals have been made, including the adoption of a single permanent contract, in which job security would increase with tenure (European Commission (2010)). Andrés et al. (2009) proposed a set of measures of structural reform of the Spanish labour market. Among them, and with the objective of addressing labour market duality, the introduction of a single permanent labor contract for new hires is proposed, with a severance pay level increasing with seniority, eliminating the use of fixed-term contracts except under very particular circumstances. These authors support that a severance pay schedule under this policy should start above the *status quo* level for temporary contracts and increase to a value below the one in practice for open-ended contracts, therefore not increasing average labour costs. Low firing costs at the beginning of the contract favour job creation, while the gradual increase creates incentives for longer durations, reducing job destruction and therefore unemployment (Bentolila, Dolado and Jimeno (2011) and references herein). This positive severance payment/tenure profile can be efficient in an environment where workers have to make firm specific investments on the job which are imperfectly monitored (Boeri, Garibaldi and Moen (2013)). This single contract proposal is in essence in line with the one made for France by Blanchard and Tirole (2003), based on the conclusion that the optimal design of an employment protection system should comprise a severance payment schedule increasing and convex in seniority, in addition to firm contributions to the State, depending on the number of workers laid off. Cahuc (2012) proposes for the French economy the maintenance of the option of a fixed-term or open-ended contract, although with a more smooth transition between firing costs in temporary and open-ended contracts in a similar "unified" framework. In addition, both the severance payment and the firm contribution to the State are proportional to the overall remuneration received from the signing date of the contract onwards. However, the severance payment as a percentage of salaries paid drops with seniority from the maximum duration of a temporary contract onwards, creating incentives to convert a temporary contract into permanent, instead of replacing it by another temporary contract.

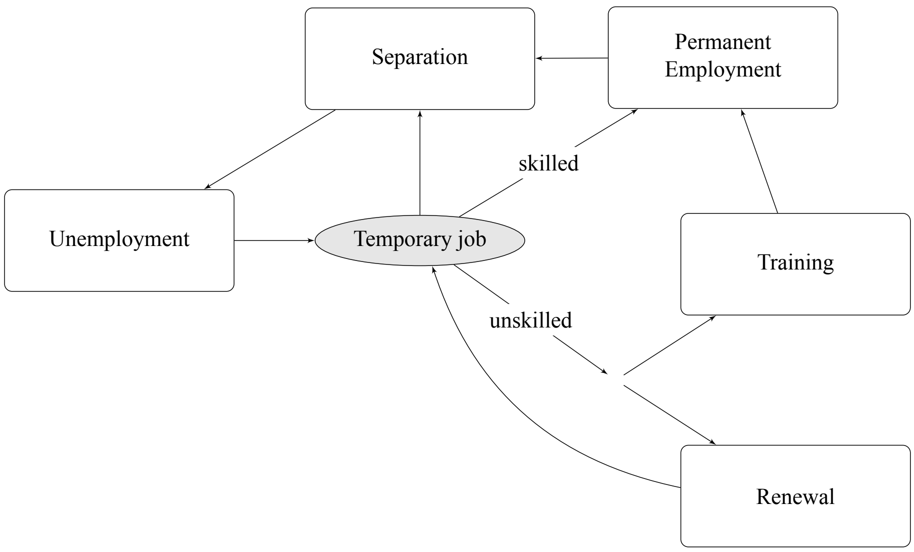
The structure of this paper is as follows. Section 3.3 describes the model, including an extension for the case of limited temporary contract renewals. Section 3.4 evaluates the model trough an analysis of the impact of shocks (both in steady state and dynamic terms) and includes policy applications that try to address the single contract framework. Section 3.5 concludes.

2.2 Model

Consider an economy with a unit mass of workers, which can be either employed or unemployed. When employed, they can be in a temporary or open-ended (permanent) contract. Workers enter the labour force each period at rate ρ and join the pool of unemployed. An identical fraction leaves the labour force each period. Separations occur each period at rate s. A share δ of the workers entering the labour force is skilled, while a share (1-δ) is unskilled. Workers become employed trough a temporary contract. This assumption, which arises endogenously in Costain et al. (2010) and Tealdi (2011) due the fact that firing costs are higher for permanent contracts, does not appear too stringent in face of the evidence that the large majority of new hires is made trough temporary contracts in strongly segmented labour markets, as mentioned above. This temporary contract is a screening device: at the moment the worker is hired the firm is not able to assess his skill level. The function associated to a temporary contract is a non-specialized task, in which workers with both types of skills can produce the same output: y^T. The permanent contract is associated with a more specialized task, that only skilled workers can perform, with productivity y^P. The assumption that permanent jobs have higher productivity than temporary is relatively common in the literature (Blanchard and Landier (2002), Boeri (2011)) and in line with a vast empirical evidence that points to positive productivity effects of learning-by-doing (see Prat (2010) and references herein).

There is a multiplicity of identical firms in the economy (which is formally equivalent to the assumption that there is one representative firm), each with several workers, divided into temporary and permanent contracts. A share λ of temporary contracts reaches the end every period. At this moment the firm will realize the skill level of the workers which have temporary contracts. The contracts of skilled workers will be automatically converted into permanent, while for unskilled workers the firm must decide which to convert into permanent (a share ϕ) and which to renew. Dismissal is always a latent hypothesis at this stage both for temporary and permanent workers, but it is assumed that because the value of a vacancy in equilibrium will be zero, this option will never be pursued in an interior equilibrium solution in which the value of temporary and permanent jobs is positive, an assumption that is confirmed *a posteriori*. Once trained, unskilled workers become skilled and are indistinguishable from initially skilled workers. These labour market flows are illustrated in Figure (2.1) (the separation and retirement flows are omitted for simplicity).

Figure 2.1: Labour market flows



Legend: The diagram describes the main worker flows in the model. Agents enter the labour market as unemployed, and if matched with a firm, enter a temporary contract. Upon its expiration, the firm realizes the skill level of the worker, which can become skilled through on-the-job training paid by the firm, and only in that case receive a permanent contract. If the firm decides not to train unskilled workers, their temporary contract will be renewed (in equilibrium). All contracts are subject to separation at an exogenous rate *s*.

As a result of labour force and employment flows, the share of skilled workers among unemployed will be α_0 and the share of skilled agents among temporary employees will be $\bar{\alpha}$. Therefore, from the share λ of temporary contracts that reaches an end every period, a share $\bar{\alpha}$ of temporary contracts (corresponding to the share of skilled agents among temporary employees) is automatically converted into permanent. The remaining workers $(1-\bar{\alpha})$ can become skilled if trained. Therefore the overall conversion rate for temporary contracts is $\lambda(\bar{\alpha}+(1-\bar{\alpha})\phi)$. Note that due to the possibility of contract renewal for unskilled workers, $\bar{\alpha}$ will only equal α_0 if the firm has always followed a strategy of conversion of all temporary contracts into permanent.

Training implies an one-off cost T to be paid by the firm when the contract is converted into a permanent one. This cost is assumed to be paid before wage negotiations take place, and therefore does not affect wage bargaining. Training has a general nature: when leaving the firm, the worker remains skilled. Finally, there are firing costs to be paid upon the separation of permanent contracts (F) and of temporary contracts (F^T). The same assumptions as in Chapter (1) apply: firing costs are processual costs and not severance payments, and they affect matches from the moment they are formed onwards.

The creation of new matches in the economy is determined by a constant returns to scale matching function, which depends on workers searching for a job (*u*)[4] and vacancies posted by firms (*v*), at a cost of *c* by period:

$$m(u_t, v_t) = m{u_t}^{\mu} v_t^{1-\mu} \tag{2.1}$$

Labour market tightness, a measure of slack in the labour market, is given by:

$$\theta_t = \frac{v_t}{u_t} \tag{2.2}$$

[4]Workers searching for a job in period *t* correspond to workers who where not in a match at the end of period *t-1* (unemployed) plus those workers which have been dismissed in the beginning of period *t*. See Trigari (2009) and Chapter (1) for a more detailed explanation.

and the probability of filling a vacancy in period *t* is given by:

$$q(\theta_t) = m\theta_t^{-\mu}; \tag{2.3}$$

which implies that the overall number of matches can be written as:

$$m(u_t, v_t) = q(\theta_t)v_t = q(\theta_t)\theta_t u_t \tag{2.4}$$

Unemployed workers are divided into skilled (α_0) and unskilled ($1 - \alpha_0$) shares :

$$u_t = \alpha_{0,t}u_t + (1 - \alpha_{0,t})u_t = u_t^s + u_t^u \tag{2.5}$$

Similarly, temporary employees are skilled (e^{TS}) and unskilled (e^{TU}) in proportions $\bar{\alpha}$ and $(1 - \bar{\alpha})$:

$$e_t^T = \bar{\alpha}_t e_t^T + (1 - \bar{\alpha}_t)e_t^T = e_t^{TU} + e_t^{TS} \tag{2.6}$$

The laws of motion for labour market flows describe the dynamics of workers in permanent contracts (e^P), skilled workers in temporary contracts (e^{TS}) and unskilled workers in temporary contracts (e^{TU}). Current employment for each type at time *t* corresponds to the stock of workers of that type in the previous period that have not separated or retired from the job plus the flow of workers which come from another state: either unemployment (in the case of temporary contracts) or temporary contracts (in the case of permanent employment).

$$e_t^P = (1-s-\rho)e_{t-1}^P + (1-s-\rho)\lambda\left[e_{t-1}^{TS} + e_{t-1}^{TU}\phi_t\right]; \tag{2.7}$$

Only agents who have been employed in the previous period can be trained: this is because the firm can only access the skill level of a worker at the end of at least one period.

$$e_t^{TS} = (1-\rho-s)(e_{t-1}^{TS} + \theta_{t-1}q(\theta_{t-1})u_{t-1}^s) - \lambda(1-\rho-s)e_{t-1}^{TS}; \tag{2.8}$$

$$e_t^{TU} = (1-s-\rho)(e_{t-1}^{TU} + \theta_{t-1}q(\theta_{t-1})(u_{t-1} - u_{t-1}^s)) - \lambda\phi_t(1-\rho-s)e_{t-1}^{TU}; \tag{2.9}$$

Equations (2.4), (2.8) and (2.9) imply that the law of motion for overall temporary employment is given by:

$$e_t^T = (1-s-\rho)e_{t-1}^T + q(\theta_{t-1})(1-s-\rho)v_{t-1} - (1-s-\rho)\lambda(\bar{\alpha}_{t-1} + (1-\bar{\alpha}_{t-1})\phi_t)e_{t-1}^T \tag{2.10}$$

Population is assumed to remain constant at unity every period, which implies:

$$1 = e_t^T + e_t^P + u_t; \tag{2.11}$$

Equations (2.7), (2.10) and (2.11) imply that the law of motion for workers searching for a job is given by:

$$u_t = u_{t-1} - \theta_{t-1}q(\theta_{t-1})(1-s-\rho)u_{t-1} + se^P_{t-1} + \rho + se^T_{t-1} - \rho u_{t-1}; \tag{2.12}$$

The overall number of skilled agents in the economy is given by permanent employees, skilled temporary workers and skilled unemployed:

$$skill_t = e^P_t + e^{TS}_t + u^s_t \tag{2.13}$$

Every period, the change in the pool of skilled agents is given by retirement and separations and by the entry of skilled workers in the labour force and training of unskilled workers:

$$skill_t = (1-\rho)skill_{t-1} + (1-\rho-s)\lambda e^{TU}_{t-1}\phi_t + \rho\delta \tag{2.14}$$

The problem faced by the representative firm is given by profit maximization, taking into account vacancy, training and firing costs, subject to the constraints implied by employment laws of motion:

$$\max_{\phi_t, e_t^P, e_t^T, v_t} E_0 \left[\sum_{t=0}^{\infty} \beta^t \Pi_t \right] =$$

$$\max_{\phi_t, e_t^P, e_t^T, v_t} E_0 \Bigg[\sum_{t=0}^{\infty} \beta^t \left[y_t^P e_t^P + y_t^T e_t^T - w_t^P e_t^P - w_t^T e_t^T - v_t c - \phi_t (1-s-\rho)(1-\bar{\alpha}_{t-1}) \lambda e_{t-1}^T T - s e_{t-1}^P F \right]$$

$$- s\beta^t \left[e_{t-1}^T + q(\theta_{t-1}) v_{t-1} \right] F^T \Bigg]$$

$$\text{s.t.} \quad e_t^P = (1-s-\rho) e_{t-1}^P + (1-s-\rho)\lambda(\bar{\alpha}_{t-1} + (1-\bar{\alpha}_{t-1})\phi_t) e_{t-1}^T$$

$$e_t^T = (1-s-\rho) e_{t-1}^T + q(\theta_{t-1})(1-s-\rho) v_{t-1} - (1-s-\rho)\lambda(\bar{\alpha}_{t-1} + (1-\bar{\alpha}_{t-1})\phi_t) e_{t-1}^T \tag{2.15}$$

where in the problem formulation is made use of the fact that $e_t^{TS} = \bar{\alpha}_t e_t^T$ and $e_t^{TU} = (1-\bar{\alpha}_t) e_t^T$.

Notice that separations affect existent matches in the end of period *t-1*, which correspond to those employed in the previous period plus new matches formed in *t-1*.

The first order conditions for this problem yield the value to the firm of a permanent and temporary contract and of a vacancy. Moreover, they yield the optimal condition for the training decision (see the Appendix for details).

Value of a permanent contract to a firm:

$$J_t^P = y_t^P - w_t^P + E_t\left[(1-\rho-s)\beta {J^P}_{t+1} - \beta s F\right] = 0 \tag{2.16}$$

The value of a temporary contract to a firm is given by:

$$\begin{aligned} J_t^T =& y_t^T - w_t^T + E_t\left[(1-\rho-s)\beta {J^T}_{t+1} - \beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T - \beta s F^T\right] \\ &+ E_t\left[\beta(1-\rho-s)(J_{t+1}^P - J_{t+1}^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right] \end{aligned} \tag{2.17}$$

The first order condition for vacancies yields the job creation condition:

$$c = q(\theta_t)E_t\left[\beta\left((1-\rho-s)J_{t+1}^T - sF^T\right)\right] \tag{2.18}$$

The first order condition for the share of temporary contracts of unskilled workers to convert into permanent implies that the firm will choose to train up to the point where the net gain from converting the contract (the value of a permanent job minus the value of a temporary job) equals the training cost.

$$J_t^P - J_t^T = T \tag{2.19}$$

Therefore, the difference between the value of a permanent and a temporary job, that determines the optimal value of ϕ, is given by:

$$
\begin{aligned}
(J_t^P - J_t^T) =& (y_t^P - y_t^T) - (w_t^P - w_t^T) + E_t\left[(1-\rho-s)\beta(J_{t+1}^P - J_{t+1}^T)\right] \\
& + E_t\left[\beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T\right] \\
& - E_t\left[\beta s(F - F^T) + \beta(1-\rho-s)(J_{t+1}^P - J_{t+1}^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right]
\end{aligned}
\tag{2.20}
$$

On the worker side, the value of of being unemployed corresponds to unemployment benefits plus expected asset values in the following period, arising from the net value of being employed in a temporary job, in the case of a successful match, or from the value of continuing unemployed otherwise.

$$
U_t = b + E_t\left[\beta q(\theta_t)\theta_t(1-\rho-s)(W_{t+1}^T - U_{t+1}) + \beta(1-\rho)U_{t+1}\right] + \underbrace{E_t\left(\beta\rho * 0\right)}_{\text{exit from labour force}} \tag{2.21}
$$

The value of a temporary contract for the worker depends on the wage earned today, on the continuation value of this state, on potential future gains of having the temporary contract converted into permanent and on the value of the outside options associated with becoming unemployed or out of the labour force.

$$
\begin{aligned}
W^T =& w_t^T + E_t\left[\beta(1-\rho-s)W_{t+1}^T + \beta(1-\rho-s)\lambda(\bar{\alpha}_t + (1-\bar{\alpha}_t)\phi_{t+1})\left(W_{t+1}^P - W_{t+1}^T\right)\right] \\
& + E_t(\beta s U_{t+1} + \underbrace{\beta\rho * 0)}_{\text{exit from labour force}}
\end{aligned}
\tag{2.22}
$$

In the case of a permanent worker, the value function depends on the wage received in the current period, plus the continuation value of remaining in a permanent contract next period, which will happen if there is no separation or retirement. In those cases, the worker receives the value of the outside option (which is nil in the case of retirement).

$$W_t^P = w_t^P + E_t\left[\beta(1-\rho-s)W_{t+1}^P + \beta s U_{t+1} + \beta\rho * 0\right] \tag{2.23}$$

The surplus of an employment relationship under a temporary and permanent contract is given, respectively, by:

$$S_t^T = J_t^T - V_t + W_t^T - U_t + F^T \tag{2.24}$$

$$S_t^P = J_t^P - V_t + W_t^P - U_t + F \tag{2.25}$$

Therefore, it is assumed that the training cost is sunk at the moment of the first wage negotiation for a permanent contract and cannot be bargained over. This is not the case for firing costs, which affect the threat points in the negotiations.

Wages are assumed to be determined through Nash bargaining, with corresponds to the maximization of the following function:

$$\max_{w_t}(W_t - U_t)^{\eta}(J_t - V_t + FC)^{(1-\eta)} \tag{2.26}$$

where η corresponds to the bargaining power of workers in the wage negotiations and FC corresponds to the relevant firing costs for each type of contract.

This implies that the corresponding Nash bargaining functions are (also using the free entry condition):

$$(1-\eta)\left(W_t^T - U_t\right) = \eta\left(J_t^T - V_t + F^T\right) \Leftrightarrow \left(J^T + F^T\right) = (1-\eta)S_t^T \tag{2.27}$$

$$(1-\eta)\left(W_t^P - U_t\right) = \eta\left(J_t^P - V_t + F\right) \Leftrightarrow \left(J^P + F\right) = (1-\eta)S_t^P \tag{2.28}$$

Equations (2.27) and (2.28), along with the value functions above, allow the determination of the overall surplus of a permanent and a temporary job (see the Appendix for details).

The surplus of a permanent job depends positively on firing costs associated to both permanent and temporary contracts, although trough different channels. Firing costs on permanent contracts increase the surplus that is required to form a match, accounting for the expected losses associated with firing costs. Firing costs in temporary contracts decrease the value of this type of job, reducing the value of the outside option for the firm when hiring with a permanent contract and therefore also contributing to an increase in the surplus of a permanent job.

$$\begin{gathered} S_t^P = y_t^P + c - b + E_t\left[\beta(1-\rho-s)S_{t+1}^P + F(1-(1-\rho)\beta) + q(\theta_t)\beta(1-\rho)F^T\right] \\ - E_t\left[q(\theta_t)\beta(1-\rho-s)\left((1-\eta)+\eta\theta_t\right)S_{t+1}^T\right] \end{gathered} \tag{2.29}$$

In the case of the surplus of a temporary contract, these factors are also present, but in addition the expected surplus for the following period is affected by the possibility of the contract coming to an end and being converted into permanent. That possibility also entails training costs for unskilled workers and a shift in the relevant firing costs binding the firm, thus implying a negative term in the firing cost gap (F-F^T). While in the case of the permanent job surplus the direct impact of firing costs is unequivocally positive, in the case of the temporary contract surplus this effect depends possibly on the gap between F and F^T.

$$S_t^T = y_t^T + E_t\left[\beta(1-\rho-s)(S_{t+1}^P - S_{t+1}^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)+(1-\rho-s)\beta S_{t+1}^T\right]$$
$$-\,E_t\left[\beta(1-\rho-s)(F-F^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)+\beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T\right]+c-b$$
$$-\,E_t\left[\beta q(\theta_t)(1-\rho-s)((1-\eta)+\eta\theta_t)(S_{t+1}^T)-F^T(1-(1-\rho)\beta(1-q(\theta_t)))\right] \tag{2.30}$$

Equations (2.27) and (2.28) and equations (2.29) and (2.30) allow for the determination of temporary and permanent contract wages (see the Appendix for a detailed derivation).

Permanent contract wages depend positively on job productivity, on unemployment benefits (that affect the reservation wage of workers) and on labour market tightness, given that if it is difficult to fill a vacancy, match specific rents are larger. Because temporary and permanent contract firing costs increase the surplus of a permanent contract, they also affect wages positively.

$$w_t^P = \eta y_t^P + b(1-\eta) + c\eta\theta_t + \eta E_t(1-(1-\rho)\beta)F + \eta E_t(q(\theta_t)\theta_t\beta(1-\rho)F^T) \tag{2.31}$$

In the case of the impact of firing costs in temporary contract wages, the same tension of forces analysed for the surplus applies, given that firing costs on temporary contracts affect positively wages due to their impact in the surplus of that contract, but the firing cost gap. Training costs affect wages negatively. In the case of training costs, given that this cost is sunk, temporary workers "pre-pay" in the form of lower wages the training costs that will be associated with the conversion of some contracts into permanent. For that reason, even if firing costs were nil and productivity levels were the same in both contracts, temporary contract wages would be lower than their permanent counterpart, in line with what is observed in the empirical literature.

$$w_t^T = \eta y_t^T + (1-\eta)b + \eta c\theta_t - E_t\left[\eta(1-\rho-s)\beta\lambda(\bar{\alpha}_t + (1-\bar{\alpha}_t)\phi_{t+1})(F-F^T)\right]$$
$$+ E_t\left[\eta F^T(1-\beta(1-\rho)) - \eta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T + \eta\theta_t q(\theta_t)\beta(1-\rho)F^T\right] \tag{2.32}$$

Finally, the value of production in the economy is given by overall output minus training,firing and vacancy posting costs:

$$y_t = y_t^P e_t^P + y_t^T e_t^T - \lambda(1-\rho-s)\phi_t e_{t-1}^{TU} T - s e_{t-1}^P F - s(e_{t-1}^T + q(\theta_{t-1})v_{t-1})F^T - cv_t \tag{2.33}$$

Replacing the first order condition (2.19) in equation (2.20) along with the expressions for wages (equations (2.31) and (2.32)) gives rise to an equilibrium expression that relates the average skill of temporary workers and the expected share of trained agents:

$$E_t\left[\eta(1-\rho-s)\beta\lambda(1-\phi_{t+1})(F-F^T)+(1-\rho-s)\beta\lambda(1-\eta\phi_{t+1})T\right]\bar{\alpha}_t =$$

$$E_t\left[(1-\eta)(y_t^P-y_t^T)-(1-(1-\rho-s)\beta(1-\eta\lambda\phi_{t+1}))\,T-\beta s(F-F^T)\right] \tag{2.34}$$

$$-\,E_t\left[\eta(1-\rho-s)\beta\lambda\phi_{t+1}(F-F^T)+\eta(1-(1-\rho)\beta)(F-F^T)\right]$$

This expression shows a clear negative relationship between $\bar{\alpha}$, the training cost and the firing cost gap $(F-F^T)$. Therefore the training decision is only affected by the relative difference between temporary and permanent contract firing costs, i.e., by the degree of segmentation in the market and not by the absolute level of firing costs. The negative relationship of $\bar{\alpha}$ with the training probability ϕ is not so obvious, but deriving the expression in order to $E_t(\phi_{t+1})$ it is possible to conclude that for $\bar{\alpha}<1$ and $0<E_t(\phi_{t+1})<1$ this derivative is negative (see the Appendix for details). Therefore, if the skill level among temporary employees is currently high, that will create incentives to reduce training next period.

2.2.1 Extension: limits to temporary contract renewal

As a extension, the possibility that the number of temporary contract renewals is limited is also analysed. This is the case for example in Portugal, where a maximum of three renewals is allowed.[5] This feature is implemented in the model as in Faccini (2014), by assuming that when a temporary contract ends, there is a share γ of those contracts that cannot be renewed, and thus the firm must choose between converting them to permanent or ending the labour relationship and posting a new

[5]Recently a proposal for the exceptional possibility of further additional renewals was approved, but this measure is planned to have a temporary nature.

vacancy.

Therefore, for each temporary contract subject to non-renewal that reaches its limit, the firm will choose the option that maximizes the future value of that employment relationship:

$$\max(J_t^P - T, V_t)$$

Similarly to what was assumed before regarding the decision of conversion versus renewal for a temporary contract, the assumption $J_t^P - T > V_t$ is considered and verified *a posteriori* (this is also the option adopted in Faccini (2014)).

Because conversions happen for $J^P - J^T \geq T$, if $J^P < T$, that condition is equivalent to $-J^T \geq \Delta$, or $J^T \leq -\Delta$, where Δ is a strictly positive number. This condition cannot be satisfied in equilibrium, because in that case there would be no creation of temporary contracts, given that the value of a temporary job would be lower than the one of a vacancy. Therefore, in the steady state, for an interior solution to exist, it must be the case that temporary contracts are always converted into permanent when the non-renewal clause is active.

Given this extension, the laws of motion for labour market flows are given by :

$$e_t^P = (1-s-\rho)e_{t-1}^P + (1-s-\rho)\lambda(1-\gamma)\left[e_{t-1}^{TS} + e_{t-1}^{TU}\phi_t\right] + (1-s-\rho)\lambda\gamma e_{t-1}^T; \tag{2.35}$$

$$e_t^{TS} = (1-\rho-s)(e_{t-1}^{TS} + \theta_{t-1}q(\theta_{t-1})u_{t-1}^s) - \lambda(1-\rho-s)e_{t-1}^{TS}; \tag{2.36}$$

$$e_t^{TU} = (1-s-\rho)(e_{t-1}^{TU}+\theta_{t-1}q(\theta_{t-1})(u_t-u_{t-1}^s))-\lambda\phi_t(1-\gamma)(1-\rho-s)e_{t-1}^{TU}-\lambda\gamma(1-\rho-s)e_{t-1}^{TU}; \tag{2.37}$$

And the law of motion for skilled workers is given by:

$$skill_t = (1-\rho)skill_{t-1} + (1-\rho-s)\lambda e_{t-1}^{TU}(\phi_t(1-\gamma)+\gamma) + \rho\delta \tag{2.38}$$

The first order conditions of the firm maximization problem are identical to those in (2.15) (see the Appendix for the full derivation), implying small changes to the value of a temporary job, which is now given by:

$$\begin{aligned} J_t^T =& y_t^T - w_t^T + E_t\left[(1-\rho-s)\beta J_{t+1}^T - \beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T - \beta s F^T\right] \\ &+ E_t\left[\beta(1-\rho-s)(J_{t+1}^P - J_{t+1}^T)(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)\right] \end{aligned} \tag{2.39}$$

The other equations that change relatively to the baseline are the conditions that define the temporary contract wage, the equilibrium value for $\bar{\alpha}$ and the value of production in the economy, which are now given by:

Temporary contract wage:

$$w_t^T = \eta y_t^T + (1-\eta)b + \eta c\theta_t - E_t\left[\eta(1-\rho-s)\beta\lambda(\bar{\alpha}_t + (1-\bar{\alpha}_t)(\phi_{t+1}(1-\gamma)+\gamma))(F-F^T)\right]$$

$$+ E_t\left[\eta F^T(1-\beta(1-\rho)) - \eta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T + \eta\theta_t q(\theta_t)\beta(1-\rho)F^T\right] \tag{2.40}$$

Equilibrium share of the skilled workers in the temporary employment pool:

$$E_t\left[\eta(1-\rho-s)\beta\lambda(1-(\phi_{t+1}(1-\gamma)+\gamma))(F-F^T) + (1-\rho-s)\beta\lambda(1-\eta(\phi_{t+1}(1-\gamma)+\gamma))T\right]\bar{\alpha}_t =$$

$$E_t\left[(1-\eta)(y_t^P - y_t^T) - (1-(1-\rho-s)\beta(1-\eta\lambda(\phi_{t+1}(1-\gamma)+\gamma)))\,T - \beta s(F-F^T)\right]$$

$$- E_t\left[\eta(1-\rho-s)\beta\lambda(\phi_{t+1}(1-\gamma)+\gamma)(F-F^T) - \eta(1-(1-\rho)\beta)(F-F^T)\right] \tag{2.41}$$

Overall output of the economy:

$$y_t = y_t^P e_t^P + y_t^T e_t^T - (\phi_t(1-\gamma)+\gamma)e_{t-1}^{TU}\lambda(1-\rho-s)T - se_{t-1}^P F - s(e_{t-1}^T + q(\theta_{t-1})v_{t-1})F - cv \tag{2.42}$$

The effect of the non-renewability clause imposed is to limit the flexibility of the firm as regards the decision of how many unskilled workers to train each period, given that those workers affected by the non-renewal clause will always be trained. As the probability of non-renewal γ increases, ϕ (which now designates the training probability for unskilled workers whose temporary jobs can be renewed) declines. As this trade-off occurs, the other variables in the model remain basically unchanged. For a large enough γ, corresponding to a very strict non-renewal clause, there will be a corner solution, according to which no temporary contract will be converted until the maximum possible number of renewals has been exhausted. In this subset of the solution space, temporary contracts will be converted into permanent up to the point where the value of a permanent job equals the training cost. Beyond that threshold, firms will simply prefer to dismiss the worker when the maximum number of temporary contract renewals comes to an end.

2.3 Results

2.3.1 Model Calibration

Table 2.1: Calibrated Parameters

Parameter	Calibrated value	Parameter	Calibrated value
Intertemporal discount factor (β)	0.99	Matching function elasticity (μ)	0.4
Entry/exit of labour force (ρ)	0.04	Nash barganing parameter(η)	0.5
Separation rate (s)	0.04		
Probability of end of a temporary contract (λ)	0.5	Share of skilled among new labour force participants (δ)	0.2
Productivity in a temporary contract (y^T)	1		
Productivity in a temporary contract (y^P)	1.025		
Training cost (T)	0.03	Cost of posting a vacancy (c)	0.06
Firing cost for permanent contracts (F)	0.16	Unemployment benefits (b)	0.87
Firing cost for temporary contracts (F^T)	0.1	Matching function scale factor (m)	0.54

The calibration of the model aims at replicating the main features of the average European labour market, with the exception that some features, that intend to reflect the characteristics of the segmented labour markets in some countries. In this vein, the country for which more empirical studies exist in this area is Spain, and therefore these were an essential source of information, although the objective of the model is not to replicate the features of the Spanish economy exclusively.

The quarterly discount factor is set to 0.99, which implies a quarterly rate of about 1 per cent.

Productivity in a temporary contract was standardized to unity. Productivity for a permanent contract was assumed to be 2.5 per cent higher than in a temporary contract, close tho the level productivity diference between old and new jobs in Kilponen and Vanhala (2009).

The share of skilled workers entering the labour force each period was calibrated to 20 per cent, which corresponds broadly to the share of the active population in the euro area with a tertiary education level in 2012 (24 per cent, according to EUROSTAT data, based on labour force surveys).

The probability of a temporary contract coming to an end each quarter is set to 0.5, implying an average duration of each contract of six months. According to OECD (2002), more than half of ongoing temporary contracts in the OECD had tenure below one year. Although this information reports to incomplete durations, it suggests that firms favour the possibility of exploring the legally possible renewals within the maximum cumulative period allowed. For example, in Portugal, this corresponds to four renewals and three years maximum in most cases (OECD (2013)).

The values for the training and firing costs were calibrated jointly with the objective of replicating in the baseline the low conversion rates of temporary to permanent contracts observed in economies with highly segmented labour markets, while maintaining reasonable values for these parameters.

According to CEDEFOP (2010), the cost of vocational training was about 1.6 per cent of labour costs in 2005 in the EU-27. This includes both direct monetary costs of training and and an estimate of lost production due to time spend in training. This implies, given the assumptions for y^p and y^T, and considering a neutral distribution of employment and a reference value for unemployment of about 10 per cent, a cost of 0.02 per worker. The value for T is calibrated at a very close value to this, 0.03. The calibration of the firing costs parameters is particularly difficult, because this cost is not related to the monetary severance payment, which constitutes just a transfer between the firm and the worker, whose impact can be contractually annulled (Lazear (1990)), but to other costs of dismissal, like a notice period obligation. The value of firing costs for temporary contracts is set at 0.1, a lower bound for the values considered in the literature that evaluates the effects of EPL without taking into account segmentation (Wesselbaum (2009)). The value for firing costs in permanent contracts was calibrated taking into account a reasonable relationship with the level for temporary firing costs. Taking the average ratio of the OECD indicators of EPL strictness for regular and temporary contracts for Portugal in 2008-2013 as a reference, the indicator of strictness for regular contracts is about 60 per cent higher or 107 per cent higher (depending on either version 3 or version 1 of the indicators) than the one for temporary contracts (OECD (2013) and associated datasets).[6] In the calibration, the value of F was considered to be 0.16, this 60 per cent above the level specified for F^T.

The values for the cost of keeping an open vacancy c, unemployment benefits b and the scale parameter of the matching function m are identical to those used in Chapter (1), and, in the case of b and m, very close to those in Sala et al. (2012).

The value for the exit rate of the labour force ρ is set to 0.04, implying an average tenure in the firm of a little above six years, approximately in line with the median enterprise tenure in the OCDE (5.4 years) (OECD (1993)). The probability s of a match being dissolved is calibrated to

[6] Note that for other segmented labour markets like Spain or France, the EPL strictness levels on temporary contracts are currently higher than those of permanent contracts. Although this partially reflects a change in policy orientation, it may also reflect the fact that these indicators are based on legal regulations and not their implementation.

0.04, such that the overall quarterly separation rate, given by separation and exit from the labour force flows is close to 0.1, a midpoint of the values in the literature (Krause and Lubik (2007)).

2.3.2 Steady State

This section provides an evaluation of the model through the analysis of the impact of several structural shocks. These include productivity shocks (either specific to the task performed by permanent workers or across all workers) and shocks to variables that define some “institutional” parameters in the economy. Namely, a shock to training costs is considered in order to illustrate what could be the effects of changes in training subsidies. In addition, three shocks to firing costs are considered, describing the separate and joint impact of changes in the associated costs for different types of contracts. Additionally, the effect of an increase in the share of skilled agents that enter the labour market, which corresponds to a long-term trend, is also analysed.

Figures (2.2) to (2.15) present both the baseline results and the new steady state values after permanent shocks for some key variables of the model, as well as the corresponding transitional dynamics between them. The steady state of the model is able to replicate the low transitions rates of temporary contracts into permanent of segmented European labour markets (slightly above 10 per cent for unskilled workers), coupled in recent years with high unemployment rates (close to 15 per cent). The incidence of permanent employment is about 60 per cent, not very far from the levels recorded in Spain, specially taking into account that the model does not consider the possibility of workers being hired directly into permanent employment. About 40 per cent of unemployed agents are skilled, but that percentage decreases to about 15 per cent in the case of temporary workers (skill share-firm). There is a positive wage gap between permanent and temporary contracts, in line with what is observed in the empirical literature, although lower (about 2 per cent) than the average values found in the empirical literature. This reflects the fact the fact that the training cost burden on wages in temporary contracts depends on the share of contracts of unskilled workers being converted into permanent, which is relatively low. Also, this model is probably not able to replicate the observed gap because it does not take into account insider-outsider issues as regards wage bargaining, which are arguably the main source of wage differentials at this level.

Permanent shock to productivity in an open-ended contract

Figure (2.2) shows, beside the baseline steady-state values mentioned above, the new steady state values after a permanent shock of 1 per cent to the productivity level of an open-ended contract has taken place. Given its higher productivity, the value of a permanent job increases, and therefore the incentives to train an unskilled worker and convert his job into permanent (translated into an increase in ϕ) also increases. Given that *ceteris paribus* the increase in the value of a permanent job also raises the asset value of a temporary job, this raises incentives to job creation, leading to an increase in vacancies and to a decline in unemployment. Consequently, labour market tightness increases and the probability of filling a vacancy declines marginally.

Permanent contract wages increase due to their higher productivity, accentuating the wage gap. As a result of more training, permanent employment increases, as does the incidence of skilled workers both among unemployed and temporary workers. Conversely, temporary employment declines. The effect on the value of production of the increased productivity is reinforced by the employment recomposition, and output increases significantly. Figure (2.3) shows the transitional dynamics between these two steady states. There is some overshooting in the response of the probability of training ϕ, given that its initial increase leads to an upward adjustment in the skill level of the economy. As firms start to find skilled agents easier among unemployed, the strategy of training unskilled workers becomes less profitable, and the initial increase in ϕ is partially corrected. The transition profile of the training probability translates into the profile of wages.

Permanent shock to productivity in both types of contracts

When the productivity shock is broad-based, essentially the effects are identical to those just described because the impact in permanent job productivity dominates, given that it is higher in level (Figures (2.4) and (2.5) present the results for a 5 per cent shock to productivity in both types of jobs). Transitional dynamics show a short-lived increase in temporary employment, reflecting increased job creation, that lasts until these additional workers are transferred to permanent contracts. The probability of training initially increases, due to the increase in the value of a permanent job, and latter on temporarily weakens, because the increased job creation creates incentives to wait and convert only skilled workers contracts. Latter on, as labour market tightness increases and the supply of skilled temporary workers is reduced again, training becomes a more interesting option once more, with the new steady state level above the original one.

These dynamics create some volatility in the convergence paths of skilled and unskilled workers. In the case of an equivalent productivity shock of negative sign, the effect in employment would be symmetrical, with temporary employment initially declining faster than permanent employment, but then picking up also very quickly, while permanent employment would decline more slowly, but in a persistent way. In addition, in the new steady state, there would be some substitution of permanent for temporary employment. This adjustment trajectory is in line with the so-called “honeymoon” effect (Boeri and Garibaldi (2007)) and also with the above-mentioned developments observed in some countries during the Great Recession.

Permanent shock to training costs

The impact of a permanent 5 per cent increase in training costs is exhibited in Figure (2.6). Because an increase in T reduces the expected return of training, the share of trained workers declines, as does the value of a temporary job. The decline in training leads to a recomposition of employment and skill characteristics which is the opposite of the one described for the productivity shock. Additionally, the decrease in the value of a temporary job implies less incentives to job creation, and therefore a decline in labour market tightness and a small increase in unemployment. Because the probability of training declines, the cost associated to it in temporary wages also decreases, giving rise to a positive effect on wages that more than compensates the direct negative impact of the increase in T.

Therefore, the wage gap actually decreases marginally following this shock. Notice however that this does not mean that overall expected costs with training decline, given that the number of unskilled temporary workers increases. The value of production, which includes firing and training costs, also declines marginally, due to the increase in training costs and due to recomposition in employment. The transitional dynamics between steady states following the shock to T can be seen in Figure (2.7). This figure shows that there is some undershooting in the training share response, given that the average skill level adjusts sluggishly. When the average skill level among workers decreases, trained workers start to play a more important role in the expected future value of a temporary job, and is more costly to wait for a skilled match from the unemployment pool. This partly corrects the disincentives to training created by the increase in T. The undershooting in the training share gives rise to some initial overshooting in the value of production and in temporary wages, because the overall cost associated with training ($\phi_t n_{t-1}(1-\bar{\alpha}_t)T$) actually decreases initially.

Permanent shock to the proportion of skilled workers entering the labour force

Figures (2.8) and (2.9) report the impact of a 50 per cent increase in the incidence of skilled workers entering the labour market. An increase in the percentage of skilled workers that enter the labour force reinforces the firms strategy of waiting to find a skilled worker in the unemployment pool instead of training an unskilled worker. This behaviour is in line with the justification presented by the majority of firms which do not train, arguing that they prefer to hire workers with the required skills and competences directly (CEDEFOP (2010)). Although this shock leads to an increase in the skill level both among temporary employees and in the overall economy, the decline in training will imply a recomposition of employment towards temporary employment. Overall production remains almost unchanged, given that the reduction in training costs compensates the employment recomposition in the long-run. Identically, the change in unemployment is virtually nil. The wage premium decreases because temporary wages marginally increase, given that the negative impact in wages associated with training costs is reduced. Therefore, the long-term trend of increase in the average qualification of workers when they enter the labour force leads the remaining low skill workers to become increasingly more "trapped", and the economy increasingly reliant in temporary employment with no significant impact in overall GDP or unemployment levels.

Permanent shock to firing costs associated with open-ended contracts

The response to an increase of 5 per cent in firing costs associated with open-ended contracts (Figures (2.10) and (2.11)) leads to a decline in the expected value of a permanent job, and therefore incentives to train decline. Because the decline in the value of a permanent job also affects the value of a temporary job, incentives to job creation decline, leading labour market tightness to decrease and unemployment to increase (marginally). The change in training decisions gives way to a recomposition of employment which favours temporary employment, resulting in a decrease in the average number of skilled agents in the economy. There is however a very marginal decline in the wage premium of open-ended contracts.

This reflects the fact that both types of wages decline due to the evolution of labour market tightness but in the case of temporary contract wages, this is partially compensated by the decline in ϕ, which reduces the negative impact of training costs in these wages. The value of production declines, given increased firing costs and the recomposition of employment and thus of production. The transitional dynamic shows an undershooting of the training share already mentioned for previous shocks.

Permanent shock to firing costs associated with temporary contracts

A similar shock, but implying a decline in temporary firing costs, aims at illustrating what happens after a two-tier reform like those observed in Europe in recent years (Figures (2.12) and (2.13)). This reform implies an increase in the value of a temporary job, which reduces the incentives to conversion of temporary contracts into permanent, while at the same time induces more job creation, leading to a decline in unemployment. As regards the composition of temporary employment, initially the average number of skilled temporary workers actually increases, as temporary employment increases and the skill composition is initially broadly unchanged.

However, as the decline in training impacts in the average skill level of the economy, temporary employment becomes (even) more unskilled. The value of production marginally increases, given that the decline in firing costs and in training costs is in this case enough to compensate for the reorientation of the economy towards the less productive sector. Wages in both types of jobs decrease, because of the impact of firing costs associated with temporary contracts in the value of unemployment and therefore in reservation wages.

However, temporary contract wages decrease less, because the impact of training and firing costs on the wage declines with the reduction in the training probability. Therefore, the economy resulting from this reform has lower unemployment, but workers are less skilled and are retained longer in temporary employment, affecting their lifetime income prospects and, if human capital is associated with endogenous growth, development prospects for the whole economy.

Permanent shock to firing costs associated with both types of contracts

Finally, Figures (2.14) and (2.15) show the steady-state levels and transitional dynamics for an institutional reform in the spirit of the single contract proposal described above. Therefore, an approximation of the firing costs levels in temporary and permanent employment was implemented, by increasing the former and decreasing the latter in the same proportion (5 per cent). The increase in F^T implies a decline in the value of a temporary job, which creates more incentives to training. However, it also reduces incentives to job creation, implying a decrease in labour market tightness and a marginal increase in unemployment. Given increased training, there is a recomposition of employment towards permanent employment and therefore towards a higher average skill level in the economy.

In the transition to the new steady-state, the value of production temporarily decreases, due to increased training costs, but latter on becomes higher than initially, given the recomposition of production towards high-productivity activities. Both types of wages increase, despite the decline in labour market tightness, because the increase in the value of firing costs for temporary contracts raises the outside option for workers (which are able to appropriate part of that value trough Nash Bargaining). In the case of temporary contracts, there is an additional positive effect arising from a reduction in the negative impact of the firing costs gap. Therefore, the wage premium declines marginally.

2.3.3 Policy Evaluation: single contract

Besides the last simulation exercise of the previous section, another possible parallelism of the model to the single contract would be a situation in which all unskilled workers would be trained, and therefore the temporary contract stage would serve the purpose of a trial period. That outcome could be achieved in the current environment by changing some of the institutionally driven variables of the model. Figure (2.16) shows the different ways this objective can be achieved either by subsidizing the training cost or increasing the average duration of a temporary contract (decreasing the probability that the contract will end in a given period), while ensuring that full training is the optimal decision for the firm.

A decrease in the training cost paid by firms reduces the wedge between the value of a permanent and temporary contract required to train an unskilled worker and convert his contract into permanent. On the other hand, an increase in the expected duration of a temporary contract reduces the value of the firms strategy of offering permanent contracts only to skilled workers, because this opportunity happens at longer intervals. In other words, a decline in λ reduces the value of a temporary job, and therefore increases incentives to convert it into a permanent job.

The function obtained from this simulation is convex. For shorter durations of temporary contracts (higher λ), the rotation of workers is higher. Because in this simulation all unskilled workers are trained, a higher worker rotation corresponds to a higher share of skilled workers in the economy. Therefore, the number of unskilled workers that the firm has to train is small and has a relatively low weight in the value average of a temporary job. Therefore a small decline in the cost of training is enough to maintain the full training policy of the firm when the duration of temporary contracts decreases marginally. Figure (2.16) shows however that only for a relatively long duration of temporary contracts (more than five quarters) is it possible to achieve full training with a partial reduction in the training cost. For shorter-duration contracts this is only possible if firms are actually paid to train (negative T), thus compensating the incentives that firms have to fill their workforce requirements for permanent contracts with skilled workers. This situation, in which temporary contracts are of shorter duration, but there is full training because firms are paid to do so, is preferable from the point of view of society, given that it leads both to lower unemployment and a higher value of production. The high skill level of this economy with strong reallocation of temporary workers into permanent contracts increases the value of a temporary job, raising incentives to job creation and therefore decreasing unemployment. The value of production in the economy is higher due to the recomposition of employment. The impact of the change in training costs will be neutral at best, because if they are subsidized by the Government, the revenue to cover that subsidy must be obtained trough taxes or other compensatory measures.

Figure (2.17) shows the result of the same type of exercise, but for training costs and firing costs for permanent contracts. The scale of the firing cost only goes up to 0.3, because beyond that the value of a permanent job would be negative and the firm would always prefer to dismiss a worker when the temporary contract ends than to convert his contract into a permanent one. The tradeoff relationship between T and F is almost linear (very slightly concave), with an inclination lower than one (in absolute value). Therefore, an increase in F can be compensated my a more moderate decline in T while firms maintain the decision to fully train. This results from the fact that an increase in F leads to a decline in the value of a permanent job, and consequently also of a temporary job (for which it represents a possible future asset value), but does not change significantly the relationship between them, not affecting the decision for ϕ substantially. On the other hand, a change in T actually affects the value of a permanent and a temporary job in opposite directions, affecting the training decision directly. Because higher firing costs reduce the incentive to create any type of job, both permanent and temporary, a policy according to which a high protection for permanent workers would be compensated by subsidies to training would be detrimental to overall employment and production.

Finally, Figure (2.18) shows an identical tradeoff, but between training costs and firing costs to temporary contracts. In this case, the relationship is also apparently linear (in fact slightly convex) but upward slopping. Because an increase in the firing costs of a temporary contract decreases the value of a temporary job, it increases incentives for conversion of these contracts into permanent. Therefore, to maintain $\phi = 1$, it is necessary that training costs increase. Over this process, because the decline in the value of a temporary job also decreases incentives to job creation, unemployment increases and temporary and permanent employment decline. Therefore, although the probability of training remains at unity, the actual number of agents to be trained declines, and consequently also the average skill level in the economy. This employment recomposition leads to a decline in the value of output. The slope of the curve in figure (2.18) is in general lower than one, as in the case of the tradeoff with permanent firing costs, but for higher levels of temporary firing costs, it becomes higher than one. As T increases, incentives to conversion decline. But for higher levels of F^T and *T*, the skill level within temporary jobs will be lower, decreasing the impact on the value of a temporary job induced by a change in T. To compensate for this effect, sharper increases in T are needed to ensure that the optimal probability of training remains at one when F^T increases.

This exercise shows that trying to achieve the same outcome of the single contract in this setup without changing, or even enhancing, the protection of temporary contracts has negative impacts for society as a whole, as it will affect incentives to job creation more strongly than training costs.

2.4 Conclusion

This paper aimed at looking at the interaction of labour market segmentation within a search and matching model with a so far relatively neglected channel: training and its externalities as regards the skill composition of the economy. In this setup, a reform of the type that took place in several European countries over the 80's and 90's, namely a reduction in employment protection for temporary contracts while leaving it virtually unchanged for open-ended contracts, can actually increase employment, but at the cost of limiting investments in training, thus damaging career prospects for unskilled workers. Given that human capital can be a determinant factor for economic growth, both directly and by making the adaptation to economic innovation easier, and may give rise to positive externalities (Acemoglu and Angrist (2001)), the impact of labour market policies on general skill accumulation cannot be disregarded. A policy along the spirit of the single contract proposal, that approximates firing costs levels in temporary and permanent contracts, can have beneficial effects for the economy in terms of unemployment, skill level and production, thus increasing welfare by any of the most common metrics. Moreover, these beneficial effects are extensive to all worker segments, decreasing inequality as measured by wage differencials. Alternative measures that try to achieve the full training result by subsidizing training without changing the levels of employment protection are socially less preferable to a policy mix with higher training costs and lower firing costs, given that the latter affect job creation more strongly.

Appendices

2..1 First order conditions

The lagrangian corresponding to the problem of profit maximization by the firm (equation (2.15)) is given by:

$$\mathscr{L}(\phi_t, e_t^P, e_t^T, v_t) = E_0\Bigg\{\sum_{t=0}^{\infty}\beta^t\Big[y_t^P e_t^P + y_t^T e_t^T - w_t^P e_t^P - w_t^T e_t^T - v_t c - \phi_t(1-s-\rho)(1-\bar{\alpha}_{t-1})\lambda e_{t-1}^T T$$

$$- s e_{t-1}^P F - s\left[e_{t-1}^T + q(\theta_{t-1})v_{t-1}\right]F^T + E_t\left[\beta\left(\Pi_{t+1}\right)\right]$$

$$- \mathscr{L}_{1t}\left[e_t^P - \big((1-s-\rho)e_{t-1}^P + (1-s-\rho)\lambda(\bar{\alpha}_{t-1} + (1-\bar{\alpha}_{t-1})\phi_t)e_{t-1}^T\big)\right]$$

$$- \mathscr{L}_{2t}\left[e_t^T - \big((1-s-\rho)e_{t-1}^T + q(\theta_{t-1})(1-s-\rho)v_{t-1} - (1-s-\rho)\lambda(\bar{\alpha}_{t-1} + (1-\bar{\alpha}_{t-1})\phi_t)e_{t-1}^T\big)\right]\Big]\Bigg\} \tag{2.43}$$

The first order conditions of this problem are given by:

$$\frac{\partial \mathscr{L}}{\partial \phi_t} \Leftrightarrow (\mathscr{L}_{1t} - \mathscr{L}_{2t}) - T = 0 \tag{2.44}$$

Equation (2.44) implies that at the optimum the firm will choose to train a share of unskilled temporary workers that ensures that the difference between the shadow value of a job under a permanent contract and a temporary contract equals the training cost.

The remaining first order conditions are given by:

$$\frac{\partial \mathscr{L}}{\partial e_t^P} \Leftrightarrow \mathscr{L}_{1t} - \left[y_t^P - w_t^P + E_t(\beta(1-\rho-s)\mathscr{L}_{1t+1}) - \beta s F\right] = 0 \tag{2.45}$$

$$\frac{\partial \mathscr{L}}{\partial e_t^T} \Leftrightarrow \mathscr{L}_{2t} - \left[y_t^T - w_t^T + E_t\left[\beta(1-\rho-s)\mathscr{L}_{2t+1} - \beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T - \beta s F^T\right]\right]$$

$$- E_t\left[\beta(1-\rho-s)(\mathscr{L}_{1t+1} - \mathscr{L}_{2t+1})(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right] = 0 \tag{2.46}$$

$$\frac{\partial \mathscr{L}}{\partial v_t} \Leftrightarrow c - E_t\left[\beta q(\theta_t)(1-\rho-s)\mathscr{L}_{2t+1} - \beta q(\theta_t) s F^T\right] = 0 \tag{2.47}$$

Defining the value of a permanent job as $J_t^P = \mathscr{L}_{1t}$ and the value of a temporary job as $J_t^T = \mathscr{L}_{2t}$ (they correspond to the derivative of the value function of the firm ir order to the current permanent and temporary employment levels, respectively) yields equations (2.16) to (2.19).

2..2 Surplus of a temporary and permanent job

The expression for the surplus of a permanent job is given by:

$$S_t^P = J_t^P - V_t + W_t^P - U_t + F \Leftrightarrow$$

$$S_t^P = y_t^P - w_t^P + E_t\left[\beta(1-\rho-s)J_{t+1}^P - \beta sF - \left(-c + q(\theta_t)\beta\left((1-\rho-s)J_{t+1}^T - sF^T\right)\right)\right] + w_t^P +$$

$$E_t\left[\beta(1-\rho-s)W_{t+1}^P + \beta sU_{t+1} - (b + \beta q(\theta_t)\theta_t(1-\rho-s)(W_{t+1}^T - U_{t+1}) + \beta(1-\rho)U_{t+1})\right] + F \Leftrightarrow$$

$$S_t^P = E_t\big[\beta(1-\rho-s)\underbrace{\left(J_{t+1}^P + W_{t+1}^P - U_{t+1}\right)}_{S_{t+1}^P - F} + c - b + F(1-\beta s) + q(\theta_t)\beta sF^T\big]$$

$$+ y_t^P - E_t\big[q(\theta_t)\beta(1-\rho-s)\underbrace{J_{t+1}^T}_{(1-\eta)S_{t+1}^T - F^T} + \beta q(\theta_t)\theta_t(1-\rho-s)\underbrace{\left(W_{t+1}^T - U_{t+1}\right)}_{\eta S_{t+1}^T}\big] \tag{2.48}$$

Replacing the expressions in braces and rearranging the terms:

$$S_t^P = E_t\left[\beta(1-\rho-s)\left(S_{t+1}^P - F\right) + c - b + F(1-\beta s) + q(\theta_t)\beta sF^T\right]$$

$$+ y_t^P - E_t\left[(\beta q(\theta_t)\theta_t(1-\rho-s)(\eta S_{t+1}^P)) + q(\theta_t)\beta(1-\rho-s)\left((1-\eta)S_{t+1}^T - F^T\right)\right] \Leftrightarrow$$

$$S_t^P = y_t^P + c - b + E_t\left[\beta(1-\rho-s)S_{t+1}^P + F(1-(1-\rho)\beta)\right]$$

$$+ E_t\left[q(\theta_t)\beta(1-\rho)F^T - q(\theta_t)\beta(1-\rho-s)\left((1-\eta) + \eta\theta_t\right)S_{t+1}^T\right]$$

The expression for the surplus of a temporary job is given by:

$$
\begin{aligned}
& S_t^T = y_t^T - w_t^T + E_t\left[(1-\rho-s)\beta J_{t+1}^T - \beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T - \beta s F^T\right] \\
& + E_t\left[\beta(1-\rho-s)(J_{t+1}^P - J_{t+1}^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)\right] \\
& - \big(-c + q(\theta_t)\beta\big((1-\rho-s)\underbrace{J_{t+1}^T}_{(1-\eta)S_{t+1}^T - F^T} - sF^T\big)\big) \\
& + w_t^T + E_t\left[\beta(1-\rho-s)W_{t+1}^T + \beta(1-\rho-s)\lambda\bar{\alpha}_t\left(W_{t+1}^P - W_{t+1}^T\right)\right] \\
& + E_t\left[\beta(1-\rho-s)\lambda(1-\bar{\alpha}_t)\phi_{t+1}\left(W_{t+1}^P - W_{t+1}^T\right) + \beta s U_{t+1}\right] \\
& - E_t[b + \beta q(\theta_t)\theta_t(1-\rho-s)\underbrace{(W_{t+1}^T - U_{t+1})}_{\eta S_{t+1}^T} + \beta(1-\rho)U_{t+1}] + F^T \Leftrightarrow
\end{aligned}
\tag{2.49}
$$

$$
\begin{aligned}
& S_t^T = y_t^T + E_t\left[\beta(1-\rho-s)(J_{t+1}^P + W_{t+1}^P - (J_{t+1}^T + W_{t+1}^T))(\lambda\phi_{t+1}(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)\right] \\
& + c - b - E_t\left[\beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T + (1-\rho-s)\beta\left(J_{t+1}^T + W_{t+1}^T - U_{t+1}^T\right)\right] \\
& - E_t\left[\beta q(\theta_t)(1-\rho-s)\left[(1-\eta)S_{t+1}^T - F^T\right] - F^T(1+q(\theta_t)\beta s - s\beta) + \beta q(\theta_t)\theta_t(1-\rho-s)\eta S_{t+1}^T\right]
\end{aligned}
$$

Note that:

$$
\begin{aligned}
& E_t\left[J_{t+1}^P + W_{t+1}^P - (J_{t+1}^T + W_{t+1}^T)\right] = E_t\left[J_{t+1}^P + W_{t+1}^P - U_{t+1} - V_{t+1} - (J_{t+1}^T + W_{t+1}^T - U_{t+1} - V_{t+1})\right] \\
& = E_t\left[(S_{t+1}^P - F) - (S_{t+1}^T - F^T)\right]
\end{aligned}
$$

Using this expression in equation (2.49):

$$S_t^T = y_t^T + E_t\left[\beta(1-\rho-s)(S_{t+1}^P - S_{t+1}^T - (F-F^T))(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right]$$

$$+ c - b - E_t\left[\beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T - (1-\rho-s)\beta\left(S_{t+1}^T - F^T\right) + \beta q(\theta_t)\theta_t(1-\rho-s)(\eta S_{t+1}^T)\right]$$

$$- E_t\left[\beta q(\theta_t)(1-\rho-s)\left[(1-\eta)S_{t+1}^T - F^T\right] - F^T(1-s\beta(1-q(\theta_t)))\right] \Leftrightarrow$$

$$S_t^T = y_t^T + E_t\left[\beta(1-\rho-s)(S_{t+1}^P - S_{t+1}^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t) + (1-\rho-s)\beta S_{t+1}^T\right]$$

$$- E_t\left[\beta(1-\rho-s)(F-F^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t) + \beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T\right] + c - b$$

$$- E_t\left[\beta q(\theta_t)(1-\rho-s)((1-\eta) + \eta\theta_t)(S_{t+1}^T) - F^T(1-(1-\rho)\beta(1-q(\theta_t)))\right] \tag{2.50}$$

2..3 Wages

Notice that from the job creation condition (Equation (2.70)) we have:

$$E_t\left(c + \beta q(\theta_t)sF^T\right) = q(\theta_t)E_t\left[\beta(1-\rho-s)((1-\eta)S_{t+1}^T - F^T)\right] \Leftrightarrow$$

$$\frac{c + E_t(\beta)q(\theta_t)(1-\rho)F^T}{q(\theta_t)(1-\rho-s)E_t(\beta)} = (1-\eta)E_t(S_{t+1}^T) \tag{2.51}$$

The equation for the wage of a permanent contract is given by:

$$(J_t^P + F) = (1-\eta)S_t^P$$

$$= (1-\eta)\left[y_t^P + c - b + E_t\left(\beta(1-\rho-s)S_{t+1}^P + F(1-(1-\rho)\beta) + q(\theta_t)\beta(1-\rho)F^T\right)\right]$$

$$-(1-\eta)E_t\left[q(\theta_t)\beta(1-\rho-s)\left((1-\eta)+\eta\theta_t\right)S_{t+1}^T\right] \tag{2.52}$$

Using equation (2.51) the last term can be written as:

$$E_t(c + q(\theta_t)\beta(1-\rho)F^T)(\eta\theta_t + (1-\eta)) \tag{2.53}$$

Therefore, using also the value of a permanent job (equation (2.16)), equation (2.52) can be written as:

$$y_t^P - w_t^P + (1-\rho-s)E_t[\beta\left((1-\eta)S_{t+1}^P - F\right)] - E_t\left(\beta s F\right) + F =$$

$$(1-\eta)y_t^P + (1-\eta)c - (1-\eta)b + E_t\left(\beta(1-\rho-s)(1-\eta)S_{t+1}^P + (1-\eta)F(1-(1-\rho)\beta)\right)$$

$$-E_t\left[(c + q(\theta_t)\beta(1-\rho)F^T)(\eta\theta_t + (1-\eta)) - (1-\eta)q(\theta_t)\beta(1-\rho)F^T\right] \tag{2.54}$$

Which simplifying yields the equation for the permanent wage:

$$w_t^P = \eta y_t^P + b(1-\eta) + c\eta\theta_t + \eta E_t(1-(1-\rho)\beta)F + \eta E_t(q(\theta_t)\theta_t\beta(1-\rho)F^T) \tag{2.55}$$

The expression for the temporary contract wage is given by:

$$(J_t^T + F^T) = (1-\eta)S_t^T \Leftrightarrow$$

$$(1-\eta)y_t^T + (1-\eta)E_t\left[\beta(1-\rho-s)(S_{t+1}^P - S_{t+1}^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t) + (1-\rho-s)\beta S_{t+1}^T\right]$$

$$-(1-\eta)E_t\left[\beta(1-\rho-s)(F-F^T)(\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t) + \beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T\right] + (1-\eta)c$$

$$-(1-\eta)E_t\left[\beta q(\theta_t)(1-\rho-s)((1-\eta)+\eta\theta_t)S_{t+1}^T - F^T(1-(1-\rho)\beta(1-q(\theta_t)))\right] - (1-\eta)b \tag{2.56}$$

The value of a temporary job (equation (2.17)) can be written as:

$$J_t^T = y_t^T - w_t^T + E_t\left[(1-\rho-s)\beta((1-\eta)S_{t+1}^T - F^T) - \beta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T - \beta s F^T\right]$$

$$+ E_t\left[\beta(1-\rho-s)\left[(1-\eta)(S_{t+1}^P - S_{t+1}^T) - (F-F^T)\right](\lambda\phi_{t+1}(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right] \tag{2.57}$$

Replacing condition (2.57) on (2.56) yields the expression for the temporary wage:

$$w_t^T = \eta y_t^T + (1-\eta)b + \eta c\theta_t - E_t\left[\eta(1-\rho-s)\beta\lambda(\bar{\alpha}_t + (1-\bar{\alpha}_t)\phi_{t+1})(F-F^T)\right] \tag{2.58}$$

$$+ E_t\left[\eta F^T(1-\beta(1-\rho)) - \eta(1-\rho-s)\lambda\phi_{t+1}(1-\bar{\alpha}_t)T + \eta\theta_t q(\theta_t)\beta(1-\rho)F^T\right]$$

2..4 Impact of the training probability in the average skill level

Equation (2.34) can be rewritten as:

$$\bar{\alpha}_t = \frac{N}{D} \tag{2.59}$$

where N stands for the numerator or the equation, and D for the denominator, such that:

$$\begin{aligned} N &= E_t\left[(1-\eta)(y_t^P - y_t^T) - (1-(1-\rho-s)\beta(1-\eta\lambda\phi_{t+1}))\,T - \beta s(F - F^T)\right] \\ &- E_t\left[(\eta(1-\rho-s)\beta\lambda\phi_{t+1}(F-F^T) + \eta(1-(1-\rho)\beta)(F-F^T)\right] \end{aligned} \tag{2.60}$$

$$D = E_t\left[\eta(1-\rho-s)\beta\lambda(1-\phi_{t+1})(F-F^T) + (1-\rho-s)\beta\lambda(1-\eta\phi_{t+1})T\right] \tag{2.61}$$

Under the assumption that $E_t(\phi_{t+1}) < 1$, $F > F^T$, $T > 0$, and that all other parameters have values in the]0,1[interval, the denominator must be positive, and therefore, N must be positive as well in order for $\bar{\alpha}_t$ to be positive.

Taking the derivative of $\bar{\alpha}_t$ in order to $E_t(\phi_{t+1})$ (in fact ϕ_{t+1} is the only forward-looking term, because in this formulation of the model β is assumed to be constant), we obtain:

$$\frac{\partial\bar{\alpha}_t}{\partial E_t(\phi_{t+1})} = \frac{1}{D}(1-\rho-s)\beta\eta\lambda(T+F-F^T)\,(\bar{\alpha}_t - 1) \tag{2.62}$$

Under the previous stated assumptions and the additional assumption $0 < \bar{\alpha}_t < 1$, this derivative is negative.

2..5 Extension: limited temporary contract renewals

The problem faced by the representative firm is in this case thus given by:

$$\max_{\phi_t, e_t^P, e_t^T, v_t} E_0 \left[\sum_{t=0}^{\infty} \beta^t \Pi_t \right] =$$

$$\max_{\phi_t, e_t^P, e_t^T, v_t} E_0 \Bigg\{ \sum_{t=0}^{\infty} \beta^t \Big[y_t^P e_t^P + y_t^T e_t^T - w_t^P e_t^P - w_t^T e_t^T - v_t c - \lambda(\phi_t(1-\gamma)+\gamma)(1-s-\rho)(1-\bar{\alpha}_{t-1})e_{t-1}^T T$$

$$- s e_{t-1}^P F - s \left[e_{t-1}^T + q(\theta_{t-1}) v_{t-1} \right] F^T \Big] \Bigg\}$$

$$\text{s.t. } e_t^P = (1-s-\rho)e_{t-1}^P + (1-s-\rho)\lambda(\bar{\alpha}_{t-1} + (1-\bar{\alpha}_{t-1})(\phi_t(1-\gamma)+\gamma))e_{t-1}^T$$

$$e_t^T = (1-s-\rho)e_{t-1}^T + q(\theta_{t-1})(1-s-\rho)v_{t-1} - (1-s-\rho)\lambda(\bar{\alpha}_{t-1}$$

$$+ (1-\bar{\alpha}_{t-1})(\phi_t(1-\gamma)+\gamma))e_{t-1}^T \tag{2.63}$$

Let $\mathscr{L}$ be the Lagrangian of the problem above and $\mathscr{L}_1$ and $\mathscr{L}_2$ be the Lagrange multipliers on the first and second constraints. The first order conditions are given by:

$$\frac{\partial \mathscr{L}}{\partial \phi_t} \Leftrightarrow (\mathscr{L}_{1t} - \mathscr{L}_{2t}) - T = 0 \tag{2.64}$$

$$\frac{\partial \mathscr{L}}{\partial e_t^P} \Leftrightarrow \mathscr{L}_{1t} - \left[y_t^P - w_t^P + E_t(\beta(1-\rho-s)\mathscr{L}_{1t+1}) - \beta s F \right] = 0 \tag{2.65}$$

$$\frac{\partial \mathscr{L}}{\partial e_t^T} \Leftrightarrow \mathscr{L}_{2t} - \left[y_t^T - w_t^T + E_t \left[\beta(1-\rho-s)\mathscr{L}_{2t+1} - \beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T \right] \right]$$

$$- E_t \left[\beta(1-\rho-s)(\mathscr{L}_{1t+1} - \mathscr{L}_{2t+1})(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t) + \beta s F^T \right] = 0 \tag{2.66}$$

$$\frac{\partial \mathscr{L}}{\partial v_t} \Leftrightarrow c - q(\theta_t) E_t \left[\beta(1-\rho-s)\mathscr{L}_{2t+1} - \beta q(\theta_t) s F^T \right] = 0 \tag{2.67}$$

Under the assumptions $\mathscr{L}_{1t} = J_t^P$ and $\mathscr{L}_{2t} = J_t^T$, these equations give rise to the following conditions:

Value of a permanent contract to a firm:

$$J_t^P = y_t^P - w_t^P + E_t \left[(1-\rho-s)\beta J_{t+1}^P - \beta s F \right] = 0 \tag{2.68}$$

Value of a temporary contract to a firm:

$$\begin{aligned} J_t^T =& y_t^T - w_t^T + E_t \left[(1-\rho-s)\beta J_{t+1}^T - \beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T - \beta s F^T \right] \\ &+ E_t \left[\beta(1-\rho-s)(J_{t+1}^P - J_{t+1}^T)(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t) \right] \end{aligned} \tag{2.69}$$

The first order condition for vacancies yields the job creation condition:

$$c = q(\theta_t)E_t\left[\beta\left((1-\rho-s)J^T_{t+1} - sF^T\right)\right] \tag{2.70}$$

The difference between the value of a permanent and a temporary job, that determines the optimal value of ϕ, is given by:

$$\begin{aligned}(J^P_t - J^T_t) =& (y^P_t - y^T_t) - (w^P_t - w^T_t) + E_t\left[(1-\rho-s)\beta(J^P_{t+1} - J^T_{t+1}) - \beta s(F - F^T)\right]\\ &+ E_t\left[\beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T\right]\\ &- E_t\left[\beta(1-\rho-s)(J^P_{t+1} - J^T_{t+1})(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)\right] = 0\end{aligned} \tag{2.71}$$

The value functions corresponding to the other possible states in this economy are given by:

Value of unemployment to an agent:

$$U_t = b + \beta q(\theta_t)\theta_t(1-\rho-s)(W^T_{t+1} - U_{t+1}) + \beta(1-\rho)U_{t+1} + \underbrace{\beta\rho * 0}_{\text{exit from labour force}} \tag{2.72}$$

Value of a temporary contract for the worker:

$$\begin{aligned}W^T =& w^T_t + E_t\left[\beta(1-\rho-s)W^T_{t+1}\right]\\ &+ E_t\left[\beta(1-\rho-s)\lambda(\bar{\alpha}_t + (1-\bar{\alpha}_t)(\phi_{t+1}(1-\gamma)+\gamma))\left(W^P_{t+1} - W^T_{t+1}\right) + \beta sU_{t+1}\right]\end{aligned} \tag{2.73}$$

Value of a permanent contract for the worker:

$$W_t^P = w_t^P + E_t\left[\beta(1-\rho-s)W_{t+1}^P + \beta s U_{t+1} + \beta\rho 0\right] \tag{2.74}$$

The surplus of an employment relationship under each type of contract is given by:

$$S_t^T = J_t^T - V_t + W_t^T - U_t + F^T \tag{2.75}$$

$$S_t^P = J_t^P - V_t + W_t^P - U_t + F \tag{2.76}$$

And the Nash bargaining functions are given by:

$$(1-\eta)\left(W_t^T - U_t\right) = \eta\left(J_t^T - V_t + F^T\right) \Leftrightarrow (J^T + F^T) = (1-\eta)S_t^T \tag{2.77}$$

$$(1-\eta)\left(W_t^P - U_t\right) = \eta\left(J_t^P - V_t + F\right) \Leftrightarrow (J^P + F) = (1-\eta)S_t^P \tag{2.78}$$

While the expression for the surplus of a permanent job is unchanged from the baseline model, for a temporary contract this is given by:

$$S_t^T = y_t^T - w_t^T + E_t\left[(1-\rho-s)\beta J_{t+1}^T - \beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T - \beta s F^T\right]$$

$$+ E_t\left[\beta(1-\rho-s)(J_{t+1}^P - J_{t+1}^T)(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)\right]$$

$$-\left[-c+q(\theta_t)\beta\left[(1-\rho-s)\underbrace{J_{t+1}^T}_{(1-\eta)S_{t+1}^T-F^T} - sF^T\right]\right]$$

$$+ w_t^T + E_t\left[\beta(1-\rho-s)W_{t+1}^T + \beta(1-\rho-s)\lambda\bar{\alpha}_t\left(W_{t+1}^P - W_{t+1}^T\right)\right]$$

$$+ E_t\left[\beta(1-\rho-s)\lambda(1-\bar{\alpha}_t)(\phi_{t+1}(1-\gamma)+\gamma)\left(W_{t+1}^P - W_{t+1}^T\right) + \beta s U_{t+1}\right]$$

$$- E_t(b+\beta q(\theta_t)\theta_t(1-\rho-s)\underbrace{(W_{t+1}^T - U_{t+1})}_{\eta S_{t+1}^T} + \beta(1-\rho)U_{t+1}) + F^T \Leftrightarrow \tag{2.79}$$

$$S_t^T = y_t^T + E_t\left[\beta(1-\rho-s)(J_{t+1}^P + W_{t+1}^P - (J_{t+1}^T + W_{t+1}^T))(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)+\lambda\bar{\alpha}_t)\right]$$

$$+ c - b - E_t\left[\beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T + (1-\rho-s)\beta\left(J_{t+1}^T + W_{t+1}^T - U_{t+1}^T\right)\right]$$

$$- E_t\left[\beta q(\theta_t)\theta_t(1-\rho-s)(\eta S_{t+1}^T) + \beta q(\theta_t)(1-\rho-s)\left[(1-\eta)S_{t+1}^T - F^T\right] - F^T(1+q(\theta_t)\beta s - s\beta)\right]$$

Note that:

$$E_t\left[J_{t+1}^P + W_{t+1}^P - (J_{t+1}^T + W_{t+1}^T)\right] = E_t\left[J_{t+1}^P + W_{t+1}^P - U_{t+1} - V_{t+1} - (J_{t+1}^T + W_{t+1}^T - U_{t+1} - V_{t+1})\right]$$

$$= E_t\left[(S_{t+1}^P - F) - (S_{t+1}^T - F^T)\right]$$

$$S_t^T = y_t^T + E_t\left[\beta(1-\rho-s)(S_{t+1}^P - S_{t+1}^T - (F - F^T))(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right]$$

$$+ c - b - E_t\left[\beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T + (1-\rho-s)\beta\left(S_{t+1}^T - F^T\right)\right]$$

$$- E_t\left[\beta q(\theta_t)\theta_t(1-\rho-s)(\eta S_{t+1}^T) + \beta q(\theta_t)(1-\rho-s)\left[(1-\eta)S_{t+1}^T - F^T\right] - F^T(1 - s\beta(1-q(\theta_t)))\right]$$

$$S_t^T = y_t^T + E_t\left[\beta(1-\rho-s)(S_{t+1}^P - S_{t+1}^T)(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t) + (1-\rho-s)\beta S_{t+1}^T\right]$$

$$- E_t\left[\beta(1-\rho-s)(F - F^T)(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right] + c - b$$

$$+ E_t\left[\beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T\right]$$

$$- E_t\left[\beta q(\theta_t)(1-\rho-s)((1-\eta)+\eta\theta_t)(S_{t+1}^T) - F^T(1-(1-\rho)\beta(1-q(\theta_t)))\right] \tag{2.80}$$

Identically, the expression for the permanent contract wage is unchanged, while the expression for the temporary contract is given by:

$$
\begin{aligned}
&(J_t^T + F^T) = (1-\eta)S_t^T \\
&= (1-\eta)y_t^T + (1-\eta)E_t\left[\beta(1-\rho-s)(S_{t+1}^P - S_{t+1}^T)(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right] \\
&+ E_t\left[(1-\rho-s)\beta S_{t+1}^T - (1-\eta)\beta(1-\rho-s)(F-F^T)(\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right] \\
&- (1-\eta)E_t\left[\beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T\right] + (1-\eta)c - (1-\eta)b \\
&- (1-\eta)E_t\left[\beta q(\theta_t)(1-\rho-s)((1-\eta)+\eta\theta_t)(S_{t+1}^T) - F^T(1-(1-\rho)\beta(1-q(\theta_t)))\right]
\end{aligned} \tag{2.81}
$$

The expression for the value of a temporary job can be written as:

$$
\begin{aligned}
J_t^T =& y_t^T - w_t^T + E_t\left[(1-\rho-s)\beta((1-\eta)S_{t+1}^T - F^T)\right] \\
&- E_t\left[\beta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T + \beta s F^T\right] \\
&+ E_t\left[\beta(1-\rho-s)\left[(1-\eta)(S_{t+1}^P - S_{t+1}^T) - (F-F^T)\right](\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t) + \lambda\bar{\alpha}_t)\right]
\end{aligned} \tag{2.82}
$$

Equating conditions (2.81) and (2.82) yields the expression for the temporary contract wage:

$$
\begin{aligned}
&w_t^T = \eta y_t^T + (1-\eta)b + \eta c\theta_t - E_t\left[\eta(1-\rho-s)\beta\lambda(\bar{\alpha}_t + (1-\bar{\alpha}_t)(\phi_{t+1}(1-\gamma)+\gamma))(F-F^T)\right] \\
&+ E_t\left[\eta F^T(1-\beta(1-\rho)) - \eta(1-\rho-s)\lambda(\phi_{t+1}(1-\gamma)+\gamma)(1-\bar{\alpha}_t)T + \eta\theta_t q(\theta_t)\beta(1-\rho)F^T\right]
\end{aligned}
$$

(2.83)

Finally, the value of production in the economy is given by overall output minus training and firing costs:

$$y_t = y_t^P e_t^P + y_t^T e_t^T - (\phi_t(1-\gamma)+\gamma)e_{t-1}^{TU}\lambda(1-\rho-s)T - se_{t-1}^P F - s(e_{t-1}^T + q(\theta_{t-1})v_{t-1})F \tag{2.84}$$

Figure 2.2: Steady-State response to a permanent productivity shock in open-ended contracts

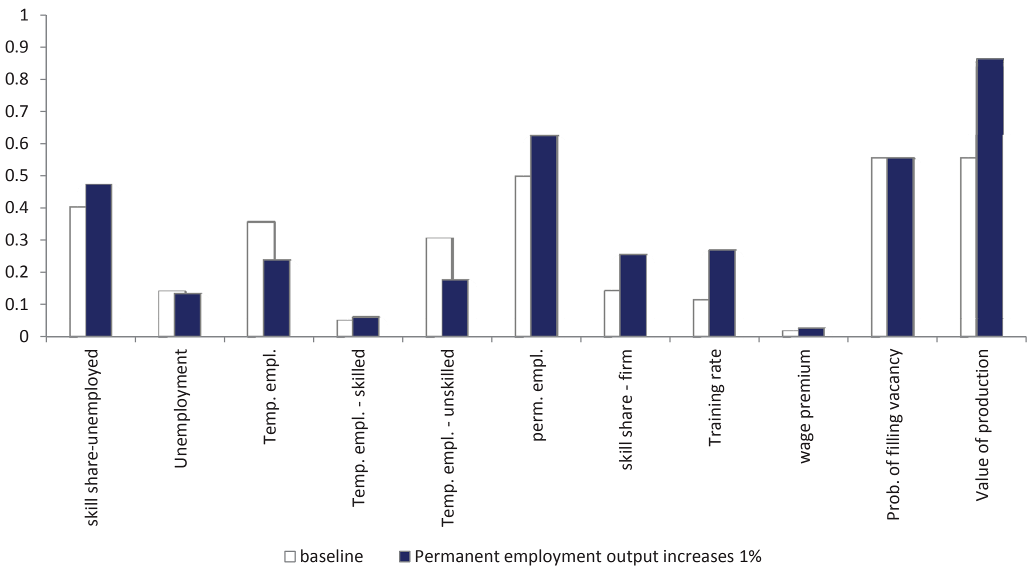


Figure 2.3: Transitional dynamics - productivity shock in open-ended contracts

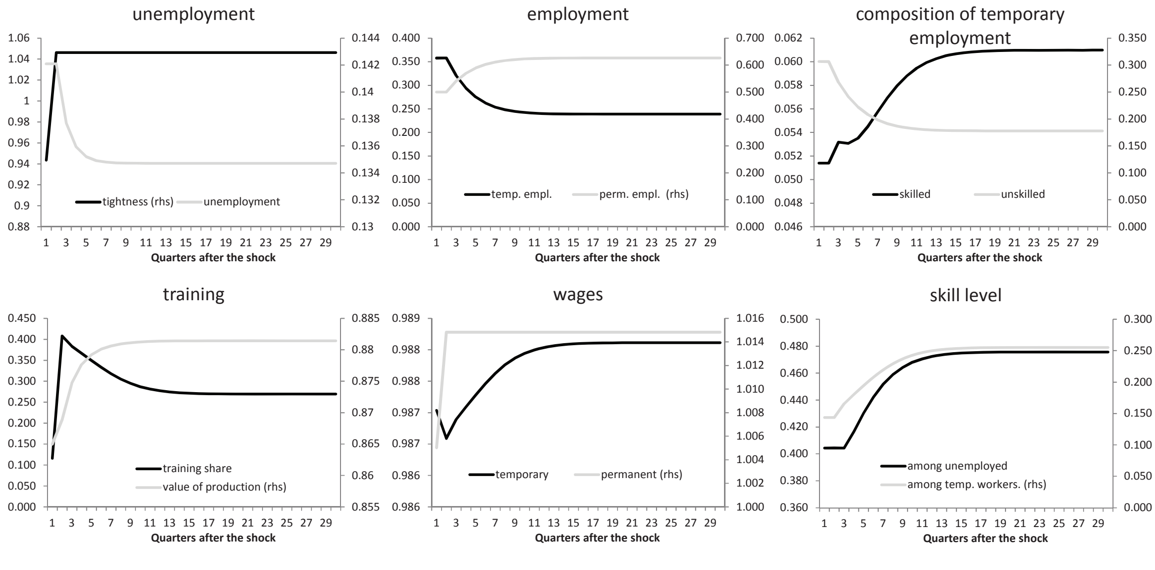


Figure 2.4: Steady-State response to a permanent productivity shock in both types of employment

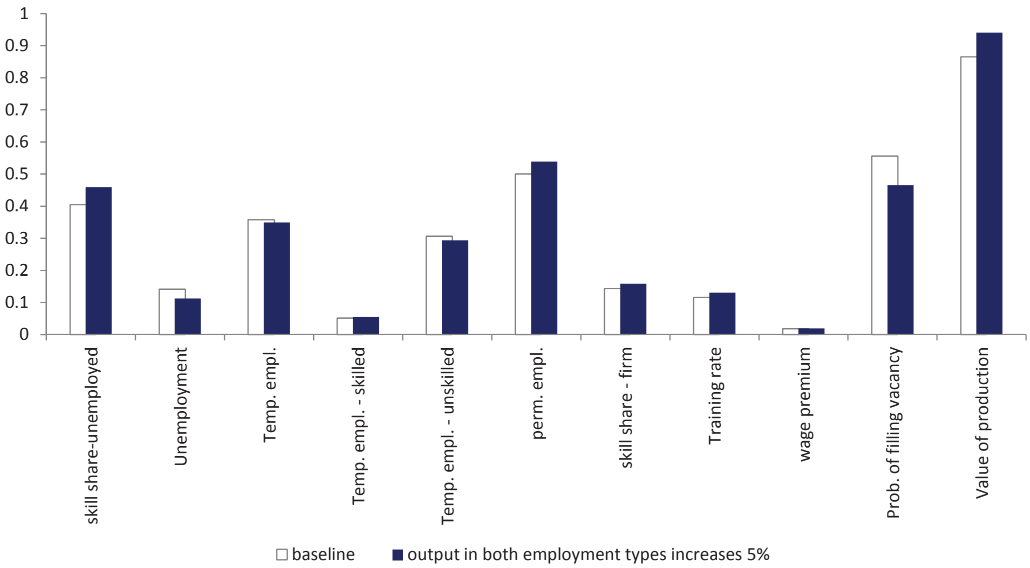


Figure 2.5: Transitional dynamics - overall productivity shock

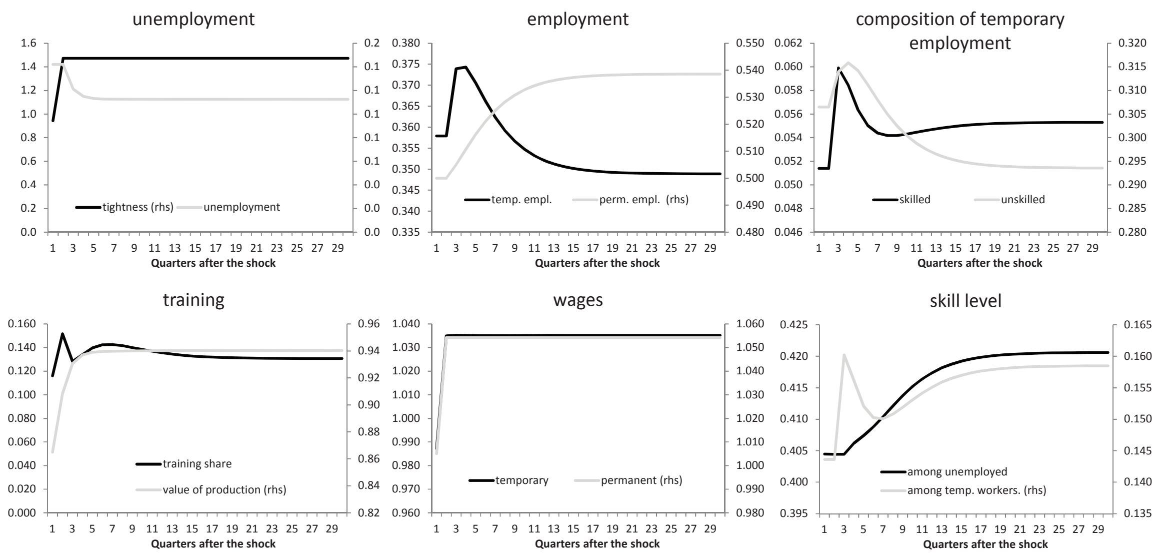


Figure 2.6: Steady-State response to a permanent training cost shock

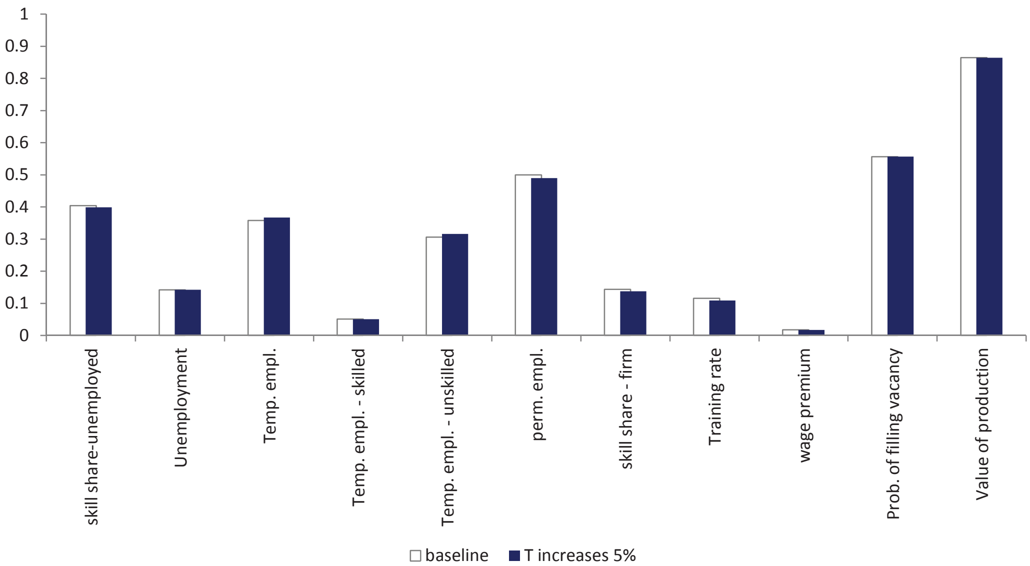


Figure 2.7: Transitional dynamics - Training cost shock

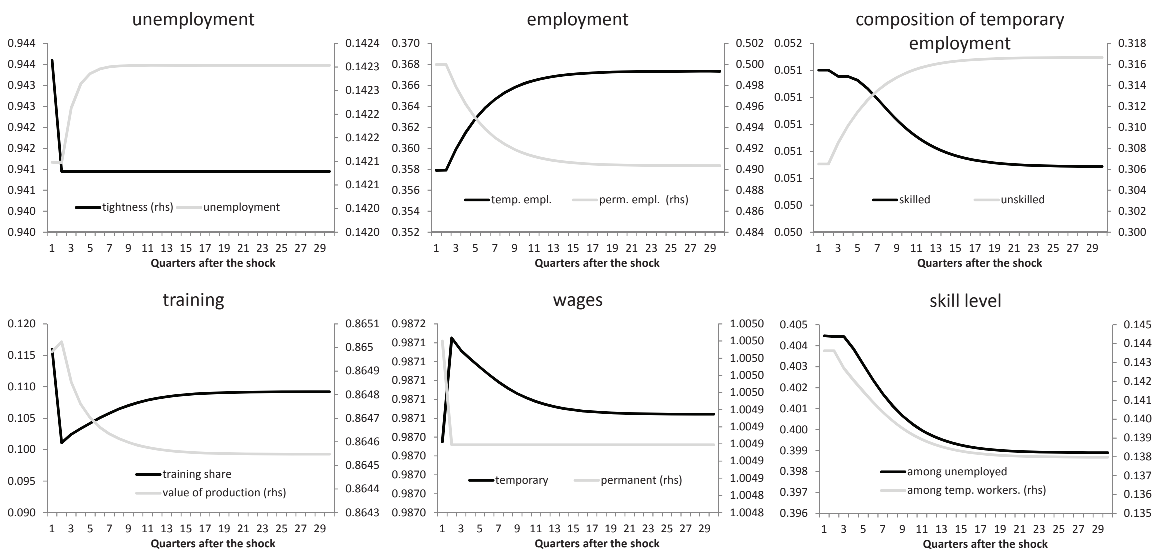


Figure 2.8: Steady-State response to a shock in the initial level of skill

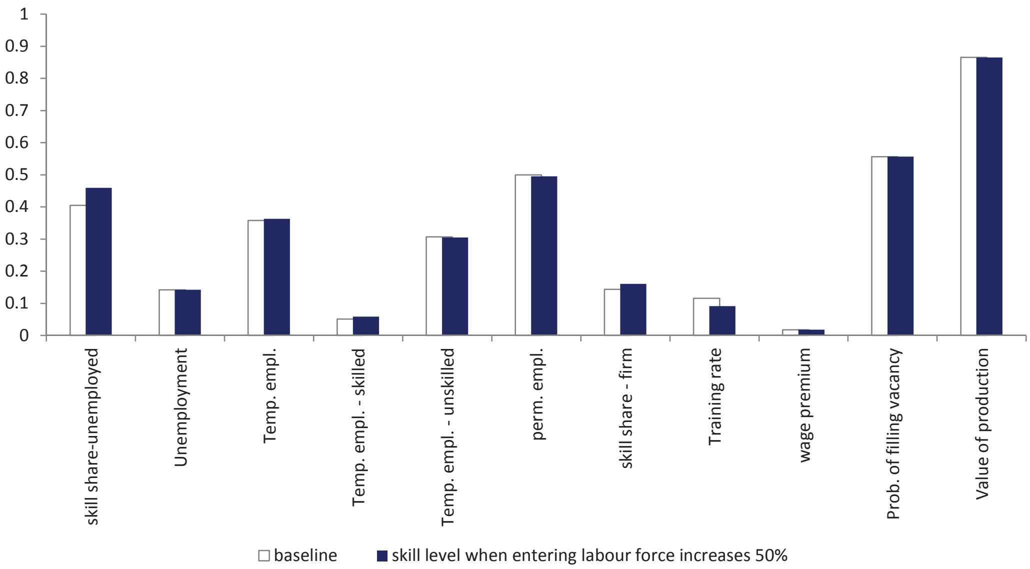


Figure 2.9: Transitional dynamics - Initial skill level shock

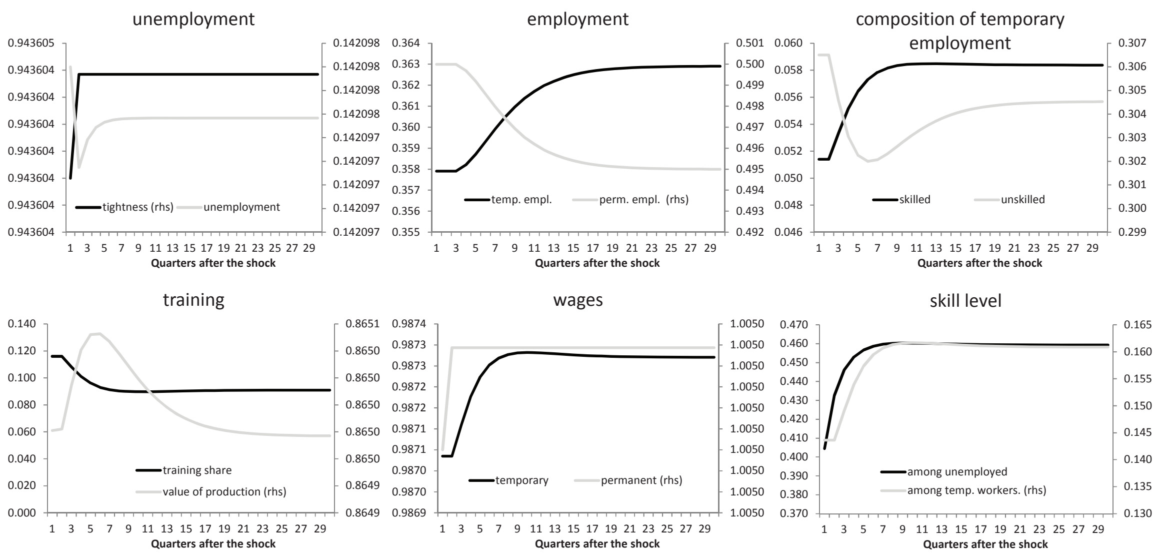


Figure 2.10: Steady-State response to a permanent shock on firing costs of open-ended contracts

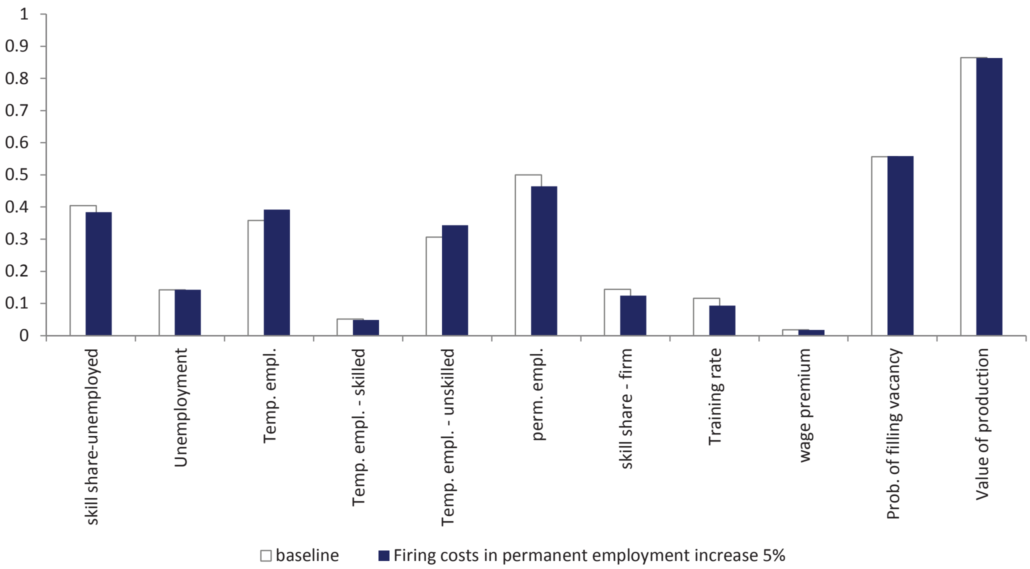


Figure 2.11: Transitional dynamics - permanent contracts' firing costs shock

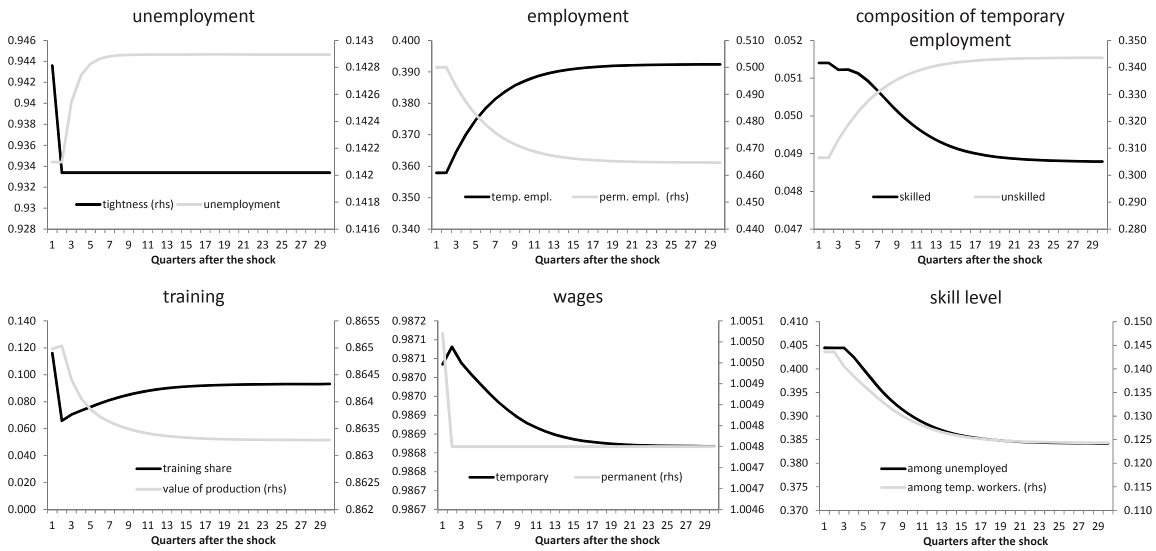


Figure 2.12: Steady-State response to a permanent shock on firing costs of temporary contracts

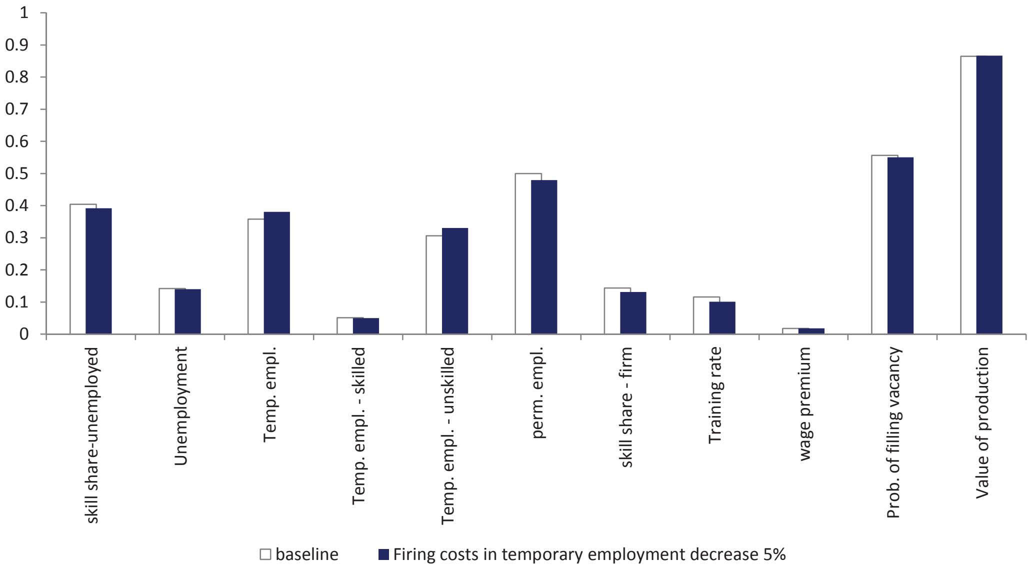


Figure 2.13: Transitional dynamics - temporary contracts' firing costs shock

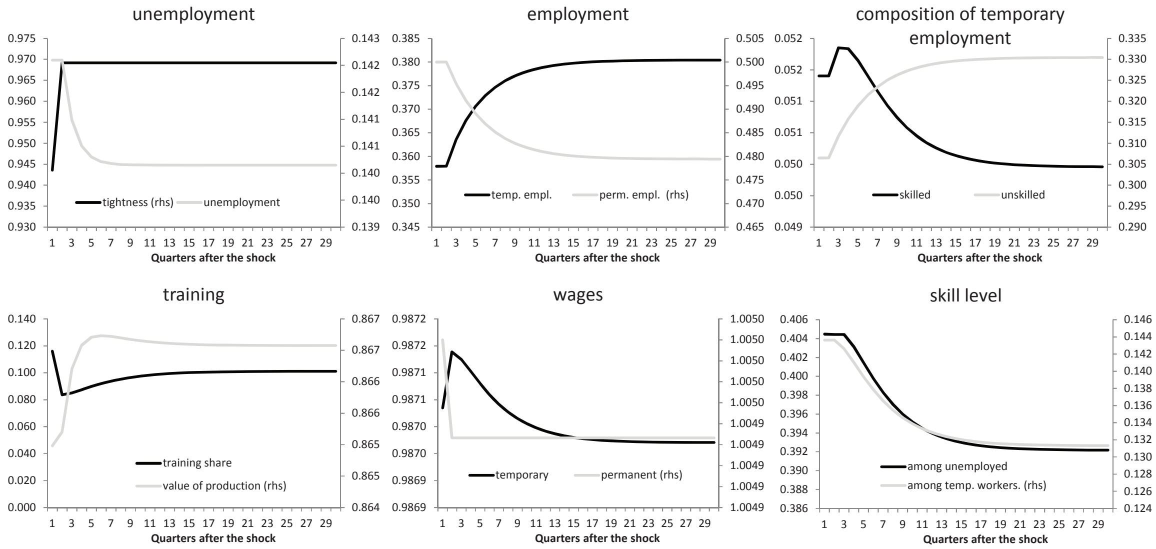


Figure 2.14: Steady-State response to a permanent shock in both types of firing costs

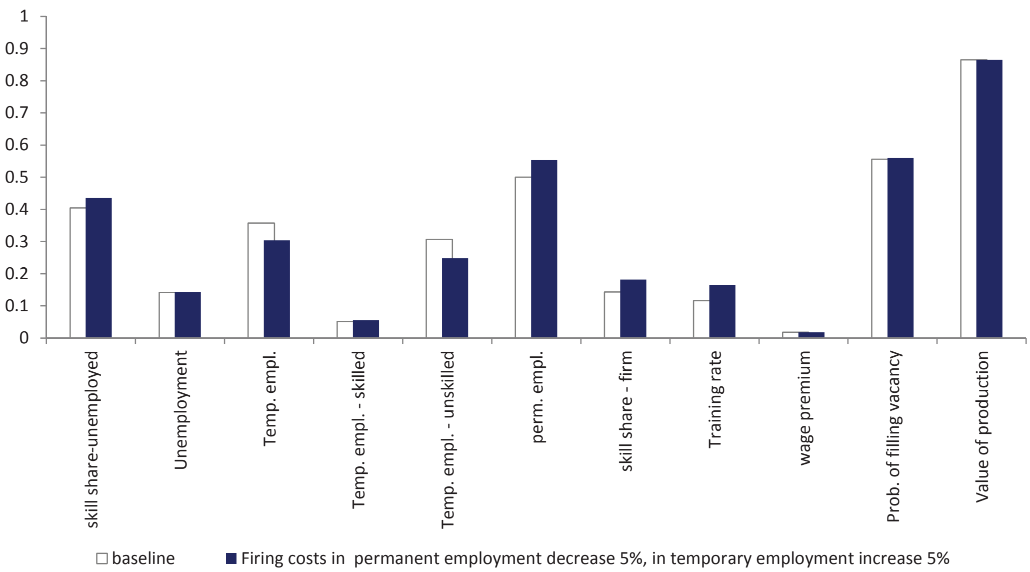


Figure 2.15: Transitional dynamics - shock on firing costs of both types of contracts

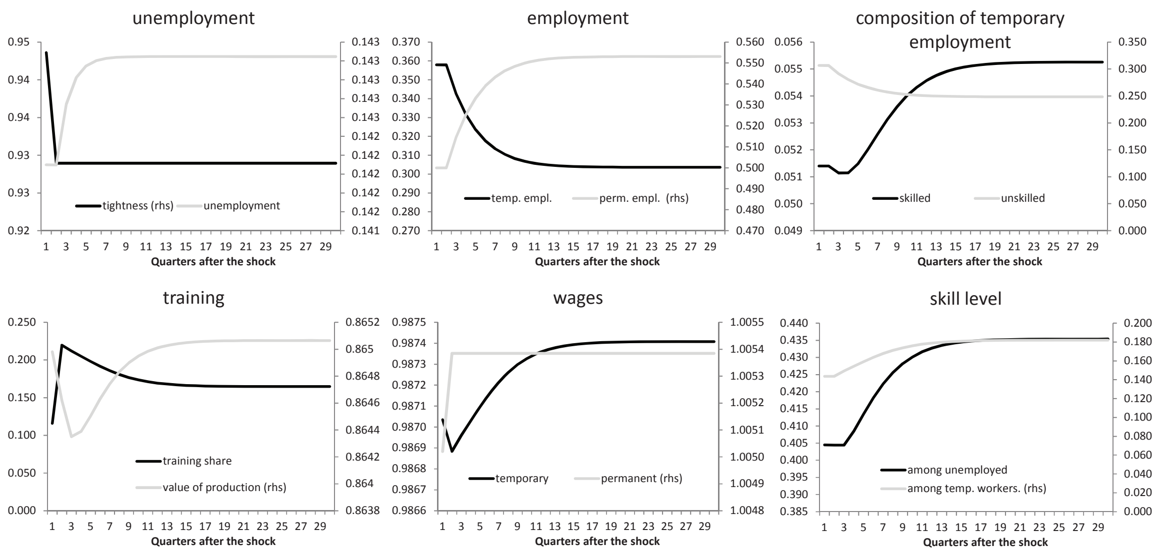


Figure 2.16: Tradeoff between training costs and length of a temporary contract for $\phi = 1$

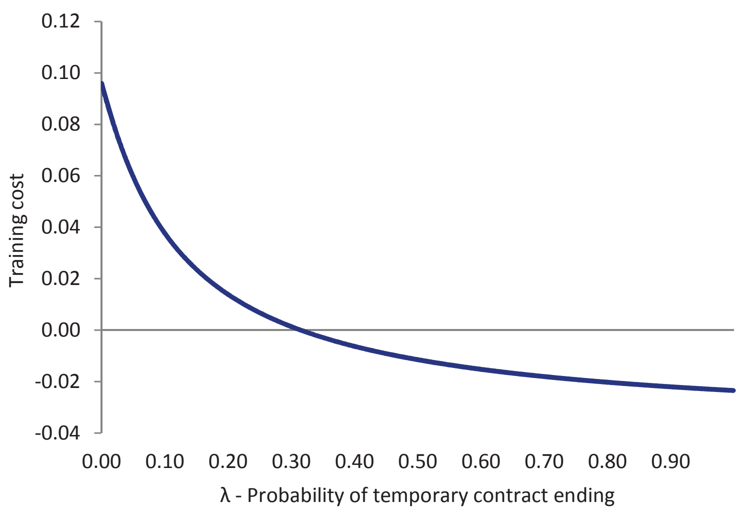


Figure 2.17: Tradeoff between training costs and firing costs in permanent contracts for $\phi = 1$

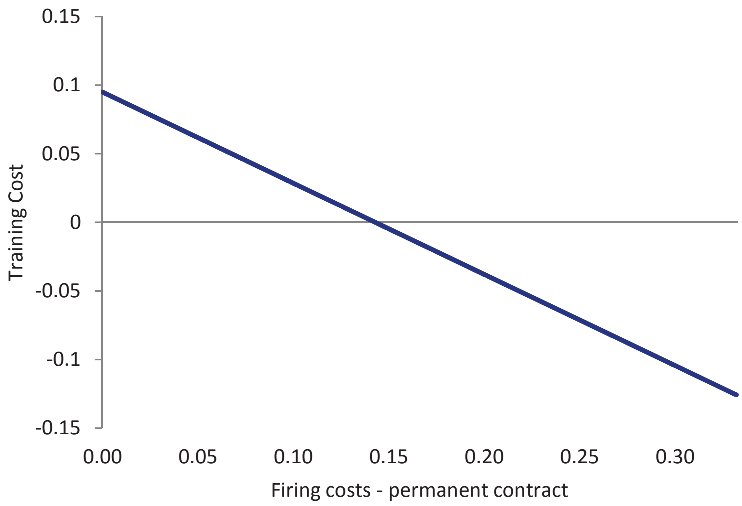
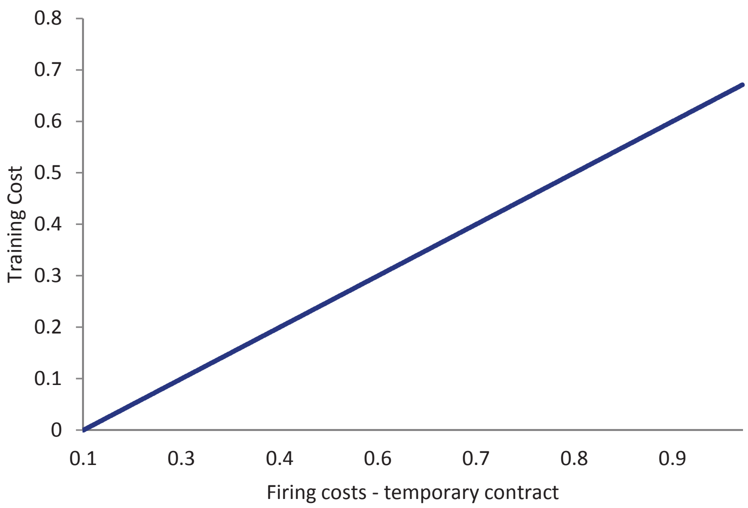


Figure 2.18: Tradeoff between training costs and firing costs in temporary contracts for $\phi = 1$



2..6 Steady-state of the model with unlimited temporary contract renewals

Resource constraint

$$y = y^P e^P + y^T e^T - \lambda(1-\rho-s)\phi e^{TU} T - s e^P F - s(e^T + q(\theta)v)F^T - cv$$

Matching function

$$m(s,v) = m s^{\mu} v^{1-\mu}$$

Transition probabilities

$$\frac{m(s,v)}{v} = q(\theta)$$

$$\frac{m(s,v)}{s} = q(\theta)\theta$$

Labour market tightness

$$\theta = \frac{v}{u}$$

Overall Employment

$$e = e^P + e^{TS} + e^{TU}$$

Permanent Employment

$$e^P = (1 - s - \rho)e^P + (1 - s - \rho)\lambda\left[e^{TS} + e^{TU}\phi\right];$$

Temporary skilled employment

$$e^{TS} = (1 - \rho - s)(e^{TS} + \theta q(\theta)u^s) - \lambda(1 - \rho - s)e^{TS};$$

Temporary unskilled employment

$$e^{TU} = (1 - s - \rho)(e^{TU} + \theta q(\theta)(u - u^s)) - \lambda\phi(1 - \rho - s)e^{TU};$$

Unemployment

$$u = 1 - e^P - e^T = u^s + u^u$$

Skilled workers

$$skill = (1 - \rho)skill + (1 - \rho - s)\lambda e^{TU}\phi + \rho\delta = e^P + e^{TS} + u^s$$

Share of skilled workers on temporary employment

$$\bar{\alpha} = \frac{e^{TS}}{e^{T}}$$

Vacancy posting condition

$$c = q(\theta)\left[\beta\left((1-\rho-s)J^{T} - sF^{T}\right)\right]$$

Value of a permanent contract to a firm

$$J^{P} = y^{P} - w^{P} + \left[(1-\rho-s)\beta J^{P} - \beta sF\right] = 0$$

Value of a temporary contract to a firm

$$J_t^{T} = y^{T} - w^{T} + \left[(1-\rho-s)\beta J^{T} + \beta(1-\rho-s)\lambda\bar{\alpha}T - \beta sF^{T}\right]$$

Permanent contract wage rate

$$w^{P} = \eta y^{P} + b(1-\eta) + c\eta\theta + \eta(1-(1-\rho)\beta)F + \eta(q(\theta)\theta\beta(1-\rho)F^{T})$$

Temporary contract wage rate

$$w^{T} = \eta y^{T} + (1-\eta)b + \eta c\theta - \left[\eta(1-\rho-s)\beta\lambda(\bar{\alpha} + (1-\bar{\alpha})\phi)(F - F^{T})\right]$$

$$+ \left[\eta F^{T}(1-\beta(1-\rho)) - \eta(1-\rho-s)\lambda\phi(1-\bar{\alpha}_t)T + \eta\theta_t q(\theta_t)\beta(1-\rho)F^{T}\right]$$

Bibliography

Acemoglu, D. and Angrist, J. (2001), How Large are Human-Capital Externalities? Evidence from Compulsory-Schooling Laws, *in* 'NBER Macroeconomics Annual 2000, Volume 15', NBER Chapters, National Bureau of Economic Research, Inc, pp. 9–74.

Albert, C., García-Serrano, C. and Hernanz, V. (2004), 'Firm-provided training and temporary contracts', *Spanish Economic Review, Springer* **7**(1), 67–88.

Andrés et al. (2009), 'Propuesta para la reactivación laboral en España', *El País, 26 April* . ("A Proposal to Restart the Spanish Labor Market", crisis09.es/PDF/restart-the-labor-market.pdf).

Arulampalam, W., Booth, A. L. and Bryan, M. L. (2004), 'Training in Europe', *Journal of the European Economic Association, MIT Press* **2**(2-3), 346–360.

Bassanini, A. and Marianna, P. (2009), Looking Inside the Perpetual-Motion Machine: Job and Worker Flows in OECD Countries, Technical report.

Belot, M., Boone, J. and Ours, J. V. (2007), 'Welfare-improving employment protection', *Economica* **74**(295), 381–396.

Bentolila, S., Dolado, J. J. and Jimeno, J. F. (2008), 'Two-tier Employment Protection Reforms: The Spanish Experience', *CESifo DICE Report, Ifo Institute for Economic Research at the University of Munich* **6**(4), 49–56.

Bentolila, S., Dolado, J. J. and Jimeno, J. F. (2011), Reforming an Insider-Outsider Labor Market: The Spanish Experience, CEPR Discussion Papers, C.E.P.R. Discussion Papers 8691, C.E.P.R. Discussion Papers.

Blanchard, O. J. and Tirole, J. (2003), *Contours of employment protection reform*, Massachusetts Institute of Technology, Department of Economics.

Blanchard, O. and Landier, A. (2002), 'The Perverse Effects of Partial Labour Market Reform: fixed–Term Contracts in France', *Economic Journal, Royal Economic Society* **112**(480), F214–F244.

Boeri, T. (2011), *Institutional Reforms and Dualism in European Labor Markets*, Vol. 4 of *Handbook of Labor Economics*, Elsevier, chapter 13, pp. 1173–1236.

Boeri, T. and Garibaldi, P. (2007), 'Two Tier Reforms of Employment Protection: a Honeymoon Effect?', *Economic Journal, Royal Economic Society* **117**(521), 357–385.

Boeri, T., Garibaldi, P. and Moen, E. R. (2013), The Economics of Severance Pay, IZA Discussion Papers 7455, Institute for the Study of Labor (IZA).

Cahuc, P. (2012), 'For a Unified Contract', *European Labour Law Journal, Intersentia* **3**(3), 191–207.

Cahuc, P., Charlot, O. and Malherbet, F. (2012), Explaining the Spread of Temporary Jobs and its Impact on Labor Turnover, CEPR Discussion Papers, C.E.P.R. Discussion Papers 8864, C.E.P.R. Discussion Papers.

Cahuc, P. and Postel-Vinay, F. (2002), 'Temporary jobs, employment protection and labor market performance', *Labour Economics, Elsevier* **9**(1), 63–91.

Cao, S., Shao, E. and Silos, P. (2011), Fixed-Term and Permanent Employment Contracts: Theory and Evidence, Working Papers, Bank of Canada 11-21, Bank of Canada.

CEDEFOP (2010), *Employer provided vocational training in Europe. Evaluation and interpretation of the third continuing vocational training survey*, number 2, Publications Office of the European Union.

Centeno, M. and Novo, Á. A. (2012), 'Excess worker turnover and fixed-term contracts: Causal evidence in a two-tier system', *Labour Economics, Elsevier* **19**(3), 320–328.

Costain, J., Jimeno, J. F. and Thomas, C. (2010), Employment fluctuations in a dual labor market, Banco de España Working Papers 1013, Banco de España.

Dolado, J., García-Serrano, C. and Jimeno, J. (2002), 'Drawing lessons from the boom of temporary jobs in spain', *The Economic Journal* **112**(480), F270–F295.

Dolado, J. J., Jansen, M. and Jimeno, J. F. (2005), Dual Employment Protection Legislation: A Framework for Analysis, CEPR Discussion Papers, C.E.P.R. Discussion Papers 5033, C.E.P.R. Discussion Papers.

Dolado, J. J. and Stucchi, R. (2008), Do Temprary Contracts Affect TFP? Evidence from Spanish Manufacturing Firms, CEPR Discussion Papers, C.E.P.R. Discussion Papers 7055, C.E.P.R. Discussion Papers.

European Commission (2004), *Employment in Europe 2004*, Luxembourg: Publications Office of the European Union.

European Commission (2005), *Employment in Europe 2005*, Luxembourg: Publications Office of the European Union.

European Commission (2010), *Employment in Europe 2010*, Luxembourg: Publications Office of the European Union.

European Commission – DG ECFIN (2010), 'Labour market and wage developments in 2009', *European Economy* (5/2010). Luxembourg: Publications Office of the European Union.

Faccini, R. (2014), ‘Reassessing Labour Market Reforms: Temporary Contracts as a Screening Device’, *The Economic Journal, Royal Economic Society* **124**(575), 167–200.

García Serrano, C. (1998), ‘Worker Turnover and Job Reallocation: The Role of Fixed-Term Contracts’, *Oxford Economic Papers, Oxford University Press* **50**(4), 709–725.

García-Serrano, C. and Jimeno, J. F. (1999), Labour Reallocation, Labour Flaws and Labour Market Institutions: Evidence from Spain, CEP Discussion Papers dp0414, Centre for Economic Performance, LSE.

Guell, M. and Petrongolo, B. (2007), ‘How binding are legal limits? Transitions from temporary to permanent work in Spain’, *Labour Economics, Elsevier* **14**(2), 153–183.

Kahn, L. M. (2010), ‘Employment protection reforms, employment and the incidence of temporary jobs in Europe: 1996-2001’, *Labour Economics, Elsevier* **17**(1), 1–15.

Kilponen, J. and Vanhala, J. (2009), Productivity and job flows: heterogeneity of new hires and continuing jobs in the business cycle, Working Paper Series, European Central Bank 1080, European Central Bank.

Krause, M. U. and Lubik, T. A. (2007), ‘The (ir)relevance of real wage rigidity in the New Keynesian model with search frictions’, *Journal of Monetary Economics, Elsevier* **54**(3), 706–727.

Lamo, A., Messina, J. and Wasmer, E. (2011), ‘Are specific skills an obstacle to labor market adjustment?’, *Labour Economics, Elsevier* **18**(2), 240–256.

Lazear, E. P. (1990), ‘Job Security Provisions and Employment’, *The Quarterly Journal of Economics, MIT Press* **105**(3), 699–726.

Mortensen, D. T. and Pissarides, C. A. (1994), ‘Job Creation and Job Destruction in the Theory of Unemployment’, *Review of Economic Studies, Oxford University Press* **61**(3), 397–415.

OECD (1993), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (1998), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2001), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2002), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2003), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2004), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2008), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2010), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2013), 'OECD EPL Database, update 2013', `http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm`.

Portugal, P. and Varejão, J. (2010), The hidden side of temporary employment: fixed-term contracts as a screening device, Working Papers 29-2010, Banco de Portugal, Economics and Research Department.

Prat, J. (2010), ‘The rate of learning-by-doing: estimates from a search-matching model’, *Journal of Applied Econometrics, John Wiley & Sons, Ltd.* **25**(6), 929–962.

Sala, H., Silva, J. I. and Toledo, M. (2012), ‘Flexibility at the Margin and Labor Market Volatility in OECD Countries’, *Scandinavian Journal of Economics, Wiley Blackwell* **114**(3), 991–1017.

Shintoyo, N. (2008), ‘Creation of jobs and firm-sponsored training in a matching model of unemployment’, *Journal of Economics, Springer* **93**(2), 145–176.

Silva, J. I. and Toledo, M. (2009), ‘Labor Turnover Costs And The Cyclical Behavior Of Vacancies And Unemployment’, *Macroeconomic Dynamics, Cambridge University Press* **13**(S1), 76–96.

Tealdi, C. (2011), How do employment contract reforms affect welfare? Theory and evidence, MPRA Paper 33573, University Library of Munich, Germany.

Trigari, A. (2009), ‘Equilibrium Unemployment, Job Flows, and Inflation Dynamics’, *Journal of Money, Credit and Banking, Blackwell Publishing* **41**(1), 1–33.

Wasmer, E. (2006), ‘General versus Specific Skills in Labor Markets with Search Frictions and Firing Costs’, *American Economic Review, American Economic Association* **96**(3), 811–831.

Wesselbaum, D. (2009), Firing Costs in a New Keynesian Model with Endogenous Separations, Kiel Working Papers 1550, Kiel Institute for the World Economy.

Chapter 3

Temporary contracts' transitions: the role of training and institutions

Abstract

Despite recent reforms, labour market segmentation is still a marked feature of several European countries. This work empirically analyses transitions out of temporary contracts, by means of a discrete duration model, with a particular focus on human capital features, labour market protection and their interaction. Transitions to open-ended contracts with the same or with a new employer are considered separately, as well as transitions to joblessness, based on data for ten European countries taken from the European Community Household Panel. Conclusions suggest that firm training policies are more relevant for intra-firm transitions, while worker characteristics are more determinant for inter-firm transitions. Labour market regulation plays a significant role in what concerns transitions to open-ended contracts, but not to joblessness, particularly in strongly segmented labour markets. In countries characterized by this type of labour market institutions, human capital features assume an increased relevance, and firm provided training may reduce the influence of the strictness of labour market regulations on the conversion of temporary contracts into open-ended.

JEL Classification: E24, J24, J41.

Keywords: Labour market institutions; work-related training; fixed-term contracts.

3.1 Introduction

This study analyses the determinants of labour market transitions for temporary contracts, with a particular emphasis on the role of human capital features and its potential interaction with labour market institutions, an issue which has not been much explored in the literature on labour market transitions. In a complementary analysis, the career dynamics of temporary workers is also investigated.

A large part of the literature on transitions from temporary to permanent jobs has focused on the ability of the former to serve as career stepping stones, particularly in segmented labour markets, characterized by large differences in employment protection for these two types of contracts. These studies include, among others, Portugal and Varejão (2009), Alba-Ramirez (1998), Amuedo-Dorantes (2000) , D'Addio and Rosholm (2005) and Booth, Francesconi and Frank (2002), which focus in general on firm and worker characteristics that favour the conversion of a temporary contract into permanent. Results on the role of temporary contracts are mixed, given that Portugal and Varejão (2009) and Booth et al. (2002) find, based on data for the Portuguese and British economy, respectively, some evidence that temporary jobs are to a large extent used for screening workers into permanent positions, while other studies, which focus on the Spanish economy, conclude that temporary contracts exhibit some characteristics of a trap. D'Addio and Rosholm (2005) find, for the European Union (EU) as a whole, that temporary jobs can be dead-ends, in particular for workers which are older and experienced non-employment previously.

Other studies have focused on the impact of labour market institutions on transitions. For example, Kahn (2010) finds some evidence that liberalizing permanent contracts increased transitions from temporary to permanent contracts in some European countries, while employment protection legislation (EPL) reforms on temporary contracts gave rise to more mixed results. There is a vast literature on the impact of EPL on job and worker turnover and, to a smaller extent, labour reallocation. OECD (1996) and OECD (1999) conclude that stricter EPL on regular contracts has little impact on job turnover but a negative impact on worker turnover. EPL on temporary contracts, on the other hand, has a negative impact on job turnover, given that it affects hiring decisions. In countries with dual labour markets, excess worker turnover (much above job turnover) tends to be concentrated in fixed-term contracts, generating excessive churning among temporary workers (Centeno and Novo (2012)) and on the other hand reduced job-to-job mobility among permanent workers, limiting job reallocation (Gielen and Tatsiramos (2012) and Orsini and Vila Nuñez (2014) among others). Orsini and Vila Nuñez (2014) argue that the recent reforms implemented in Spain placing a cap on severance payments for some open-ended contracts increased on-the job search for workers in permanent jobs, which is relatively low by European standards (as in other countries with strict EPL).

Both of these aspects of the impact of labour market segmentation with low protection of temporary contracts (excessive churning on temporary contracts and reduced job-to-job mobility on permanent ones) can have detrimental consequences for the economy. On the one hand, it may imply that temporary workers receive less training, which can have longer term impacts in terms of the skill level of the economy and output (see Chapter (2)). On the other hand, lack of job mobility among permanent contracts may limit job creation and the reallocation of resources in the economy (Orsini and Vila Nuñez (2014)).

Although the positive influence of education on transitions from temporary to permanent jobs is found in several studies, like Alba-Ramirez (1998), Amuedo-Dorantes (2000) and Booth et al. (2002), the connection between training decisions and transitions is less explored in the literature. In fact, Portugal and Varejão (2009) find that promotion of temporary contracts to open-ended tends to happen more often in firms which invest more in training, although these firms are less likely than other to hire temporary workers. However, these workers do not necessarily receive training, at least while they have temporary status (Albert et al. (2004) and Bassanini et al. (2005)). Melero (2004) finds that training has a positive effect on promotions for women and no effect on quits, concluding that training has an *ex-post* role, in the sense that promotion takes place after the accumulation of human capital, and not before (as an incentive to that acquisition). Additionally, Fitzenberger et al. (2010) conclude that training programmes have positive impacts on the transitions from unemployment to employment.

Even less explored in the literature is the interaction between labour market institutions, namely EPL, and training decisions. A dual labour market implies high turnover among temporary workers, which discourages training, not only because it increases the potential for a "poaching" externality, but because firms can simply look for workers which have the skills required.[1] Bassanini et al. (2005) concluded that an increase in the strictness of labour market regulation, evaluated on the basis of the Organisation for Economic Co-operation and Development (OECD) EPL indicators, is found to have a negative impact on training incidence. Therefore, for workers for which training actually takes place in a highly regulated labour market, it provides a much stronger signalling impact about the ability of that worker, given that higher ability workers are likely to self-select into training firms (Autor (2001)).

The analysis in the current work is disaggregated into transitions within the same firm (intra-firm transitions) and with another firm (inter-firm transitions). This feature is to my knowledge not yet present in the literature. In fact, most studies focus on all types of transitions to permanent employment not distinguishing employer type (Alba-Ramirez (1998), Amuedo-Dorantes (2000) and Booth et al. (2002)). In the case of Melero (2004), transitions to a better job both with the same

[1] Because all training is to some extent general and to some extent specific and so partially transferable to other firms, potential benefits from training accrue not only to the firm providing it and to the worker acquiring it, but also to other firms that can potentially hire the worker latter on. This constitutes the "poaching" externality (European Commission (2008)).

and with a new employer are analysed separately, but the definition of "better job" is subjective to the workers in the sample and therefore not necessarily connected to the nature of the contractual relationships involved. Sicherman and Galor (1990) makes the distinction between intra and inter-firm transitions, but focuses on occupational, not contractual changes.

In addition, there is some literature on job-to-job changes. For example, Gielen and Tatsiramos (2012) analyse the behaviour of job-to-job transitions due to quits in both temporary and permanent contracts and its interaction with EPL levels. They find that job satisfaction has a relevant role in the decision to quit a job, but not in countries with strict EPL, a fact which is associated with higher mobility costs in this context. These analyses however do not take into account the specific nature of inter-firm transitions from temporary to permanent contracts, given that the reasons to quit a job may be substantially different for temporary and permanent workers. In the case of temporary workers this movement may result from the expectation of contract non-renewal or non-conversion. In fact, according to the data used in this study, the reasons that lead to the end of a temporary and a permanent job are somewhat different, given that for the former the end of the contract assumes substantial relevance.

This distinction of transitions according to employer type is also motivated by the fact that the role of training may be different given the type of transition obtained. If training is more productive to high ability workers (Autor (2001)), it may be very relevant for obtaining a job by providing a signaling role to new employers. However, if firms believe that workers are unlikely to remain in the firm they will be more reluctant to invest in training. Reinforcing this effect, workers may show less commitment to employers who invest less in skills (OECD (1993)). This will be particularly so if the training provided is of general nature, which may lead the training firm to suffer from a "poaching" externality. These features may lead inter-firm transitions from temporary to permanent contracts to be favoured by training, but more by general training, while intra-firm transitions are more likely to benefit from firm-specific training. Melero (2004) finds that, in the case of imperfect information, general training should favour promotion less than vocational, because promotion will signal to other potential employers the productivity of that worker (which was private information of the firm before).

The results presented in this paper show that interactions between training and EPL influence transitions to permanent contracts, both with the same and with a different employer, albeit in slightly different ways. In fact, the nature of the human resources policy of the firm and the human capital level of the worker appear to affect results in a distinct way depending on the employer type. For transitions to a permanent job with the same employer, the nature of the firm appears to be the most relevant feature, while for inter-firm transitions, the characteristics of the worker seem to be more relevant. Moreover, being in a training firm insulates to some extent temporary workers from the impact of changes to labour market protection. In addition, the breakdown of results for two country groups shows that EPL affects transitions mainly for segmented labour markets.

Results also show that a sequence of temporary jobs reduces the hazard of transitions from temporary employment to any of the destination states considered. This conclusion is similar to the one obtained by Gagliarducci (2005) for the Italian economy, particulary for cases in which there are interruptions between temporary jobs. Furthermore, the higher the number of cumulative previous temporary jobs, the stronger is this effect, which suggests that the personal professional history of each worker may influence the likelihood of transition. The career of temporary workers prior to transition, namely the number and duration of temporary contracts held, is also investigated, in order to offer a complementary analysis to the previous results.

A sequence of temporary contracts can have positive or negative effects on human capital, summarized in Gagliarducci (2005). On the one hand it can create networking, but it may also lead to human capital depreciation, particularly if the jobs are very different or subject to interruptions. It can also provide mixing signals about a worker, indicating either the dynamism of a worker in search of the best job match or his lack of ability (otherwise the worker would have been hired on a permanent basis). It can also be the result of demand factors, in the sense that firms can use temporary employment as a buffer for short-run labour force needs.

The empirical literature on this topic, although relatively scarce, has found some evidence of negative occurrence and duration dependence in job-to-job movements. Booth, Francesconi and García-Serrano (1997) analyses job mobility and career paths in Britain for workers with both temporary and permanent contracts. Results point to occurrence dependence in the sense that the duration of each job increases as jobs accumulate. They also find that the recent personal history of job mobility (whether the previous job ended due to quit, layoff or other reasons) affects the duration of the job. Kahn (2012) concludes that search effort for temporary workers decreases with contract duration. This may translate into negative duration dependence for transitions between temporary contracts.

The empirical results obtained do not contradict this theory, showing that there is negative occurrence dependence and that longer temporary durations disfavour further job changes, ie. experience is valued, but only for maintaining a given temporary contract. The pattern of occurrence and duration dependence among the spells of temporary jobs may inform the impact of policy measures like increasing the maximum duration or renewal limit for a temporary contract with the same employer prior to dismissal or conversion into open-ended.

Finally, an analysis of the determinants of the number of temporary contracts held by a worker is performed through a count model. This allows for the cross check of some of the results stemming from transition analysis.

The remainder of the paper is set out as follows: Section 3.2 presents the database, sample construction and evidence from descriptive statistics. Section 3.3 presents the modelling approach followed and Section 3.4 describes estimation results, both for transitions from and within temporary employment, as well as for the analysis on the number of temporary contracts held by workers. Finally, Section 3.5 concludes.

3.2 Data and exploratory analysis

3.2.1 Data

The European Community Household Survey (ECHP) is an harmonized longitudinal survey covering fifteen EU member states (Belgium, Denmark, Germany, Greece, Spain, France, Italy, Ireland, Luxembourg, The Netherlands, Portugal, United Kingdom, Austria, Finland and Sweden) and comprising 8 waves (from 1994 to 2001) for the majority of countries. The survey is carried out by national data collection units and coordinated by the Statistical Office of the European Union (Eurostat).

The main advantages of this database are its longitudinal nature and standardized methodology and questionnaire, which allows to analyse individual transitions and cross-country comparisons. However, for three countries (Germany, Luxembourg and UK) the results available for the majority of the survey are based on national questionnaires, whose coverage (both in terms of time and questions asked) and answer structure differs in some cases from the ECHP. Due to these limitations, these countries were not considered in the estimation. Sweden was also excluded from the estimation due to the limited time coverage of the information and unavailability of data on the starting month of a job. Another advantage of this database is the wide span of topics covered in the questionnaire. In particular, for the current study, the availability of questions regarding training incidence, duration, and nature, as well as firm training choices is of interest. However, for estimation only part of this information could be used due to sample size limitations. In fact, item non-response is found to be a much more relevant problem for this database than panel attrition (Bassanini and Brunello (2006)). Due to absence of information on firm provision of education or training, France was also excluded from the estimation sample. Therefore, the analysis is restricted to the remaining ten countries.

Estimation required the sample selection to be further restricted. Only dependent employees working more than 15 hours per week and followed in the survey for at least two consecutive years are considered. Employment status is consistent with the International Labour Organization standards. Data from the first wave of the survey could not be used, given that information on the type of contract held by the worker is only available from wave 2 onwards.[2] Furthermore, only observations in which workers state being in a permanent contract or in a fixed or short-term contract are considered. The treatment of duration prior to the beginning of the survey restricts the sample to those observations for which information on year and month of start of the current job is available, which implies that only agents that started their job at the earliest two years before they joined the survey are considered. Moreover, for agents which recorded multiple transitions from a temporary contract to one of the risk states, only the first transition is considered. Individuals which have reported having permanent jobs prior to a temporary contract have also been excluded from estimation.

Finally, the sample is restricted by the availability of information on the regressors considered. These comprise firm characteristics, including sector of activity (public or private and agriculture,

[2]The exact wording of this question is "What type of employment contract do you have in your main job? Please indicate which of the following best describes your situation." The options available for answer are: permanent employment, fixed-term or short-term contract, casual work with no contract and some other working arrangement.

industry or services), provision of training to employees and number of employees in the production unit in which the worker is employed. In addition, worker characteristics are also considered, namely gender, age, highest level of general or higher education completed (ISCED[3] level), job satisfaction[4] and attendance of education or training in the recent past. Finally, job or career information like duration of current job and a dummy for the number of temporary contracts held prior to the current one is also considered. The available sample comprises 8947 observations and 5910 individuals after these conditions are satisfied.

In addition, a country level measure of the strictness of labour market regulation is considered, namely the indicator related to labour legislation included in the International Institute for Management Development (IMD) World Competitiveness Yearbook. This is an yearly assessment of country competitiveness, which includes the results of an executive opinion survey on several issues, including whether labour regulations (hiring/firing practices, minimum wages, etc.) hinder business activities. An increase in the indicator of labour market regulation implies an increase in flexibility at this level. The use of this soft data indicator is preferred to the most commonly used OECD EPL indicator given that the latter relates only to legislative changes, with no measure of their enforceability, and does not allow for a time series interpretation (Antunes and Centeno (2007)). In addition, the scope of the question implied in the indicator is broader than just EPL. The main drawback of the IMD indicator is that labour regulations affecting temporary and permanent contracts are not treated separately.

The analysis is developed for the the overall sample and for two country subgroups. Group M

[3]ISCED is the acronym for the International Standard Classification of Education, provided by the United Nations Educational, Scientific and Cultural Organization (UNESCO).

[4]The indicator on job satisfaction consists of an average of the evaluation of workers regarding several aspects of their job. The exact wording of the question is "How satisfied are you with your present job or business in terms of earnings, hours of work, working conditions etc." and the topics considered are earnings, job security, type of work, number of working hours, working time, working conditions/environment and distance to job/commuting. A higher value implies higher satisfaction, from 1 (not satisfied) to 6 (fully satisfied).

(more segmented labour markets) is composed of Spain, Portugal and Italy, while group L (less segmented labour markets) contains the remaining countries. This partition was adopted because countries in group M provide the largest part of the sample for transitions and are among those with highest share of temporary contracts in employment both at the time of the ECHP survey, maintaining that status in recent years (Table (3.1)). In addition, these countries implemented two-tier labour market reforms over the 80's and 90's (Boeri (2011)), maintaining however strict levels of labour market protection (OECD (2013)) and are among those in the European Union with lowest training incidence (Bassanini et al. (2005)). This situation distinguishes them from Finland, which also has a high share of temporary contracts in employment. The distinction of southern European countries from the remaining was also adopted by Boeri, Nicoletti and Scarpetta (2000) due to their combination of strict regulation on both the labour and product markets. These country subsamples allow to control to what extent results are driven by group M countries, where temporary contracts share a relatively similar institutional framework.

3.2.2 Exploratory Analysis

Table (3.1) shows the composition of employment across the countries considered for estimation. Countries of Group M (Spain, Portugal and Italy) are among those with higher share of temporary contracts. An update of this information for more recent years, based on data from the OECD, shows that the ranking of countries has not changed significantly, with Portugal and Italy increasing the weight of temporary contracts and Spain reducing it marginally.[5] Table (3.2) shows descriptive statistics concerning some human capital characteristics by type of contract. Contrarily to what other analyses found (for example European Commission (2005)), the average education

[5]The temporary employment concept in the OECD data is more encompassing than the fixed-term aggregate in the ECHP. However, based on data from the two databases for 2000-2001, the employment share defined by fixed-term plus other contracts in the ECHP is very comparable to the OECD aggregate, with differences of less than five percentage points.

level of fixed-term and permanent workers is very similar, despite a more unfavourable distribution between secondary and primary education for the former, given that the weight of third-level education is actually higher for temporary employees. Although these workers are not unskilled, they feel in much larger proportion than permanent workers that their skills are not adequately used and that they could fulfill more demanding tasks. Fixed-term workers are also more likely to be enrolled in education or training than permanent workers, particularly in general training, which suggests that in some cases a temporary job may serve as a complement to undergoing general education.

The main reason for leaving a job pointed by temporary workers is the fact that their contract ended, while the second most common reason is quitting to a better job. This is in sharp contrast with the situation of permanent employers, which mention obtaining a better job as their main reason to change employment. This finding suggests that the literature on overall job-to-job movements may not be adequate to the specificities of transitions from temporary to permanent contracts.

Table (3.3) shows how this employment structure translates into temporary worker flows for the sample considered. About half of workers change state after one year, and a large share of workers obtain a permanent contract each period, the majority of which by promotion with the same employer. One distinctive feature is that while the share of temporary workers that is promoted to a permanent job with the same employer is relatively stable cross country (ranging from about 17% to 33%), the share of workers that transition to an open-ended contract with a new employer is more heterogenous. In fact, the share of inter-firm transitions is lower for countries with a higher share of temporary workers, which also show a higher percentage of transitions into joblessness (unemployment plus inactivity). This evidence suggests that there is a margin for use of temporary contracts that is similar across countries (possibly related to temporary labour needs from firms), but there is another share that corresponds to the fulfilment of permanent labour necessities that is done at least initially with temporary contracts. This option may be related to institutional reasons or other. This evidence is reconcilable with a lower share of temporary workers obtaining open-ended contracts with new employers in countries with high incidence of temporary contracts if the institutional framework is characterized by high EPL on permanent contracts (that limits job-to-job mobility) and low EPL on temporary contracts (which leads to a higher share of temporary contracts in the economy (Kahn (2010)). This framework is also compatible with a very high number of job-to-job transitions for temporary workers (allowing for a high turnover for fixed-term contracts as a whole and simultaneously low inter-firm transitions from temporary to permanent jobs).

Table (3.4) shows the values of the IMD indicator on labour regulations for the countries analysed, both for the sample period and more recent years. Results show that, as mentioned, in group M countries labour regulations are perceived as being stricter, with no major change in ranking towards recent years. In addition, there is some overlapping of countries with a low share of inter-firm transitions and with strict labour regulations.

Tables (3.5), (3.6) and (3.7) show the descriptive statistics for the sample used, which illustrate the main differences between workers that experience intra and inter-firm transitions and also transitions into joblessness. These statistics correspond to the sample averages of all the individual level variables used in estimation. For time-varying variables (except age), the lagged values were considered, not only to reduce potential regressor endogeneity issues, but also because that would be the only way to make models comparable by considering the characteristics of the departure state for all competing risks. For example, the time frame of the question regarding training spans over the year prior to the one of the survey, so a worker that has changed job in survey year *t* can report in that survey training received either with his previous or current employer.[6]

[6] The exact question on training for survey year *t* is: Have you at any time since January of *year t-1* been in vocational education or training, including any part-time or short courses?

Regarding individuals characteristics by the type of transition experienced, those agents that obtain a permanent job with a new employer tend to be younger than the average temporary worker in both country groups. The average education level for all types workers is clearly higher in country L group. For the sample as a whole, the education level of workers that transition to open-ended contracts with new employers is higher than for other groups, a result that stems from group M countries. These workers also received training in the period prior to transition in higher proportion than those that experienced intra-firm transitions, a feature which is visible for both country groups, although more notorious for group M (and which is present for the majority of countries). Firm-provided training has much larger incidence in group L countries. However, for this group of countries inter-firm transitions originate with higher probability from employers of companies that do not provide training. However, the share of workers with have received training notwithstanding being in a non training firm is higher for inter-firm transitions than for promotion with the same employer. This training obtained by agents employed in non-training firms is assumed to be to a large extent self-financed, and referred as such henceforth.[7] Additionally, for group M countries, the probability of obtaining a permanent job with a new employer appears to depend favourably on training, independently of its financing. The probability of being in a training firm is slightly higher for workers which latter transition into permanent employment, which is a feature arising mostly from country group M. In the case of group L, this is only true for workers which are promoted to permanent with the same employer. Workers experiencing the first temporary contract recorded in the survey are much more likely to make a transition than those which had at least one previous temporary contract, and this reflects in particular transitions to joblessness. This feature is particularly notorious for group L countries. Transitions to joblessness are made by workers with a higher average age and a lower education level than those going to other states,

[7] Additionally, although data is only available for a smaller sample, details on firm training provision suggest that companies that provide training to their workers are in their majority, but not exclusively, responsible for the payment of that training.

which are mostly female and that work in production units that are on average smaller and less likely to provide training. These characteristics are common to both country groups.

3.3 Modelling approach

The main variable of analysis is the time elapsed since the admission into a fixed-term contract with a given employer. Given the annual frequency of the survey, a discrete duration model was adopted. The competing risk approach adopted takes into account three modes of exit from temporary employment: being promoted to permanent with the same employer, obtain an open-ended contract with a new employer or joblessness (unemployment or inactivity). Two possible specifications are considered: initially unobserved heterogeneity is not considered but latter this hypothesis is accounted for.

Each period, the length of a spell, in this case of a temporary contract, is expressed as a random variable T, with an associated cumulative distribution function $F(t)$. The elapsed time since the beginning of the spell is given by the survivor function $S(t) = 1 - F(t)$.

In a discrete duration setup in which data is grouped, time is aggregated into intervals of the time $]a_i, a_j]$ where $a_i = \{0, 1, ...a_{j-1}\}$ and $a_j = \{1, 2, ...\infty\}$. In that case, the hazard rate corresponds to the probability that a spell ends in interval a_j, given that it lasted up until interval a_{j-1}:

$$h(a_j) = Pr(a_{j-1} < T \leq a_j | T > a_{j-1}) \Leftrightarrow$$

$$h(a_j) = 1 - \frac{S(a_j)}{S(a_{j-1})} \tag{3.1}$$

And therefore, the survival function is given by:

$$S(a_j) = \prod_{k=1}^{j} (1 - h(a_k)) \tag{3.2}$$

The duration is modeled by assuming a proportional hazard model, where $h_0(t)$ represents the baseline hazard function and λ_t the proportional changes implied by different values of the covariates X_t:

$$h(t, X_t) = h_0(t)\lambda_t \tag{3.3}$$

The modeling approach followed was a complementary log-log (cloglog) specification, which corresponds to the discrete time representation of a proportional hazards model with grouped data (see Jenkins (2005) for a proof). In fact, if the hazard rate of the the continuous process can be specified as:

$$h(t, X_t) = h_0(t)\exp(\beta' X_t) \tag{3.4}$$

where $h_0(t)$ is the baseline hazard and X is the vector of (possibly) time varying covariates, the discrete time hazard can be expressed as :

$$\begin{gathered} \ln\left(-\ln\left[1 - h(a_j, X_t)\right]\right) = \beta' X_t + \gamma_j \Leftrightarrow \\ h(a_j, X_t) = 1 - \exp[-\exp\left(\beta' X_t + \gamma_j\right)] \end{gathered} \tag{3.5}$$

where γ_j is log of the difference in the integrated continuous time baseline hazard evaluated at the extremes of the interval $]a_{j-1}, a_j]$.

This parametric approach, followed for example by Portugal and Varejão (2009), was preferred to the multinomial logit model used by other authors (D'Addio and Rosholm (2005)) because the process governing transitions is continuous, although survival times are grouped into intervals. Given that the cloglog model is directly derived from that assumption, as shown above, it is more suited for the problem under analysis, while the multinomial logit is more appropriate for situations in which durations are intrinsically discrete (Jenkins (2005)).

The approach followed is semi-parametric in the sense that the baseline hazard is assumed to be constant over a given interval, but no model is imposed to fit the whole duration. For simplicity, competing risks are assumed to be independent. In a continuous duration model, this would imply that the model would simplify to three single cause hazard models. In a discrete duration model, that simplification is only possible if transitions are assumed to occur at the limits of intervals, i.e., at the moments the survey takes place (Portugal and Varejão (2009)).

Given the competing risk approach, a latent duration variable is associated with each exit mode from a temporary job, given that it may end when the worker transitions to permanent employment with the same employer (T_{SE}), with a different employer (T_{DE}) or due to joblessness (T_J), and only the minimum of the latent failure times, if any, is observed: $t = \min(T_{SE}, T_{DE}, T_{JB}, T_C)$, where T_C corresponds to the duration of censored spells.

Consider the destination specific censoring indicators for spell i:

$$\delta^{SE} = \begin{cases} 1 \quad \text{if spell ends with transition with the same employer} \\ 0 \text{ otherwise} \end{cases} \tag{3.6}$$

$$\delta^{DE} = \begin{cases} 1 \quad \text{if spell ends with transition with a different employer} \\ 0 \text{ otherwise} \end{cases} \tag{3.7}$$

$$\delta^{JB} = \begin{cases} 1 \quad \text{if spell ends with joblessness} \\ 0 \text{ otherwise} \end{cases} \tag{3.8}$$

Then the contribution to the likelihood of the problem generated by an individual with a spell length of J intervals (J if the number of the last interval in which the agent is observed) is given by (the subscript C denotes censored spells):

$$\mathcal{L} = (\mathcal{L}_{SE})^{\delta^{SE}} (\mathcal{L}_{DE})^{\delta^{DE}} (\mathcal{L}_{JB})^{\delta^{JB}} (\mathcal{L}_{C})^{\left(1-\delta^{SE}-\delta^{DE}-\delta^{JB}\right)} \tag{3.9}$$

where $\mathcal{L}_{SE} = \left[\frac{h_{SE}(a_J)}{1-h_{SE}(a_J)}\right] S_{SE}(a_J) S_{DE}(a_J) S_{JB}(a_J)$

The expressions for the other exit routes follow identically. Replacing them in equation (3.9), the likelihood contribution is given by (see Jenkins (2005) for details on the derivation):

$$\mathcal{L} = \left[\frac{h_{SE}(a_J)}{1-h_{SE}(a_J)}\right]^{\delta^{SE}} \left[\frac{h_{DE}(a_J)}{1-h_{DE}(a_J)}\right]^{\delta^{DE}} \left[\frac{h_{JB}(a_J)}{1-h_{JB}(a_J)}\right]^{\delta^{JB}} S_{SE}(a_J)\ \ S_{DE}(a_J)\ \ S_{JB}(a_J) \tag{3.10}$$

given that for the censored spells, $\mathcal{L}_C = (S_{SE}(a_J)\ \ S_{DE}(a_J)\ \ S_{JB}(a_J))$

And therefore, the overall likelihood of the problem (where *i* designates an individual and J_i the last interval in which agent *i* is observed, which corresponds to the moment of transition or censoring) is given by:

$$\mathcal{L} = \prod_{i=1}^{n} \left[\frac{h_{SE}(a_{J_i})}{1-h_{SE}(a_{J_i})}\right]^{\delta^{SE}} \left[\frac{h_{DE}(a_{J_i})}{1-h_{DE}(a_{J_i})}\right]^{\delta^{DE}} \left[\frac{h_{JB}(a_{J_i})}{1-h_{JB}(a_{J_i})}\right]^{\delta^{JB}} S_{SE}(a_{J_i})\ \ S_{DE}(a_{J_i})\ \ S_{JB}(a_{J_i}) \tag{3.11}$$

Additionally, the presence of unobserved heterogeneity is considered. In that case, if the continuous frequency hazard function is given by:

$$h(t, X_t|v) = h_0(t)\exp(\beta' X_t)v \tag{3.12}$$

where v is an unobservable individual effect, assumed to be a random variable with unit mean, finite variance and independently distributed from *t* and *X*, that only assumes positive values. In that case the hazard can be modeled as:

$$\ln\left(-\ln\left[1-h(a_j,X_t)\right]\right)=\beta' X_t+\gamma_j+u \tag{3.13}$$

where $u=\ln(v)$.

This model will be estimated assuming both a Normal distribution for *u* with mean zero and a *Gamma* distribution for v.[8]

In Section (3.4.2), a discrete duration model is also used to model transitions between temporary contracts. However, in this case the model involves multiple spells, but for simplicity, the competing competing risk framework is not considered.

With multiple spells (but without considering competing risks), the contribution to the likelihood of the problem of a given individual that only experienced one spell is given by (see Willett and Singer (1995) for a detailed derivation):

$$\mathcal{L}_1=\left[\frac{h_1(a_{M1})}{1-h_1(a_{M1})}\right]^{1-c_{M1}} S_1(a_{M1}) \tag{3.14}$$

where $c_{M1}=1$ if the spell is censored in interval *M*, the last one in which the individual is observed for the first spell.

[8]The case with *Gamma* distribution was estimated using the user-written *Stata* program pgmhaz8, developed by Stephen P.Jenkins, whereas the case with the Normal distribution was estimated directly with Stata routines.

More generally, for an individual experiencing k spells, the contribution for the likelihood is given by:

$$\mathcal{L} = \prod_{k=1}^{Mk} \left[\frac{h_k(a_{Mk})}{1 - h_k(a_{Mk})} \right]^{1-c_{Mk}} S_k(a_{Mk}) \tag{3.15}$$

3.4 Estimation Results

3.4.1 Transitions out of temporary employment

Overall Sample

Table (3.8) presents the results of the estimation of the competing risks duration model for transitions out of temporary employment for the case in which unobserved heterogeneity was not considered. Robust standard errors (in order to correct for potential error heteroskedasticity) are presented in parenthesis.[9]

One note on coefficient interpretation: in a continuous proportional hazard model, the exponential of the coefficients can be interpreted as hazard ratios, the proportional change in the hazard rate when a covariate changes one unit relatively to the reference category. Given that the cloglog model corresponds to the discrete version of a continuous proportional hazard model, the exponential of coefficients in Table (3.8) can be interpreted as the hazard ratio of the corresponding

[9]The option for robust standard errors instead of country and year clustered errors was made for practical reasons – the inability of controlling for two clustering variables in Stata for this model – as well as for theoretical reasons. In particular, Cameron and Miller (2015) argue that cluster-specific fixed effects, like country and year control variables, may absorb systematic within-cluster correlation if it is believed that within-cluster correlation of errors is solely driven by a common shock process.

continuous model. Therefore, a positive (negative) coefficient associated to a given covariate will imply that an increase in that covariate corresponds to a higher (lower) hazard than for the reference category. [10].

For the estimated models presented in Tables (3.8) to (3.13), a non-parametric approach was followed as regards the estimation of the hazard rate, with dummies representing regular intervals of duration of the temporary job. These durations are measured at the beginning of intervals, therefore corresponding to the minimum duration in the temporary job. The last dummy included covers minimum durations above 2.5 years. Due to legal limitations on the maximum duration of a temporary contract, closed intervals above that duration would lead to the exclusion of some countries from that parameter estimation sample.

As above mentioned, time-varying regressors enter the model in lagged terms. In addition, the variable related to labour market flexibility (IMD indicator) is standardized across countries to facilitate the interpretation of interaction effects.

A large part of spells is left-censored, given that the temporary job has already started when the individual enters the survey. To account for this feature, given that the year and month of start of the job is available, duration is measured using a combination of stock sampling and flow sampling. Elapsed duration in months is measured when the individual declares to be in a temporary job for the first time as the date of the survey interview minus the date of start of the current job, and afterwards a year is added to duration for each year of the survey in which the state of holding a temporary contract is maintained.[11] Durations in the sample are subject to some degree of

[10]Like in the multinomial logit model, the coefficients report to the risk of transition due to a specific exit route j, and do not allow for direct inference about the overall probability of exit from temporary employment, which is dependent on the coefficients estimated for all competing risks. That interpretation is only valid if the coefficient on the model for exit route j is the highest (or the lowest) of all the competing risks estimates for that covariate (see Thomas (1996)).

[11]This strategy was pursued due to intra-firm transitions, for which the precise date of transition cannot be ascertained, and to limit problems of loss of observations and inconsistencies for other transitions. In the

measuring error resulting from possible recording errors in the survey.[12]

Results in Table (3.8), column 2 for temporary workers who were promoted to permanent with the same employer show positive duration dependence, and therefore the probability of promotion to a permanent contract increases with the duration of the job. This result is similar to the one obtained by other authors (Portugal and Varejão (2009) and Alba-Ramirez (1998), Amuedo-Dorantes (2000) and Booth et al. (2002)), although results in the literature are in many cases not extensive to both genders. This result is consistent with a situation in which worker and firm share investments in firm-specific skills, which progress with time on-the-job (Booth et al. (1997)). There is a peak of conversions for contracts that lasted more than two years and a half (this corresponds to the legal duration limit of temporary contracts for some countries at that time, including Belgium, Denmark and Portugal (OECD (2004))). Guell and Petrongolo (2007) find evidence for Spain of similar spikes in transitions at one and three years of contract duration. The fact that firms appear to explore to some extent the legal limits of the contracts is in line with Chapter 2 and suggests that firms take advantage of the lower (actual and potential) firing costs associated with temporary contracts while it is possible to retain the option value of converting the worker to a permanent position.

Workers that have higher formal education show a higher hazard of promotion to a permanent contract than their lower educated counterparts. The same is true for temporary jobs in training-providing firms, when compared to the situation of workers which neither receive training nor work in training firms, independently of whether the worker has actively taken advantage of that feature

case of inter-firm transitions, information on small periods of joblessness between jobs could be retrieved from the database, but this route is not explored because the focus of this work is on more persistent states, corresponding to career changes. In addition, that approach would lead to further loss of observations. However, this implies that many short-duration transitions through joblessness are not captured, as well as many short duration contracts.

[12] In fact, some inconsistencies arise when measuring elapsed duration while entering the sample, given that, probably due to recording errors, the date of start of the current job recorded for some individuals is posterior to the date of interview, resulting in a negative duration. An elapsed duration of some days was attributed to these cases, to avoid further loss of observations.

in the recent past. These findings are in line with the theory that both education and training are correlated with ability (European Commission (2008) and Autor (2001)), and therefore not only high ability workers could self-select intro training firms, but also, as they reveal that ability over the duration of the temporary job, firms are more likely to promote them into permanent positions. On the contrary, there is a significant negative impact on the hazard for those workers which received training prior to transition while employed in a non-training firm. This suggests that this training was self-financed and had a more general nature than the one that could have been obtained inside the firm. Because general training provides skills which are transferable, it increases the workers ability to obtain other potential employers, and this could be seen by the firm offering the temporary contract as a signal that the worker could be searching for another job, or could simply become over-qualified for the current job. But on alternative, this could also be the result of low promotion prospects for the worker within his current firm.

An increase in labour market flexibility, measured as an increase in the IMD indicator, has a positive effect on the hazard to a permanent contract with the same employer. However, the equations include regressors that control for the interaction between IMD and the firm-worker pairs training status, and these show that the impact of the IMD indicator is only relevant for workers of non-training firms. That is, workers in training firms are somewhat insulated of the negative impact that a strict labour market legislation will have on transition to a permanent contract. This suggests that possibly training firms invest more in selection to find skilled workers whose expected productivity will cover the costs of training and hire with the ultimate objective of converting that temporary job into permanent. In that case, the expected value of the permanent job would be high enough to determine conversion independently of (small) changes in labour market protection. In the context of Chapter 2, this would correspond to firms that realize when the temporary contract comes to an end that the expected value of a permanent job once the worker is trained minus the cost of training is always larger than the value of the alternative option of temporary contract renewal (or dismissal, in case the legal renewal limit has been achieved).

Other significant coefficients signal that workers enrolled in the agricultural and in the public sector have a lower hazard than their counterparts of being promoted to permanent with the same employer, which possibly reflects the seasonal nature of many of the jobs in agriculture. In addition, higher job satisfaction implies and increased hazard of transition.

As regards inter-firm transitions (Table 3.8, column 3), duration dependence is negative but not significant, and therefore there is no large difference in the probability of leaving to obtain an open-ended with a new firm after only a few months of tenure or after two years. Booth et al. (1997) claim that because match quality is perceived over time, bad matches should end over the first months of the job, and therefore the separation hazard is expected to decline after that. In addition, Melero (2004) concludes that the probability of moving to a better job decreases with tenure and, to a lesser extent, with labour market experience. In fact, most of the coefficients estimated for tenures longer than the reference of zero to three months minimum duration are negative, although the hazard is not monotonically decreasing. However, these transitions may occur due to different reasons over time, given that initially they may be due to the realization of the poor quality of the match, and at a later stage motivated by the perception that promotion to an open-ended contract with the same employer will not be possible. In fact, Kahn (2012) finds that search intensity in a temporary job increases as the contract approaches its end.[13]

Gielen and Tatsiramos (2012) show, using also ECHP data, although only for workers in permanent employment, that quits to better jobs are related to job satisfaction in the initial job, but that connection is weaker in countries with higher level of job protection. This results from higher mo-

[13] The coefficient closest to significance relates to a tenure of a minimum of 15 to 18 months, which is probably in most cases longer than the first renewal of the temporary contract but still before the end of its legal limit, which supports this view.

bility costs in more regulated labour markets, which prevent individuals with low job satisfaction from quitting, due to the low probability of finding a better suiting job. Results in Table (3.8), column 3 are in line with this conclusion, given that job satisfaction does not have a significant impact on the hazard, while on the other hand a higher level of labour regulation flexibility has a positive effect on transitions with a new employer. This effect is in fact determined by group M countries. This result is also in line with Bassanini and Garnero (2013) who find, based on industry data, that more stringent EPL on regular contracts reduces job-to-job mobility, and its effect is concentrated in intra-industry job-to-job movements, particularly in movements to open-ended jobs (however it is not possible to control whether the previous contract of the worker was temporary or permanent). As concerns human capital effects, both formal education and training favour transitions to a permanent job with a new employer, independently of whether that training was obtained in a training firm (and thus has more likely a vocational nature) or not. However, the interaction coefficients between the IMD indicator and firm-worker training show that a change in labour market flexibility has no significant impact on the hazard of workers that received training within training firms, possibly because these type of transitions are more related to firm competition than to the overall state of the labour market. Workers with all other training status types see the hazard associated to inter-firm transitions increase with less strict labour market regulation. Additionally, men have a higher probability of experiencing inter-firm transitions, in line with the findings by Booth et al. (1997) that job quitting behaviour is more pronounced for this group. Older workers, on the other hand, have lower hazards than their younger counterparts, possibly because mobility costs increase with age (Winkelmann and Zimmermann (1998)), while benefits to hiring firms decrease, given that they have less time to benefit from the new worker skills.

The view that a temporary job is an experience good (Melero (2004) and references herein) is also supported by the negative duration dependence found for transitions to joblessness (Table

(3.8), column 4), given that both the firm and the worker access the quality of the match, and as the job progresses the probability that the match is found to be poor decreases. Human capital determinants have an impact on transitions to joblessness that is to a large extent of symmetrical sign to those in the model for intra-firm transitions, given that education and presence in a training firm reduce the hazard to non-employment, while having received training by a non-training firm increases it. However, the degree of EPL strictness does not have a significant effect on these transitions, independently of training status, in tandem with the unclear sign found in the literature for the impact of EPL on unemployment levels (see Boeri and van Ours (2013) and Blanchard and Portugal (2001), among others). Smaller firms are more likely to originate transitions into joblessness, possibly because in these cases the end of the job is more directly connected with the survival of the firm itself. The lower hazard of men into joblessness is possibly associated with higher incidence of transitions of women into inactivity due to family reasons.

A feature which is common to the three competing destinations is the strong and negative impact on the hazard of having had at least one previous temporary contract. This regressor tries to control for initial conditions, limiting the problem of the sample of unavailability of the whole career history of workers. Having at least one previous temporary contract has a large negative impact on the hazard of leaving temporary employment, particularly trough joblessness. Moreover, this effect is increasing in the number of previous temporary jobs held (results available upon request). This feature suggests that some workers may be trapped in a succession of temporary employment cycles. Section (3.4.2) analyses the career trajectories of these workers in more detail.[14]

Results in Table (3.9) show the same model specifications, but considering the possibility of

[14]Other potential explanatory variables that were included in the models but revealed not significant included country level measures of product market regulation, given that Autor (2001) concludes that firms provide more general training as market competition increases. In addition, whether the worker lives in a couple, job status (supervisory, intermediate and non-supervisory) and part-time status were also considered as regressors and found not significant.

unobserved heterogeneity, assuming that the error terms follow a Normal distribution. The possibility of errors following a *Gamma* distribution was also tested, but given that it was not possible to obtain convergence for the model of intra-firm transitions and that remaining results were very similar to those obtained with the normal distribution, they are not presented here. The value for ρ defines the percentage of the variance determined by intra-class variance (in this case individuals) and therefore the relevance of the estimated unobserved heterogeneity effects. The estimates presented suggest that unobserved heterogeneity is not relevant for workers which transition to permanent with the same employer but has some influence for other modes of exit. Likelihood ratio tests for the significance of ρ can not be computed for these estimates given the assumption of clustering in the data.[15] However, test results computed disregarding this issue confirm that ρ is not significant for intra-firm transitions but is for other destination states.

The consequences for the results of not considering unobserved heterogeneity are those usually found in the literature, namely an underestimation of duration dependence for most horizons and of the absolute value of coefficient estimates. The impacts on estimated coefficients and their significance are however very limited, possibly due to the use of a flexible baseline hazard specification (Jenkins (2005)). Despite this, given that unobserved heterogeneity appears to be relevant, it is taken into account in the remainder of results.

Results by country group

Tables (3.10) to (3.12) show the results of the estimation of the competing risk models for country groups M and L, respectively. Although in many cases results are qualitatively similar for both

[15]According to information from Stata support, available on `http://www.stata.com/support/faqs/statistics/likelihood-ratio-test/`, the likelihood associated with maximum likelihood estimates for clustered data is not a true likelihood; i.e., it is not the distribution of the sample, because when there is clustering, individual observations are no longer independent, and the likelihood does not reflect this. Therefore, it should not be used for variance estimation using standard formulas.

groups, the significance or even the sign of some coefficients differs across them. This section focuses on the most relevant of these differences.

For workers that obtain an open-ended contract with the same employer (Table (3.10)), the impact of higher formal education is only significant for group M countries, possibly because in some of these countries it is still attained by a relatively low share of the population. The positive interaction effects of receiving training and being in a training firm found for the overall sample stem from country group L, while for country M groups, these effects are not statistically significant, which can be related to the low incidence of vocational training in these countries (CEDEFOP (2010)). However, training status impacts on the effect that the degree of labour market regulation has on transitions. As mentioned earlier for the overall sample, workers that are enrolled in temporary contracts in training firms do not benefit so much in terms of increased hazard from higher labour market flexility. On the other hand, labour market regulation does not have any significant effect on duration in group L countries.

Concerning workers which transition to a permanent job with a new employer (Table (3.11)), as mentioned in the previous subsection, results seem to confirm those in Gielen and Tatsiramos (2012) given that job satisfaction has a negative significant impact on transitions to a new employer in group L countries and labour market regulation measures do not have in general a significant effect, while the opposite happens for group M countries. This result suggests that an open-ended contract obtained with a new employer may ensue a voluntary quit for group L, while for group M countries it may reflect the end of the temporary contract, and therefore be more affected by institutional than individual effects. Possibly due to this, the negative impact of age and positive impact for male workers on the hazard stems from group L countries only. However, formal education only has a positive impact on transitions for group M, which may stem from the same reason pointed out for intra-firm transitions. The impact of receiving training prior to transition is not significant for any country group individually (although it has a higher p-value for group L countries), contrarily to what was found for the overall sample.

In the case of transitions to joblessness (Table (3.12)), there do not appear to be major differences between the two country groups, with the exception of the indicator of labour market regulation, which has a positive and significant sign in the case of group M. Given the finding that labour reallocation is larger in countries (or labour market segments) with less strict regulation, job-to-job transitions will be more frequent, and the survey measurement is more likely to coincide with unemployment periods between jobs, simply because flows into and out of unemployment will be higher.

As for the overall sample, for all country groups and transition types there is a negative impact in the hazard associated with having at least one temporary job prior to the current one. Given the consistency of this result, the career paths of temporary workers up to the moment of transition are analysed in the next section.

3.4.2 Transitions within temporary employment

In order to access what determines a job history composed of several temporary jobs, that will limit the possibility of transition to permanent employment, a duration model with repeated spells is estimated for transitions from temporary to temporary job for the workers whose transitions served as basis for the previous results. This may also help shed some light on the impact of policies that extend the maximum legal duration of temporary contracts, given that this will affect the career history of workers.

For simplicity, the model estimated is a discrete duration model identical to the one in the previous section but with repeated spells, in which the dependent variable corresponds to a transition from a temporary contract to another. Only one possible destination is considered, due to computational simplicity. However, the possibility that a temporary worker was laid off from his previous job, and therefore possibly endured at least a small period of unemployment between jobs is controlled for in estimation indirectly, by including the reason why the worker left the previous job as a regressor. Given that the indetermination regarding the moment of transition that affect the data used in the previous section is not an issue in this case, the minimum duration for each temporary job is obtained in the same way as described for initial elapsed duration in the previous section, i.e., by using information on the date of survey interview and date of start of current job to ascertain the elapsed duration on the job.

The set of regressors considered is identical to the one in the previous section, but many revealed not significant, notably the impact of labour market regulation and human capital variables. Moreover, additional regressors were considered, namely the reason for leaving the previous job, given the evidence in Booth et al. (1997) that the recent history of job mobility impacts tenure at the current job. The job status held in each job (supervisory, intermediate or non-supervisory) was also included, given that it was found to be significant in Gagliarducci (2005), although it revealed not to be significant in this case.

Results in Table (3.13) show that with the duration of a temporary contract, the probability of moving to another one decreases, although this difference is only significant for durations above one year, and in country group L, for durations above 18 months. This result is in line with the findings of Booth et al. (1997) for all types of job changes, that job tenure increases as job accumulate, which may partially stem from lower job search intensity with elapsed contract duration (Kahn (2012)).

There is also negative occurrence dependence, given that being in the second temporary job episode of the survey decreases the hazard of moving to the next one.[16] Therefore, experience both in the current temporary job or in the previous one appears to be valuable to employers, leading temporary contracts to be longer, and possibly renewed. Other factors that favour persistence in a temporary job are higher formal education, age (for group L countries only), as well as working in the services sector and being female (for group M only).

As concerns previous work history, the reasons to leave the previous job displayed in Table (3.2) that are not directly job related, i.e., all aside firm quit to a better job, layoff ("obliged to stop by employer") or end of contract were aggregated in a categorical variable labelled "other". Although results are not statistically significant, they show a positive impact on the hazard of moving to another temporary job for workers which left their previous job due to contract end.[17] Assuming that unobserved heterogeneity is controlled for, the impact of previous job history should not reflect individual characteristics, and possibly suggests some signalling role that job history may have for employers.

Results are not sharply different across country groups. However, negative occurrence dependence is only relevant for group M countries, and duration dependence effects are much stronger, suggesting a stronger importance of career history for this group. The effect of gender (men have a higher hazard of transition to another temporary job) and of sector of activity (being in the services sector reduces the probability of changing temporary job) are only significant for country group M. On the other hand, there is a positive effect on the duration of a given temporary job for older workers and of working in the private sector only from group L countries.

[16] The fact that there is available information regarding the previous job of individuals experiencing their first temporary job episode in the sample shows that the beginning of the survey does not coincide in many cases with the start of the workers career.

[17] The non-significance of this result is possibly due to the limited number of observations, given that including observations for France and the UK, which was possible but not pursued for consistency with the previous section, would render this coefficient significant.

These results complement those in the previous section in showing that a succession of temporary contracts increases stability within temporary employment, but decreases the probability of transition to any other state. Workers more prone to experience multiple temporary jobs tend to be men, with lower formal education and a reduced number of previous, short-duration temporary jobs outside the services sector. Therefore a policy that increases the maximum legal duration of a temporary job is expected to increase permanence in that job, given that increased duration of a temporary job reduces the probability of transition to another one, and also improves prospects of promotion into a permanent job (and reduces the probability of transition into joblessness). However, as argued by Kahn (2012), because job search effort tends to increase only near the end of the contract, an increase in maximum job duration may reduce transitions to permanent jobs with new employers. Moreover, in protected and segmented labour markets, firms may maintain temporary workers until the end of the contract even if they do not plan to convert it to permanent and during that period not provide training to those workers, reducing probabilities of transition either with the same or another employer.

3.4.3 Number of temporary jobs held by a worker

As a further complementary analysis, the overall number of temporary contracts held by workers over the period of the sample is analysed. Given that some worker and firm characteristics favour transitions to permanent employment and/or longer durations of temporary contracts, these should consequently imply a lower count of temporary contracts. To this purpose, a truncated negative binomial model where the dependent variable is the number of temporary contracts was estimated on the basis of the sample of Section (3.4.2). Given the characteristics of the sample used, each worker has at least one temporary contract, and therefore the model is truncated at zero. The negative binomial model is adopted given its capacity to accommodate overdispersion of the data. This model can be interpreted as a mixture distribution where the count variable has a Poisson distribution but there is unobserved heterogeneity in the data, which can be modelled using a *Gamma* distribution (Cameron and Trivedi (2005)). The assumption of overdispersion appears reasonable given the observation of the count variable histogram, which shows and apparent excessive count of ones, and was confirmed through a test on estimation output.

Therefore, if the random count variable y has a Poisson distribution with parameter $\lambda = \mu\nu$, where μ is a deterministic component and ν is a random variable characterized by a *Gamma* distribution with variance α, the marginal density of y is given by the following negative binomial distribution:

$$h(y|\mu, \alpha) = \frac{\Gamma(\alpha + y)}{\Gamma(\alpha)\Gamma(y + 1)} \left(\frac{\alpha}{\alpha + \mu}\right)^{\alpha} \left(\frac{\mu}{\mu + \alpha}\right)^{y} \tag{3.16}$$

Estimation results for this model, both for the overall sample and for the country group breakdown are presented in Table (3.14). Standard deviations of the coefficients are presented in normal brackets and marginal effects in square brackets.[18] The additional output ln(α) refers to the estimate of the logarithm of α, the parameter that accounts for overdispersion of the data in the negative binomial distribution. Therefore, a test of $\alpha = 0$ can be seen as a test of validation of the overdispersion assumption and consequently of the choice for the negative binomial model.[19] Stata provides a likelihood ratio test for the significance of α that takes into account the truncated distribution of α. The probability of occurrence of a value more extreme than the test statistic is described as "p-value of LR test for $\alpha = 0$" in Table (3.14). Results do not lead to the rejection of

[18]Marginal affects are evaluated at the average of continuous regressors and at the reference categories of categorical variables.

[19]However, because α must be greater than or equal to zero, the standard normal will not be the correct asymptotic distribution of α (Long and Freese (2001)).

the overdispersion hypothesis, although for group L countries only at the 10 per cent significance level.

The set of regressors considered encompasses that of previous sections whenever possible. In this case, interaction effects between training received by the worker and supplied by the firm were not included, given that they were found to be not significant. In the case of variables whose values change across jobs, like sector of activity or size of the firm, the values attributed to the first temporary job were considered. This was not only the approach followed in Winkelmann and Zimmermann (1998) but also the most reasonable possibility given the large number of observations corresponding to only one job.

Results in the second column of Table (3.14) confirm some of the results of the previous sections, in the sense that some worker and firm characteristics that were found in Section (3.4.1) to determine an increase in the probability of transition to permanent employment and to decrease the probability of transition to unemployment are also found to reduce the expected number of temporary jobs held by a worker. Additionally, some factors found in Section (3.4.2) to increase the duration of a temporary job are also found to reduce the count of temporary jobs. Therefore, a lower number of temporary jobs results from the joint effects of higher probability of transition to permanent positions and from longer durations of the temporary contracts actually held.

In particular, higher education levels increase the probability of transitions to permanent employment and decreases the one to unemployment. Correspondingly, higher education has an (almost significant) negative impact on the number of temporary contracts held. When divided by country groups (columns 3 and 4 of Table (3.14)), this result appears to stem from countries with more segmented labour markets, where education levels above basic imply a decline of 0.1 in the average expected number of temporary jobs held. For country group L, a higher education level favours a higher number of temporary contracts. This may be related to fundamental differences in the use and purposes of temporary contracts in both groups of countries: as a screening device or a buffer for shocks in segmented markets and as part of a vocational training system for other countries.

As regards training variables, receiving training is not significant in explaining the number of temporary jobs held. However, being in a training firm in the first temporary job has a negative impact on the number of jobs held: workers in these firms have an expected 0.07 lower count of temporary jobs. A similar result is found across country groups, although it is only significant at the 10 per cent level for less segmented economies.

According to results in Section (3.4.1), being in the private sector also favours transitions to permanent employment and discourages transitions to unemployment. In fact, being in this sector is also significant as regards an expected reduction in the number of temporary jobs held. Looking at country group results, this result appears to stem from non-segmented economies, while it is non-significant for segmented economies. Again, this may be related to public training and education policies that differ across country groups. Working in the services sector in the first temporary job recorded in the sample implies a reduction in the expected count of 0.16 when compared to working agriculture, in line with what the transitions analysis suggested. This results apparently stems from group M countries, where this effect is even stronger. However, for the industrial sector this result is only close to significant. Job satisfaction in the first temporary job held also reduces the expected number of temporary jobs for the overall sample, in line with its expected impact on transitions obtained in Section (3.4.1). However, this regressor is not significant for country groups. Finally, working in an intermediate sized firm ((20-99) employees) in the first job captured by the survey tends to lead to a higher number of temporary jobs, which is in line with the previous conclusion that larger firms reduce the hazard of transition to joblessness. Some of the characteristics mentioned, namely higher education, being female (only for country group M) and working in the services sector were also found in Section (3.4.2) to increase the expected duration of a temporary job. These results suggest that, with the exception of education, firm or firm-related characteristics (like job satisfaction) appear to be more determinant than individual characteristics to the number of temporary contracts held by workers.

3.5 Conclusion

This work analysed transitions from temporary to permanent contracts in European countries, with a special focus on human capital aspects and their interaction with labour market institutions. A new perspective was adopted given that the possibility of obtaining an open-ended contract through a promotion with the current employer or having to change job to obtain it were analysed separately. Results support the view that these channels are similar in some aspects, namely that they both benefit from the education of workers and from increases in labour market flexibility, as measured by the IMD. However, they also present differences, namely regarding duration dependence, and interactions between labour market flexibility and different aspects of training. Intra-firm transitions from a temporary to an open-ended contract are facilitated for workers enrolled in training firms, and these transitions appear to be somewhat protected from the effects of changes in labour market protection. On the other hand, the training characteristics of the worker and not of the firm appear to be relevant in the case of inter-firm transitions. The breakdown of results across country groups indicate that in segmented labour markets institutional aspects play a large role in transitions, rendering individual aspects in some cases a more secondary role.

In addition, results show that workers which experience a sequence of temporary contracts tend to be trapped to some extent in that segment of the labour market, although their probability of transition into joblessness is also smaller. This result, along with some evidence of negative occurrence dependence in job-to-job movements indicate that a policy of extension of the maximum duration of temporary contracts may have beneficial effects as regards transitions to permanent jobs.

An analysis of the number of temporary contracts held by workers on the basis of a count model allows to cross-check some of these results, reinforcing the importance of firm characteristics in the careers of temporary workers.

There some margins for improvement in the current work. In particular, competing risks in duration analysis were assumed to be independent, a feature common in literature, not only for tractability reasons, but also because a dependent risk model is not identified with single-spell data without additional structure (van den Berg (2005)). One approach adopted in the literature was the specification of a multivariate proportional hazard model, where the distribution of unobserved heterogeneity is specified parametrically, and the correlation structure between unobserved variables is not very flexible. Other approaches allow for more flexible mutual dependence between unobserved explanatory variables, which in some cases implied the the use of discrete multivariate distributions with a limited number of support points. One application of this method can be found in Bonnal, Fougère and Sérandon (1997). Gordon (2002) proposes a generalized dependent risk approach in which risks are drawn from a multivariate normal distribution and therefore related stochastically. In this case no analytical solution for the survivor function exists, and therefore maximum likelihood with numeric integration or Bayesian methods must be used in estimation.

Further research would benefit from a disaggregated analysis of labour market regulations into those affecting temporary and permanent employment, which was not possible with the available data. This would allow to ascertain whether differences observed between country groups stem from overall higher levels of employment protection in southern European countries or from the differences in protection between the two segments, ie., what is the importance of absolute and relative strictness of EPL.

Appendices

Table 3.1: Composition of employment by contract type

Country	1995-2001				2008-2012
	permanent	fixed-term	none	other	temporary employment[a]
Spain	64.1	29.7	3.8	2.4	25.7
Finland	84.2	13.5	1.7	0.5	15.3
Portugal	80.0	10.6	3.3	6.1	22.1
Belgium	89.1	8.8	0.4	1.6	8.3
Greece	76.8	8.6	14.0	0.6	11.5
Italy	86.9	7.9	3.2	2.0	13.1
Ireland	82.1	6.1	8.7	3.1	9.4
Denmark	88.3	5.6	5.5	0.6	8.6
Austria	91.7	4.9	0.4	3.0	9.2
Netherlands	89.4	3.3	0.7	6.6	18.6

Notes.[a] Share in dependent employment, OECD data. Data sorted in descending order by share of fixed-term contracts in 1995-2001.

Sources: ECHP and OECD.

Table 3.2: Employer characteristics by contract type

	Type of contract					
	Permanent	Fixed-term	None	Other	Total	Observations
Higher level of education completed						
Third level	23.5	24.4	8.2	12.4	22.7	51818
Secondary level second stage	37.6	30.6	31.6	25.9	36.3	83009
Secondary level less than second stage	38.9	45.1	60.2	61.8	41.0	93818
Skills for a more demanding job?						
Yes	52.7	58.8	54.5	48.1	53.3	117676
No	47.3	41.2	45.5	51.9	46.7	103196
Enrolment in Education or training						
Yes	24.9	30.9	19.3	19.7	25.2	58293
No	75.1	69.1	80.7	80.3	74.8	173370
Type of course attended						
General+Vocational+Language	0.9	2.0	0.8	0.5	1.1	615
General+Vocational	4.7	5.9	6.4	11.0	5.1	2946
General+Language	1.8	5.7	4.9	2.6	2.4	1416
Vocational+Language	11.9	7.9	3.0	4.2	10.9	6363
General	10.1	29.4	48.0	33.3	14.3	8307
Vocational	58.3	38.4	26.9	38.8	54.3	31681
Language	12.3	10.6	10.0	9.6	11.9	6965
Reason for end of previous job						
Obtained better Job	43.1	23.0	18.8	27.8	38.6	49403
Obliged to stop by employer	15.1	12.9	21.0	13.4	15.0	19235
End of contract	13.4	44.0	27.0	22.4	18.7	23891
Sale/closure of family business	2.0	1.7	3.8	1.8	2.1	2626
Marriage	10.1	2.4	5.9	5.6	8.6	11064
Children related	2.9	2.5	4.1	4.4	2.9	3770
Looking after other persons	0.1	0.1	0.3	0.2	0.1	168
Partner’ job required moving	0.6	0.4	0.3	0.5	0.5	654
Study, national service	3.4	4.8	7.2	4.1	3.8	4878
Illness	1.0	1.3	2.4	2.9	1.2	1551
Retirement	0.8	0.6	1.2	0.7	0.8	969
Other	7.5	6.3	8.1	16.3	7.7	9863
Observations	47662	7569	1693	1369	58293	

Source: ECHP.

Note: the statistics presented are the average proportion of the sample corresponding to each category, with the exception of job satisfaction, for which the average sample value is reported.

Table 3.3: Transitions from temporary jobs

Country	Remain Temporary	Intra-firm transition	Inter-firm transition	Joblessness	Observa-tions
Spain	56.2	17.5	4.3	22.1	3917
Portugal	54.2	24.8	6.6	14.5	1361
Finland	45.6	16.7	8.5	29.2	945
Greece	53.9	18.0	8.8	19.4	434
Italy	44.1	20.2	10.3	25.4	891
Belgium	51.0	26.8	12.1	10.1	298
Austria	36.7	33.3	14.4	15.5	264
Ireland	39.2	26.5	18.0	16.3	245
Denmark	34.8	23.3	21.5	20.4	270
Netherlands	39.8	17.7	25.8	16.8	322
Total	51.0	20.0	8.1	20.9	8947
Observations	4562	1791	726	1868	8947

Note: Data sorted in ascending order by share of transitions to tenure with a new employer.

Source: ECHP.

Table 3.4: IMD- Labour regulations indicator

	1995-2001	2008-2012
Italy	2.4	3.7
Belgium	3.1	3.3
Spain	3.4	3.4
Portugal	3.9	3.9
Austria	4.1	5.4
Greece	4.2	3.6
Netherlands	4.5	4.4
Finland	4.6	5.0
Ireland	5.9	5.2
Denmark	7.6	8.1

Notes: Data sorted in ascending order by 1995-2001 values.

A higher value of the indicator implies higher perceived flexibility in the economy.

Source: IMD World Competitiveness Online.

Table 3.5: Descriptive statistics - Overall Sample

Variable	Overall	Remain temporary	Intra-firm transition	Inter-firm transition	Joblessness
Duration in months:					
$]0, 3[$	0.20	0.18	0.13	0.25	0.28
$[3, 6[$	0.15	0.14	0.10	0.15	0.20
$[6, 9[$	0.10	0.10	0.09	0.12	0.11
$[9, 12[$	0.08	0.07	0.08	0.09	0.08
$[12, 15[$	0.11	0.11	0.13	0.11	0.10
$[15, 18[$	0.08	0.08	0.09	0.06	0.06
$[18, 21[$	0.05	0.05	0.06	0.04	0.04
$[21, 24[$	0.04	0.04	0.05	0.03	0.02
$[24, 30[$	0.08	0.09	0.10	0.06	0.05
≥ 30	0.12	0.14	0.17	0.08	0.05
First job	0.58	0.39	0.75	0.77	0.80
Not first job	0.42	0.61	0.25	0.23	0.20
Age [16,30[	0.54	0.53	0.54	0.60	0.53
Age [30,45[	0.33	0.35	0.35	0.32	0.29
Age [45,65]	0.13	0.13	0.12	0.08	0.18
Firm size <20 workers	0.48	0.46	0.48	0.44	0.54
Firm size 20-99 workers	0.28	0.30	0.27	0.26	0.27
Firm size >99 workers	0.24	0.24	0.25	0.29	0.19
Secondary education or more	0.53	0.52	0.58	0.64	0.47
Less than secondary education	0.47	0.48	0.42	0.36	0.53
Training worker	0.34	0.32	0.33	0.44	0.34
No training worker	0.66	0.68	0.67	0.56	0.66
Training firm	0.24	0.24	0.30	0.31	0.18
No training firm	0.76	0.76	0.70	0.69	0.82
Training worker+firm	0.15	0.14	0.18	0.21	0.11
Training worker+no training firm	0.18	0.17	0.15	0.22	0.24
No training worker+training firm	0.09	0.09	0.12	0.10	0.07
No training worker+no training firm	0.57	0.59	0.55	0.47	0.59
Men	0.52	0.54	0.52	0.54	0.47
Women	0.48	0.46	0.48	0.46	0.53
Agriculture	0.04	0.05	0.02	0.03	0.06
Industry	0.33	0.34	0.35	0.30	0.29
Services	0.63	0.62	0.63	0.67	0.65
Private sector	0.73	0.72	0.77	0.73	0.71
Public sector	0.27	0.28	0.23	0.27	0.29
Job satisfaction	3.88	3.85	4.00	4.01	3.77
Observations	8947	4562	1791	726	1868

Note: the statistics presented are the average proportion of the sample corresponding to each category, with the exception of job satisfaction, for which the average sample value is reported.

Source: ECHP.

Table 3.6: Descriptive statistics - Group M Countries

Variable	Overall	Remain tempo-rary	Intra-firm transition	Inter-firm transition	Jobless-ness
Duration in months:					
$]0,3[$	0.19	0.18	0.11	0.20	0.27
$[3,6[$	0.14	0.14	0.08	0.13	0.18
$[6,9[$	0.09	0.09	0.08	0.13	0.10
$[9,12[$	0.07	0.07	0.08	0.09	0.09
$[12,15[$	0.11	0.11	0.13	0.13	0.11
$[15,18[$	0.08	0.08	0.09	0.06	0.06
$[18,21[$	0.05	0.06	0.06	0.05	0.04
$[21,24[$	0.04	0.04	0.05	0.03	0.03
$[24,30[$	0.09	0.09	0.11	0.07	0.06
≥ 30	0.13	0.14	0.20	0.11	0.06
First job	0.54	0.36	0.73	0.74	0.77
Not first job	0.46	0.64	0.27	0.26	0.23
Age [16,30[	0.57	0.56	0.58	0.65	0.55
Age [30,45[	0.31	0.32	0.32	0.27	0.29
Age [45,65]	0.12	0.12	0.10	0.07	0.16
Firm size $<$20 workers	0.51	0.49	0.52	0.52	0.56
Firm size 20-99 workers	0.29	0.30	0.28	0.27	0.27
Firm size $>$99 workers	0.20	0.22	0.20	0.21	0.17
Secondary education or more	0.43	0.42	0.49	0.57	0.37
Less than secondary education	0.57	0.58	0.51	0.43	0.63
Training worker	0.27	0.26	0.26	0.36	0.27
No training worker	0.73	0.74	0.74	0.64	0.73
Training firm	0.14	0.14	0.18	0.17	0.11
No training firm	0.86	0.86	0.82	0.83	0.89
Training worker+firm	0.07	0.07	0.09	0.12	0.05
Training worker+no training firm	0.19	0.19	0.17	0.25	0.22
No training worker+training firm	0.07	0.07	0.09	0.05	0.06
No training worker+no training firm	0.66	0.67	0.65	0.59	0.67
Men	0.57	0.59	0.56	0.56	0.51
Women	0.43	0.41	0.44	0.44	0.49
Agriculture	0.05	0.06	0.03	0.04	0.07
Industry	0.38	0.40	0.39	0.34	0.33
Services	0.57	0.54	0.58	0.63	0.60
Private sector	0.82	0.82	0.85	0.82	0.80
Public sector	0.18	0.18	0.15	0.18	0.20
Job satisfaction	3.73	3.73	3.85	3.79	3.59
Observations	6169	3330	1202	349	1288

Note: the statistics presented are the average proportion of the sample corresponding to each category, with the exception of job satisfaction, for which the average sample value is reported.

Source: ECHP.

Table 3.7: Descriptive statistics - Group L Countries

Variable	Overall	Remain tempo-rary	Intra-firm transition	Inter-firm transition	Jobless-ness
Duration in months:					
$]0,3[$	0.21	0.16	0.16	0.29	0.31
$[3,6[$	0.16	0.14	0.14	0.18	0.23
$[6,9[$	0.12	0.12	0.12	0.11	0.14
$[9,12[$	0.08	0.09	0.08	0.08	0.07
$[12,15[$	0.11	0.11	0.13	0.10	0.09
$[15,18[$	0.07	0.08	0.09	0.06	0.04
$[18,21[$	0.04	0.04	0.06	0.03	0.03
$[21,24[$	0.03	0.03	0.06	0.03	0.02
$[24,30[$	0.07	0.09	0.07	0.05	0.03
≥ 30	0.10	0.14	0.09	0.06	0.03
First job	0.67	0.48	0.80	0.79	0.88
Not first job	0.33	0.52	0.20	0.21	0.12
Age [16,30[	0.46	0.42	0.44	0.56	0.49
Age [30,45[	0.38	0.42	0.41	0.36	0.28
Age [45,65]	0.16	0.16	0.15	0.08	0.22
Firm size $<$20 workers	0.41	0.40	0.39	0.37	0.49
Firm size 20-99 workers	0.28	0.31	0.25	0.26	0.26
Firm size $>$99 workers	0.31	0.29	0.36	0.37	0.24
Secondary education or more	0.76	0.80	0.77	0.71	0.68
Less than secondary education	0.24	0.20	0.23	0.29	0.32
Training worker	0.49	0.48	0.47	0.50	0.50
No training worker	0.51	0.52	0.53	0.50	0.50
Training firm	0.46	0.49	0.55	0.44	0.33
No training firm	0.54	0.51	0.45	0.56	0.67
Training worker+firm	0.32	0.34	0.37	0.31	0.23
Training worker+no training firm	0.17	0.14	0.10	0.20	0.27
No training worker+training firm	0.14	0.15	0.18	0.14	0.10
No training worker+no training firm	0.37	0.37	0.35	0.36	0.40
Men	0.42	0.39	0.44	0.52	0.38
Women	0.58	0.61	0.56	0.48	0.62
Agriculture	0.02	0.02	0.02	0.02	0.03
Industry	0.21	0.17	0.26	0.26	0.21
Services	0.77	0.81	0.72	0.72	0.76
Private sector	0.53	0.45	0.62	0.64	0.52
Public sector	0.47	0.55	0.38	0.36	0.48
Job satisfaction	4.22	4.19	4.32	4.23	4.18
Observations	2778	1232	589	377	580

Note: the statistics presented are the average proportion of the sample corresponding to each category, with the exception of job satisfaction, for which the average sample value is reported.

Source: ECHP.

Table 3.8: Transitions - Results without unobserved heterogeneity

VARIABLES	Same employer	Diferent employer	Joblessness
Duration in months:			
$[3, 6[$	0.1166	-0.1477	-0.1212*
	(0.1004)	(0.1212)	(0.0677)
$[6, 9[$	0.3739***	0.0416	-0.4275***
	(0.1042)	(0.131)	(0.0828)
$[9, 12[$	0.4661***	-0.0842	-0.3782***
	(0.1101)	(0.1498)	(0.0935)
$[12, 15[$	0.8105***	-0.0746	-0.4177***
	(0.0953)	(0.1353)	(0.086)
$[15, 18[$	0.8244***	-0.2646	-0.6034***
	(0.1058)	(0.1705)	(0.1081)
$[18, 21[$	0.8403***	-0.199	-0.7248***
	(0.1178)	(0.2033)	(0.1301)
$[21, 24[$	0.9813***	-0.1618	-0.8303***
	(0.1253)	(0.226)	(0.153)
$[24, 30[$	0.9654***	-0.2111	-0.7186***
	(0.1045)	(0.1712)	(0.1127)
≥ 30	1.1300***	-0.1453	-1.1605***
	(0.0948)	(0.1538)	(0.114)
Not first job	-0.9981***	-0.7289***	-1.2463***
	(0.0571)	(0.09)	(0.0595)
Age [30,45[	0.0744	-0.1447*	-0.1789***
	(0.0551)	(0.0877)	(0.0567)
Age [45,65]	-0.0508	-0.6825***	0.1749**
	(0.0815)	(0.1516)	(0.0691)
Firm size 20-99 workers	-0.0684	-0.0669	-0.1115**
	(0.0587)	(0.0941)	(0.0559)
Firm size $>$99 workers	-0.0506	-0.0323	-0.2130***
	(0.0632)	(0.0986)	(0.0657)
Secondary education or more	0.2581***	0.1978**	-0.4585***
	(0.0576)	(0.091)	(0.056)
Training worker+firm	0.2361***	0.2972**	-0.5205***
	(0.0814)	(0.13)	(0.0972)
Training worker+no training firm	-0.1559**	0.2063*	0.1377**
	(0.0784)	(0.1066)	(0.0661)
No training worker+training firm	0.2769***	-0.0932	-0.2765***
	(0.0839)	(0.1492)	(0.0986)
IMD Labour market Regulations	0.3716***	0.5281***	0.0971
	(0.0931)	(0.1352)	(0.0964)
IMD Training worker+firm	-0.3274***	-0.3641***	0.0845
	(0.0823)	(0.1058)	(0.0989)
IMD Training worker+no training firm	-0.157	-0.13	0.0554
	(0.0997)	(0.1134)	(0.088)
IMD No training worker+training firm	-0.2424**	-0.1172	-0.0831
	(0.0981)	(0.1258)	(0.116)
Men	0.0543	0.3002***	-0.2295***
	(0.0522)	(0.0803)	(0.0512)
Industry	0.5451***	0.2307	-0.2235**
	(0.161)	(0.2335)	(0.1069)
Services	0.4417***	0.2818	-0.1213
	(0.1607)	(0.2283)	(0.1052)
Job satisfaction	0.1652***	-0.0199	-0.1763***
	(0.0301)	(0.0435)	(0.0276)
Private sector	0.5139***	0.3104***	-0.2452***
	(0.0676)	(0.0971)	(0.0608)
Constant	-3.6851***	-2.5842***	0.7402**
	(0.3574)	(0.4979)	(0.3406)
Observations	8,947	8,947	8,947
Country dummies	yes	yes	yes
Time dummies	yes	yes	yes
Log-pseudolikelihood	-4078	-2280	-3973

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.9: Transitions - Results with unobserved heterogeneity

VARIABLES	Same employer	Diferent employer	Joblessness
Duration in months:			
$[3, 6[$	0.1166	-0.1494	-0.1259*
	(0.1003)	(0.136)	(0.0716)
$[6, 9[$	0.3739***	0.0641	-0.4443***
	(0.1041)	(0.1485)	(0.0867)
$[9, 12[$	0.4661***	-0.0594	-0.3885***
	(0.11)	(0.1682)	(0.0981)
$[12, 15[$	0.8105***	0.023	-0.3803***
	(0.0972)	(0.1554)	(0.0934)
$[15, 18[$	0.8245***	-0.1668	-0.5726***
	(0.1082)	(0.1953)	(0.1136)
$[18, 21[$	0.8404***	-0.0802	-0.6988***
	(0.1207)	(0.2311)	(0.1352)
$[21, 24[$	0.9814***	-0.0497	-0.8167***
	(0.1273)	(0.2557)	(0.1578)
$[24, 30[$	0.9655***	-0.0187	-0.6619***
	(0.1135)	(0.2071)	(0.1214)
≥ 30	1.1303***	0.0702	-1.0957***
	(0.1188)	(0.1972)	(0.1262)
Not first job	-0.9981***	-0.8352***	-1.3165***
	(0.0623)	(0.1164)	(0.0726)
Age [30,45[	0.0744	-0.1477	-0.1858***
	(0.0565)	(0.1002)	(0.0599)
Age [45,65]	-0.0508	-0.7493***	0.1871**
	(0.0813)	(0.1716)	(0.0734)
Firm size 20-99 workers	-0.0684	-0.075	-0.1170*
	(0.0583)	(0.1057)	(0.0597)
Firm size >99 workers	-0.0506	-0.036	-0.2213***
	(0.0628)	(0.1135)	(0.0708)
Secondary education or more	0.2581***	0.2398**	-0.4864***
	(0.0579)	(0.1045)	(0.0611)
Training worker+firm	0.2361***	0.3316**	-0.5437***
	(0.0838)	(0.1457)	(0.1023)
Training worker+no training firm	-0.1559**	0.2314*	0.1420**
	(0.0775)	(0.1211)	(0.0695)
No training worker+training firm	0.2769***	-0.0995	-0.2906***
	(0.0829)	(0.1666)	(0.1046)
IMD Labour market Regulations	0.3716***	0.5968***	0.1056
	(0.0933)	(0.1542)	(0.1017)
IMD Training worker+firm	-0.3274***	-0.4309***	0.0804
	(0.0853)	(0.1326)	(0.1024)
IMD Training worker+no training firm	-0.157	-0.1361	0.0584
	(0.0999)	(0.1357)	(0.0925)
IMD No training worker+training firm	-0.2424**	-0.1548	-0.0877
	(0.0969)	(0.1488)	(0.122)
Men	0.0543	0.3433***	-0.2522***
	(0.052)	(0.0946)	(0.0561)
Industry	0.5451***	0.2778	-0.2379**
	(0.1588)	(0.2641)	(0.1163)
Services	0.4418***	0.3137	-0.1316
	(0.159)	(0.2577)	(0.1141)
Job satisfaction	0.1652***	-0.0132	-0.1845***
	(0.0301)	(0.0492)	(0.0297)
Private sector	0.5140***	0.3343***	-0.2627***
	(0.0704)	(0.1111)	(0.0659)
Constant	-3.6854***	-3.1474***	0.7546**
	(0.3635)	(0.6032)	(0.3581)
Observations	8,947	8,947	8,947
Country dummies	yes	yes	yes
Time dummies	yes	yes	yes
ρ	0.000145	0.433	0.127
Log-pseudolikelihood	-4078	-2277	-3972

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.10: Transitions to an open-ended contract with the same employer- Results with unobserved heterogeneity, by country group

VARIABLES	Group M	Group L
Duration in months:		
$[3,6[$	-0.0249	0.3203**
	(0.1345)	(0.1592)
$[6,9[$	0.3264**	0.4397**
	(0.136)	(0.175)
$[9,12[$	0.5595***	0.3238
	(0.1359)	(0.2007)
$[12,15[$	0.8899***	0.6921***
	(0.1405)	(0.175)
$[15,18[$	0.8345***	0.8430***
	(0.151)	(0.2022)
$[18,21[$	0.8306***	1.0660***
	(0.1712)	(0.2351)
$[21,24[$	0.9767***	1.2425***
	(0.1734)	(0.2447)
$[24,30[$	1.1344***	0.6910***
	(0.1896)	(0.2254)
≥ 30	1.3625***	0.7686***
	(0.2624)	(0.2351)
Not first job	-1.1371***	-0.8137***
	(0.1231)	(0.1205)
Age [30,45[	0.0875	0.1215
	(0.0703)	(0.1077)
Age [45,65]	-0.0867	0.0906
	(0.1052)	(0.1396)
Firm size 20-99 workers	-0.0787	-0.0793
	(0.069)	(0.1171)
Firm size >99 workers	-0.1854**	0.1014
	(0.0816)	(0.1161)
Secondary education or more	0.2924***	0.1154
	(0.0745)	(0.1207)
Training worker+firm	0.0823	0.3545**
	(0.1512)	(0.149)
Training worker+no training firm	-0.0274	-0.5504***
	(0.1041)	(0.1877)
No training worker+training firm	0.1378	0.3105*
	(0.1463)	(0.1618)
IMD Labour market Regulations	0.8715***	-0.1196
	(0.1701)	(0.1557)
IMD Training worker+firm	-0.4753**	-0.1829
	(0.2328)	(0.1299)
IMD Training worker+no training firm	-0.0553	0.1506
	(0.1736)	(0.1776)
IMD No training worker+training firm	-0.5308**	-0.0534
	(0.2398)	(0.144)
Men	0.0725	-0.0251
	(0.0665)	(0.0956)
Industry	0.4722***	0.6873*
	(0.1832)	(0.3548)
Services	0.4103**	0.4982
	(0.1845)	(0.3476)
Job satisfaction	0.1837***	0.1429**
	(0.0371)	(0.061)
Private sector	0.4597***	0.5792***
	(0.0953)	(0.114)
Constant	-2.5364***	-2.6162***
	(0.3344)	(0.606)
Observations	6,169	2,778
Country dummies	yes	yes
Time dummies	yes	yes
ρ	0	0.156
Log-pseudolikelihood	-2704	-1309

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.11: Transitions to an open-ended contract with a new employer - Results with unobserved heterogeneity, by country group

VARIABLES	Group M	Group L
Duration in months:		
$[3, 6[$	-0.1588	-0.1603
	(0.2045)	(0.18)
$[6, 9[$	0.3078	-0.1513
	(0.2088)	(0.2049)
$[9, 12[$	0.005	-0.1345
	(0.2351)	(0.2402)
$[12, 15[$	0.3401*	-0.3048
	(0.2045)	(0.224)
$[15, 18[$	-0.1482	-0.1867
	(0.27)	(0.2847)
$[18, 21[$	-0.0188	-0.0375
	(0.3065)	(0.3448)
$[21, 24[$	-0.0946	0.0601
	(0.3602)	(0.3771)
$[24, 30[$	0.1165	-0.1775
	(0.2638)	(0.3035)
≥ 30	0.2033	-0.1167
	(0.2532)	(0.2959)
Not first job	-0.8723***	-0.7677***
	(0.1568)	(0.1681)
Age [30,45[	-0.0986	-0.172
	(0.143)	(0.1377)
Age [45,65]	-0.3211	-1.0154***
	(0.2371)	(0.2405)
Firm size 20-99 workers	-0.0788	-0.1173
	(0.1404)	(0.1565)
Firm size >99 workers	-0.0583	-0.0597
	(0.1635)	(0.1564)
Secondary education or more	0.4502***	-0.1151
	(0.1351)	(0.1502)
Training worker+firm	0.2955	0.2864
	(0.2656)	(0.2132)
Training worker+no training firm	0.1718	0.3009
	(0.1863)	(0.2083)
No training worker+training firm	-0.0709	0.0689
	(0.3172)	(0.2324)
IMD Labour market Regulations	0.9167***	0.3207
	(0.2551)	(0.204)
IMD Training worker+firm	-0.6117*	-0.2983*
	(0.371)	(0.1728)
IMD Training worker+no training firm	-0.1352	-0.1226
	(0.2819)	(0.1978)
IMD No training worker+training firm	0.3953	-0.1702
	(0.483)	(0.1971)
Men	0.2097	0.4527***
	(0.1287)	(0.1368)
Industry	0.2251	0.2347
	(0.33)	(0.4336)
Services	0.2849	0.23
	(0.3276)	(0.4099)
Job satisfaction	0.067	-0.1252*
	(0.0661)	(0.0734)
Private sector	0.3312**	0.2933**
	(0.1683)	(0.1462)
Constant	-2.6979***	-1.6212**
	(0.6101)	(0.7812)
Observations	6,169	2,778
Country dummies	yes	yes
Time dummies	yes	yes
ρ	0.406	0.381
Log-pseudolikelihood	-1254	-1003

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.12: Transitions to joblessness - Results with unobserved heterogeneity, by country group

VARIABLES	Group M	Group L
Duration in months:		
$[3, 6[$	-0.088	-0.2153*
	(0.0898)	(0.122)
$[6, 9[$	-0.4299***	-0.4913***
	(0.1096)	(0.1452)
$[9, 12[$	-0.2395**	-0.7290***
	(0.1168)	(0.1872)
$[12, 15[$	-0.2813**	-0.5330***
	(0.1148)	(0.1661)
$[15, 18[$	-0.4786***	-0.7809***
	(0.1334)	(0.2304)
$[18, 21[$	-0.6686***	-0.7090***
	(0.1609)	(0.2583)
$[21, 24[$	-0.7528***	-0.8715***
	(0.1869)	(0.3045)
$[24, 30[$	-0.4726***	-1.2146***
	(0.1417)	(0.263)
≥ 30	-0.9357***	-1.6515***
	(0.1437)	(0.2856)
Not first job	-1.3041***	-1.4091***
	(0.0868)	(0.14)
Age [30,45[	-0.0788	-0.3801***
	(0.0709)	(0.1121)
Age [45,65]	0.2007**	0.195
	(0.0924)	(0.1218)
Firm size 20-99 workers	-0.1404*	-0.1382
	(0.0722)	(0.1093)
Firm size >99 workers	-0.2795***	-0.2406**
	(0.0901)	(0.1222)
Secondary education or more	-0.4972***	-0.4314***
	(0.0749)	(0.1146)
Training worker+firm	-0.3783*	-0.8711***
	(0.195)	(0.1639)
Training worker+no training firm	-0.0153	0.1498
	(0.1065)	(0.1375)
No training worker+training firm	-0.1909	-0.6098***
	(0.2021)	(0.191)
IMD Labour market Regulations	0.3737**	-0.2114
	(0.151)	(0.1638)
IMD Training worker+firm	-0.1325	0.4092***
	(0.3107)	(0.1562)
IMD Training worker+no training firm	-0.2636	0.1938
	(0.161)	(0.1605)
IMD No training worker+training firm	-0.1497	0.2521
	(0.3066)	(0.1865)
Men	-0.2947***	-0.1914*
	(0.0683)	(0.0996)
Industry	-0.2862**	-0.1006
	(0.1281)	(0.2941)
Services	-0.1526	-0.0982
	(0.1273)	(0.2788)
Job satisfaction	-0.2258***	-0.0836
	(0.0352)	(0.0573)
Private sector	-0.2918***	-0.3131***
	(0.0869)	(0.1037)
Constant	1.4113***	0.8286
	(0.2591	-0.5309
Observations	6,169	2,778
Country dummies	yes	yes
Time dummies	yes	yes
ρ	0.146	0.0884
Log-pseudolikelihood	-2765	-1175

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.13: Transitions between temporary jobs - Results with unobserved heterogeneity

VARIABLES	Overall	Group M	Group L
episode 2	-0.4069***	-0.4040***	-0.3617
	(0.1044)	(0.1165)	(0.2338)
episode 3	-0.2405	-0.2959	0.1676
	(0.1911)	(0.2154)	(0.4055)
Duration in months:			
$[6, 12[$	-0.0575	-0.0506	-0.0619
	(0.1)	(0.1138)	(0.2112)
$[12, 18[$	-0.2371**	-0.2503**	-0.171
	(0.1017)	(0.1139)	(0.2328)
$[18, 24[$	-0.6210***	-0.6283***	-0.5633**
	(0.1392)	(0.16)	(0.2851)
≥ 24	-0.9024***	-1.0442***	-0.3959
	(0.1372)	(0.158)	(0.276)
Age [30,45[	0.0585	0.1253	-0.2233
	(0.0798)	(0.0908)	(0.1584)
Age [45,65]	-0.1797	-0.0956	-0.5010**
	(0.112)	(0.1261)	(0.2338)
Men	0.1939**	0.2352**	0.1182
	(0.0805)	(0.0919)	(0.1749)
Secondary education or more	-0.2371***	-0.2028**	-0.3388*
	(0.0831)	(0.0941)	(0.1927)
Industry	-0.0756	-0.1177	0.7391
	(0.1467)	(0.1532)	(0.612)
Services	-0.2486*	-0.2777*	0.4949
	(0.1495)	(0.158)	(0.6123)
Private sector	-0.0978	0.1108	-0.4644***
	(0.0967)	(0.1281)	(0.1771)
Supervisory	0.2534	0.3641	0.1499
	(0.2539)	(0.3173)	(0.3889)
Intermediate	0.1755	0.1584	0.1703
	(0.1197)	(0.1443)	(0.2148)
Previous job: quit	-0.1368	-0.1255	-0.2999
	(0.1349)	(0.1577)	(0.2725)
Previous job: layoff	-0.2044	-0.2233	-0.1505
	(0.1602)	(0.1862)	(0.3236)
Previous job: contract end	0.1638	0.1065	0.3149
	(0.1166)	(0.1385)	(0.2119)
Constant	-1.0828***	-1.1159***	-1.5461**
	(0.2936)	(0.2492)(0.6821)	
Observations	3,948	2,870	1,078
Country dummies	yes	yes	yes
Time dummies	yes	yes	yes
ρ	0.0577	0.0516	0
Log-pseudolikelihood	-1933	-1458	-461.6

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.14: Number of temporary jobs held by a worker - Count model results

VARIABLES	Overall	Group M	Group L
Secondary education or more	-0.0873	-0.1686	0.2446
	(0.0556)	(0.0646)**	(0.1227)*
	[-0.0463]	[-0.1034]	[0.0886]
Age [30,45[	0.0642	0.0334	0.1565
	(0.0854)	(0.1017)	(0.1557)
	[0.0350]	[0.0214]	[0.0610]
Age [45,65[	-0.0963	-0.1630	0.1678
	(0.1513)	(0.1805)	(0.2743)
	[-0.0484]	[-0.0946]	[0.0658]
Men	0.0797	0.1044	0.0068
	(0.0537)	(0.0621)	(0.1067)
	[0.0422]	[0.0646]	[0.0026]
Not living in a couple	-0.0734	-0.0295	-0.1074
	(0.0644)	(0.0763)	(0.1202)
	[-0.0392]	[-0.0185]	[-0.0410]
Experience	-0.0033	-0.0009	-0.0114
	(0.0046)	(0.0053)	(0.0088)
	[-0.0018]	[-0.0005]	[-0.0044]
Private sector	-0.1907	0.0009	-0.4800
	(0.0658)**	(0.0839)	(0.1174)**
	[-0.1068]	[0.0006]	[-0.1871]
Intermediate	-0.1917	-0.2108	-0.1935
	(0.1886)	(0.2231)	(0.3441)
	[-0.1167]	[-0.1518]	[-0.0899]
Non-supervisory	-0.2388	-0.2525	-0.3034
	(0.1705)	(0.2005)	(0.3153)
	[-0.1421]	[-0.1783]	[-0.1337]
Firm size 20-99 workers	0.1346	0.1248	0.1717
	(0.0568)*	(0.0638)	(0.1226)
	[0.0737]	[0.0796]	[0.0688]
Firm size >99 workers	-0.0083	0.0341	-0.0236
	(0.0683)	(0.0800)	(0.1332)
	[-0.0042]	[0.0208]	[-0.0086]
Training worker	0.0545	0.0359	0.1673
	(0.0588)	(0.0679)	(0.1173)
	[0.0292]	[0.0226]	[0.0642]
Training firm	-0.1451	-0.1384	-0.2010
	(0.0715)*	(0.0915)	(0.1147)
	[-0.0739]	[-0.0822]	[-0.0764]
Job satisfaction	-0.0580	-0.0451	-0.0941
	(0.0283)*	(0.0314)	(0.0636)
	[-0.0308]	[-0.0282]	[-0.0361]
Part-time job	-0.1244	-0.0718	-0.2479
	(0.0853)	(0.1025)	(0.1517)
	[-0.0629]	[-0.0436]	[-0.0874]
Industry	-0.1740	-0.1937	0.0640
	(0.1103)	(0.1148)	(0.3617)
	[-0.1063]	[-0.1404]	[0.0237]
Services	-0.2749	-0.3088	0.0706
	(0.1095)*	(0.1156)**	(0.3469)
	[-0.1599]	[-0.2119]	[0.0262]
Constant	-0.1070	-0.0850	-0.3371
	(0.3034)	(0.2893)	(0.6068)
ln(α)	-1.5342	-1.6708	-1.7593
p-value of LR test for $\alpha = 0$	(0.000)***	(0.001)**	(0.080)*
Observations	5,246	3,441	1,805
Country dummies	yes	yes	yes

Robust standard errors in parentheses. Marginal effects in square brackets.
*** p<0.01, ** p<0.05, * p<0.1

Bibliography

Alba-Ramirez, A. (1998), 'How temporary is temporary employment in Spain?', *Journal of Labor Research, Springer* **19**(4), 695–710.

Albert, C., García-Serrano, C. and Hernanz, V. (2004), 'Firm-provided training and temporary contracts', *Spanish Economic Review, Springer* **7**(1), 67–88.

Amuedo-Dorantes, C. (2000), 'Work transitions into and out of involuntary temporary employment in a segmented market: Evidence from Spain', *Industrial and Labor Relations Review, Cornell University, ILR School* **53**(2), 309–325.

Antunes, A. R. and Centeno, M. (2007), Do labor market policies affect employment composition? Lessons from European countries, Working Papers w200721, Banco de Portugal, Economics and Research Department.

Autor, D. H. (2001), 'Why do temporary help firms provide free general skills training?', *The Quarterly Journal of Economics, MIT Press* **116**(4), 1409–1448.

Bassanini, A., Booth, A. L., Brunello, G., De Paola, M. and Leuven, E. (2005), Workplace Training in Europe, IZA Discussion Papers 1640, Institute for the Study of Labor (IZA).

Bassanini, A. and Brunello, G. (2006), Is Training More Frequent When the Wage Premium Is Smaller?, Post-Print halshs-00129742, HAL.

Bassanini, A. and Garnero, A. (2013), 'Dismissal protection and worker flows in OECD countries: Evidence from cross-country/cross-industry data', *Labour Economics, Elsevier* **21**(C), 25–41.

Blanchard, O. and Portugal, P. (2001), 'What Hides Behind an Unemployment Rate: Comparing Portuguese and U.S. Labor Markets', *American Economic Review, American Economic Association* **91**(1), 187–207.

Boeri, T. (2011), Institutional Reforms and Dualism in European Labor Markets, Vol. 4 of *Handbook of Labor Economics*, Elsevier, pp. 1173–1236.

Boeri, T., Nicoletti, G. and Scarpetta, S. (2000), Regulation and labour market performance, *in* 'Regulatory reform and competitiveness in Europe', Vol. 1, Edward Elgar Publishers, pp. 324–380.

Boeri, T. and van Ours, J. (2013), *The Economics of Imperfect Labor Markets: Second Edition*, Vol. 1 of *Economics Books*, Princeton University Press.

Bonnal, L., Fougère, D. and Sérandon, A. (1997), 'Evaluating the Impact of French Employment Policies on Individual Labour Market Histories', *Review of Economic Studies* **64**(4), 683–713.

Booth, A. L., Francesconi, M. and Frank, J. (2002), 'Temporary Jobs: Stepping Stones Or Dead Ends?', *Economic Journal, Royal Economic Society* **112**(480), F189–F213.

Booth, A. L., Francesconi, M. and García-Serrano, C. (1997), Job Tenure: Does History Matter?, CEPR Discussion Papers 1531, C.E.P.R. Discussion Papers.

Cameron, A. C. and Miller, D. L. (2015), 'A practitioner's guide to cluster-robust inference', *Forthcoming in Journal of Human Resources* .

Cameron, A. C. and Trivedi, P. K. (2005), *Microeconometrics: Methods and Applications*, Cambridge, Cambridge University Press.

Cameron, A. C. and Trivedi, P. K. (2010), *Microeconometrics Using Stata, Revised Edition*, Stata Press books, StataCorp LP.

CEDEFOP (2010), *Employeer provided vocational training in Europe. Evaluation and interpretation of the third continuing vocational training survey*, number 2, Publications Office of the European Union.

Centeno, M. and Novo, Á. A. (2012), 'Excess worker turnover and fixed-term contracts: Causal evidence in a two-tier system', *Labour Economics, Elsevier* **19**(3), 320–328.

D'Addio, A. C. and Rosholm, M. (2005), 'Exits from temporary jobs in Europe: A competing risks analysis', *Labour Economics, Elsevier* **12**(4), 449–468.

European Commission (2005), *Employment in Europe 2005*, Luxembourg: Publications Office of the European Union.

European Commission (2008), *Employment in Europe 2008*, Luxembourg: Publications Office of the European Union.

Fitzenberger, B., Osikominu, A. and Paul, M. (2010), The Heterogeneous Effects of Training Incidence and Duration on Labor Market Transitions, IZA Discussion Papers 5269, Institute for the Study of Labor (IZA).

Gagliarducci, S. (2005), 'The dynamics of repeated temporary jobs', *Labour Economics, Elsevier* **12**(4), 429–448.

Gielen, A. C. and Tatsiramos, K. (2012), 'Quit behavior and the role of job protection', *Labour Economics, Elsevier* **19**(4), 624–632.

Gordon, S. C. (2002), 'Stochastic dependence in competing risks', *American Journal of Political Science* pp. 200–217.

Guell, M. and Petrongolo, B. (2007), 'How binding are legal limits? Transitions from temporary to permanent work in Spain', *Labour Economics, Elsevier* **14**(2), 153–183.

Jenkins, S. P. (2005), 'Survival analysis', *Unpublished manuscript, Institute for Social and Economic Research, University of Essex, Colchester, UK* .

Kahn, L. M. (2010), 'Employment protection reforms, employment and the incidence of temporary jobs in Europe: 1996-2001', *Labour Economics, Elsevier* **17**(1), 1–15.

Kahn, L. M. (2012), 'Temporary jobs and job search effort in Europe', *Labour Economics, Elsevier* **19**(1), 113–128.

Long, J. S. and Freese, J. (2001), *Regression models for categorical dependent variables using Stata*, College Station, Texas, Stata press.

Melero, M. E. (2004), Evidence on training and career paths: Human capital, information and incentives, IZA Discussion Papers 1377, Institute for the Study of Labor (IZA).

OECD (1993), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (1996), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (1999), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2004), *OECD employment outlook*, Organization for Economic Cooperation and Development.

OECD (2013), 'OECD EPL Database, update 2013', `http://www.oecd.org/employment/emp/oecdindicatorsofemploymentprotection.htm`.

Orsini, K. and Vila Nuñez, S. (2014), The impact of the Spanish labour market reform on the on-the-job search rate, *in* 'ECFIN Country Focus', number 7, European Commission.

Portugal, P. and Varejão, J. (2009), Why do firms use fixed-term contracts?, IZA Discussion Papers 4380, Institute for the Study of Labor (IZA).

Sicherman, N. and Galor, O. (1990), 'A Theory of Career Mobility', *Journal of Political Economy, University of Chicago Press* **98**(1), 169–92.

Thomas, J. M. (1996), 'On the interpretation of covariate estimates in independent competing-risks models', *Bulletin of Economic Research, Wiley Blackwell* **48**(1), 27–39.

van den Berg, G. J. (2005), Competing risks models, Technical Report 25, Working Paper, IFAU-Institute for Labour Market Policy Evaluation.

Willett, J. B. and Singer, J. D. (1995), 'It's déjà vu all over again: Using multiple-spell discrete-time survival analysis', *Journal of Educational and Behavioral Statistics, Sage Publications* **20**(1), 41–67.

Winkelmann, R. and Zimmermann, K. F. (1998), 'Is job stability declining in Germany? Evidence from count data models', *Applied economics* **30**(11), 1413–1420.