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Abstract

The aim of this paper is to highlight the interaction between inflation persistence and the labor market institutions in a New Keynesian model with a search and matching labor market. In this framework, I reintroduce severance pay and show that the negotiation of this severance pay creates a new real rigidity into wage dynamics. Indeed, following the *bonding critique*, in a context of free negotiation and in presence of firing costs, workers agree to pay a share of severance pay in order to reduce the burden on firms. Then, a contribution system appears, affecting the real wage dynamics and inflation persistence through the New Keynesian Phillips curve.

JEL classification: E31, E32, J31.

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1 Introduction

Recent literature focuses on factors driving inflation persistence because of two main reasons: first, from a theoretical point of view , recent DSGE models are unable to replicate the sluggish response of inflation in concert with a large response of output. Secondly, in order to stabilize inflation central bankers need to understand what drives inflation dynamics. For instance, the amplitude of monetary policy response to a shock will directly depend on the degree of inflation persistence. From a pure european point of view, inflation persistence is a central preoccupation for policymakers as it is highlighted by Altissimo et al. (2006). In this article, the authors present the different results of the Eurosystem Inflation Persistence Network (IPN *hereafter*). One of them is the uncertainty about the qualitative and the quantitative nature of inflation persistence. This uncertainty affects the conduite of the monetary policy such as a more gradually response to economic shock.

The aim of this paper is to provide a theoretical framework able to replicate inflation persistence as measured in empirical data. Thus, I stress the role of firing costs and, in particular, of severance pay in explaining inflation persistence. Following Garibaldi and Violante (2005), I extend the model of Trigari (2006) with right-to-manage bargaining. I compare three situations : a first one in which firing costs are set by the law; a second one in which bargained firing costs are introduced but where the real wage is efficiently bargained; a third one in which firing costs are efficiently bargained but where the real wage is set thanks to right-to-manage bargaining. I show that right-to-manage bargaining combined with bargained firing costs are able to increase inflation persistence in DSGE models.

The structural form of inflation persistence highlights three sources of persistence: the central bank behavior, intrinsic persistence (that is transmitted from inflation itself) and inherited persistence from other variables such as the output gap or marginal cost. As expounded by Fuhrer (2010), in a world Calvo (1983), the New Keynesian Phillips Curve (NKPC hereafter) takes the form of a pure forward-looking curve where inherited persistence as only source of inflation persistence, where marginal cost is the key variable. Because of this NKPC that links the inflation level and firms' marginal cost, both labor market institutions and the real wage play a fundamental role in inflation persistence. For instance, Trigari (2006) shows that wage bar-

gaining has a great impact on inflation persistence. The author distinguishes two different Nash bargaining process : the efficient bargaining where workers and firms negotiate conjointly both the real wage and the hours worked; and the right-to-manage bargaining where firms and workers negotiate together the real wage but where firms set the hours worked unilateraly and according to the level of the real wage. Right-to-manage bargaining triggers a wage channel and links the real wage to firms' marginal cost. This channel engraves wage dynamics into inflation dynamics thanks to the NKPC. Following this literature, Christoffel and Linzert (2006), Blanchard and Gali (2007), Christoffel et al. (2009b), Tsoukis et al. (2011) among others show the importance of the real wage rigidity for explaining inflation persistence.

As expounded by Galí (2010), the introduction of wage rigidity has been realized thanks to two main approaches: a stream of the literature suggests to introduce rigidity on the intensity in which the real wage is renegotiated. Among them, Christoffel and Linzert (2006) introduce a wage norm into a DSGE model. In this case, the real wage is forced to stay close to its recent history. In a right-to-manage framework, the authors show that wage norm significantly increases inflation persistence. The second approach assumes that the real wage is no longer continuously bargained. A nominal rigidity *à la* Calvo (1983) is assumed so that, while a share of the real wages is re-optimized, another share of the real wages remains unchanged for several periods. In this paper, I suggest a third approach using severance pay. Specifically, wage rigidity is *per se* obtained thanks to the model and there is no "*ad hoc*" rigidity added concerning wage dynamics.

This approach is motivated by an empirical assessment: as expounded by Thomas (2006), there is a negative correlation between the level of firing costs and the business cycle fluctuations. In a search and matching model, the author shows that firing costs decrease the volatility of job destruction. In turn, this reduction translates into a lower volatility of business cycle fluctuations. Veracierto (2008) finds similar results in a real business cycle model following a productivity shock. Macit (2010) emphasizes that there is a negative correlation between the OECD's Employment Protection Legislation (EPL *hereafter*) index and the real wage and inflation volatilities. Macit (2010) introduces a lay-off tax into a DSGE model with search and matching frictions in order to analyse how firing costs affect the real wage negotiation. In an efficient bargaing framework, firing costs increase insiders' real wage

while their decrease outsiders' one. However, even if firing costs impact the real wage dynaics, they do not improve the degree of inflation persistence into New Keynesian models. Two mains reasons can explain this fact. First, in the efficient bargaining framework, real wage does not affect directly the firms' marginal cost, which is the key variable in the NKPC. Secondly, lay-off tax is assumed to be constant and does not vary depending on the business cycle fluctuations. Starting from this assessment, I propose to analyse the impact of severance pay on inflation persistence in a right-to-manage bargaining framework.

Since the work of Lazear (1990), severance pay of firing costs have been neglected from theoretical models. Severance pay represents a transfer from firms to workers that can be undone freely by workers in case of perfect flexible wage bargaining framework. Thus, severance pay has no impact on firms' decisions. This theoretical point is known as the bonding critique. From a theoretical perspective, the consequence of the bonding critique is straightforward: firing costs are modeled as a tax, without transfers from firms to workers. However, Garibaldi and Violante (2002, 2005) recently showed that severance pay must be reintroduced into theoretical models for two main reasons. First, from a quantitative point of view, severance pay is at least as important as taxes in global firing costs. In Italy, they represent approximately 80% of global firing costs. Secondly, severance pay and tax component of firing costs do not have the same impact on employment expect in the case of full wage rigidity. Thus, transfers induced by severance pay play a crucial role in labor market's dynamics. Moreover, Fella (2007) also argues that severance pay has no impact in firms' decisions because the theoretical framework in which they are studied is not relevant. Finally, I show that the optimal behavior highlighted by Lazear, which allows workers to avoid the effects of severance pay, can be understood as a contribution system to the worker's job protection. This contribution system will introduce a new intrinsic rigidity in wage dynamics that will be turned into inflation persistence thanks to the wage channel and the NKPC.

For this purpose, I model firing costs similarly to Garibaldi and Violante (2005). I assume they are composed by two elements: a tax component and a transfer component. The tax component generally represents a notice period that is a cost for firms in case of lay-off. It does not affect workers' decisions. By contrast, severance pay is both a cost for firms and a temporary

new income for workers. Then, I compare four different situations. I take as reference the model of Trigari (2006): I model a labor market in which the real wage is efficiently bargained and in which there is no firing cost. Then, I compare this situation to three others. I gradually introduce severance pay in order to identify which bargained severance pay characteristic affects inflation persistence. First, I reintroduce into a New Keynesian model a fix severance pay in order to study the impact of the transfer resulting from this severance pay. Then, I allow workers and firms to efficiently negotiate the level of severance pays, following Garibaldi and Violante (2005). Thereafter, two situations are distinguished: a first situation in which the real wage is efficiently negotiated and a second situation in which the real wage is negotiated following the right-to-manage bargaining framework. This distinction is essential in order to evaluate the importance of the wage channel expounded by the literature.[1,2]

My findings can be summarized as follows: in the right-to-manage bargaining framework, the contribution system implied by bargained severance pay improves inflation persistence in the standard New Keynesian model. When firing costs are fixed, their two components act similarly on wages: they both increase insiders' the real wage and they decrease outsiders' the real wage. When severance pay is bargained, the impact of firing costs on insiders' wage becomes ambiguous: as it has usually been shown in the literature, the contemporary impact of firing cost on wage is positive. However, because workers and firms can optimally bargain the level of severance pay, workers agree to contribute for a part of the job protection of the next period. This effect decreases the level of the real wage. This contribution system introduces a new source of rigidity in the wage dynamics that, in return, increases the level of inflation persistence when the wage channel is present.

The rest of the paper is structured as follows. Section 2 presents the New Keynesian framework and section 3 focuses on the negotiation of wage

[1]Another case can be found in the literature: Macit (2010) investigates the case where there is only a fixed tax on lay-off and where wage is efficiently bargained. Especially, the author shows that firing costs affect differently outsider and insiders. However, this distinction does not allows the model to replicate infation persistence.

[2]Only the last case will be presented in the paper. The three others cases that I study are presented in Appendix A.

and hours worked. Section 4 presents the wage channel under the right-to-manage bargaining. Section 5 presents the calibration choice while section 6 presents my results. Section 7 concludes.

2 The New Keynesian framework

In this section, I give details about the New Keynesian framework that closely follows Trigari (2006). The economy is composed of a representative household, a Central Bank and three industrial sectors: an intermediate goods sector, a retail goods sector and a final goods sector. For simplicity's sake, firms producing in the intermediate goods sector are simply called *firms*; firms producing in the retail goods sector are called *retailers*; and finally the firm producing in the final good sector is called the *final goods firm*. This separation allows me to study distincly the labor market *à la* Mortensen and Pissarides (1994) and the price setting.

Retailers evolve in a monopolistic competition market. Nevertheless, firms and retailers meet each other in a perfect competitive market, so as the representative household and the final goods firm do. One can note that this artificial separation is neutral with regard to inflation persistence.[3]

2.1 The representative household

I assume that there is a representative household composed by a continuum of homogeneous workers indexed on the unit interval. As in Merz (1995), each worker insures each other members of the household by sharing his earned income, namely his wage or his unemployment benefits. Following Christoffel et al. (2009a), the instantaneous utility function is separable in consumption and leisure. The latter is given for each member of the representative household by:

$$U(c_t, c_{t-1}) - g(h_t), \tag{2.1}$$

with

$$g(h_t) = \kappa_h \frac{h_t^{1+\phi}}{1+\phi}, \tag{2.2}$$

[3]This neutrality has been showed by Sveen and Weinke (2007), Christoffel et al. (2009a), Kuester (2010) and Thomas (2011).

and

$$U(c_t, c_{t-1}) = \log(c_t - ec_{t-1}), \tag{2.3}$$

where (c_t, c_{t-1}) represents the utility derived from consumption and $g(h_t)$ represents the disutility derived from the labor supply h_t. The degree of habit formation in consumption is represented by $e > 0$. The labor supply elasticity is $1/\phi$, and $\kappa_h > 0$ is a scale parameter. I assume that there are some consumption habits in the household members' behavior in order to let retailers adjust their production to a shock thanks to the extensive margin rather than the intensive margin, that is to say employment rather than hours worked. This assumption is consistent with Trigari (2009) for the US economy and Rogerson and Shimer (2011) for the OECD countries.

The representative household's maximization problem is

$$\max_{c,t,B_t} E_t \sum_{s=0}^{\infty} \beta^s [U(c_{t+s}, c_{t+s-1}) - G_{t+s}], \tag{2.4}$$

subject to

$$c_t + \frac{B_t}{p_t r_t^n} = d_t + \frac{B_{t-1}}{p_t}. \tag{2.5}$$

The utility of the representative household depends on the level of consumption per capita as well as the total cost of labor supply G_{t+s}. Here, I assume there is no inactive worker in the economy. A member of the representative household can only be employed or unemployed.

The discount factor is represented by $\beta \in [0, 1]$. The representative household holds one-period bonds B_t with price $1/r_t^n$, where r_t^n is the nominal interest rate. The Consumer Price Index is noted p_t and d_t is the real income per capita in t.

The maximization of the household's program yields the standard Euler equation

$$\lambda_t = \frac{1}{c_t - ec_{t-1}} - E_t \beta \frac{e}{c_{t+1} - ec_t} \tag{2.6}$$

$$\lambda_t = r_t E_t \lambda_{t+1}, \tag{2.7}$$

where λ_t is the marginal utility of consumption in t and where

$$r_t = \frac{r_t^n}{E_t[\pi_{t+1}]}. \tag{2.8}$$

2.2 The labor market

In the model, workers can be either employed or unemployed. When they are unemployed, workers seek for a job without paying any cost in terms of utility whereas the supply of labor is painful. Firms can have their job filled or vacant. Unlike workers, firms have to pay a cost to post a vacancy. This cost is assumed to be constant.[4]

I assume that firms and workers meet each other in the labor market according to the following standard matching function:

$$m_t = \sigma_m u_t^{\sigma} v_t^{1-\sigma}, \tag{2.9}$$

where m_t is for the number of new matches in the labor market, $\sigma_m > 0$ measures the efficiency of the matching process, u_t is the number of job seekers and v_t is the number of vacancies. I assume that there is no on-the-job search: a worker looks for a new job only when he is fired. The job separation rate is assumed to be exogenous and equal to ρ.

According to the matching function, I define the probability q_t for a firm to fill its job and the probability s_t for a worker to find a job, respectively, as:

$$q_t = \frac{m_t}{v_t} \tag{2.10}$$

and

$$s_t = \frac{m_t}{u_t}. \tag{2.11}$$

[4]Authors as Gertler and Trigari (2006) have made the assumption of variable vacancy costs. Indeed, Gertler and Trigari (2006) assume that hiring costs can be a convex function of the firms' hiring rate. They assume that the more the hiring rate increases, the more costly hire will be. However, for sake of simplicity, I assume that no such costs are present in the economy since it makes no difference in terms of inflation persistence.

Moreover, employment dynamics are given by:

$$n_t = (1 - \rho)n_{t-1} + m_{t-1}, \tag{2.12}$$

where n is the level of employment. Equation (2.12) reads that employment is function of the number of jobs that are not destroyed during the previous period plus the number of new matches during the previous period. Here, I assume that new matches are made at the end of the period. It implies that a new match can only be productive at the beginning of the following period and that hiring a worker is costly in terms of time.

Furthermore, the number of job seekers is equal to the $(1 - n_t)$ workers unemployed at the beginning of the period plus the ρn_t workers who lost their job at the beginning of the period. Thus, I can define the number of job seekers as

$$u_t = 1 - (1 - \rho)n_t. \tag{2.13}$$

Finally, the level of unemployment is given by

$$\Omega_t = 1 - n_t. \tag{2.14}$$

2.3 The different firms

I present the relationship between the different kind of firms. Firms on the intermediate goods sector and firms on the retail goods sector are separated in order to distinguish the labor market interactions from the price setting.

Intermediate goods firms are hiring workers on the labor market. These firms produce intermediate goods only thanks to labor services and sell them to retailers. Then, retailers turn these goods into differentiated goods thanks to a one-to-one technology to finally sell these goods to the final good firms. At the end, the final goods firm aggregates the differentiated goods and sells the final goods to the representative household.

2.3.1 The intermediate goods firms

There is an continuum of firms in monopolistic competition in the intermediate goods sector. Following Mortensen and Pissarides (1999), I assume that

firms can hire only a unique worker. When it is the case, they produce only thanks to labor services and according to the production function:

$$f(h_t) = zh_t^{\alpha}, \tag{2.15}$$

where z is the technological factor for all the firms and with $\alpha \in (0, 1)$ a scale parameter. When firms do not find a worker, they produce nothing.

2.3.2 Retailers, the final good firms and the price setting

I assume there is a continuum i of retailers indexed on the unit interval. These retailers produce their goods according to a technology that changes an intermediate good x_t in a perfect competitive market into a differentiated good y_{it}. Differentiate goods are then imperfect substitute goods and give retailers a market power. Thus, retailers become price setters and can maximize their profits according to their price.

Then, differentiate goods are sold to the final goods firm that aggregates them into final goods y_t.

The final goods firm produces thanks to the following CES production function:

$$y_t = \left[\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{2.16}$$

with $\varepsilon > 1$ the elasticity of substitution between each differentiate goods.

The final goods firm maximizes its profit by choosing the level of each differentiated good that it will include as factor of production. The maximization of profit yields the following demand function for each good y_{it}:

$$y_{it} = \left(\frac{p_{it}}{p_t} \right)^{-\varepsilon} y_t, \tag{2.17}$$

The CPI is defined as follows

$$p_t = \left[\int_0^1 p_{it}^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}}. \tag{2.18}$$

I assume that the economy is subject to some nominal rigidities following Calvo (1983). Retailers can re-optimize their price each period given the probability $1-\varphi$. Then, a share φ of retailers is stuck with its previous price while a share $(1-\varphi)$ of retailers can optimally re-optimize its price. The maximization of the retailers' program yields the optimal level of p_{it}^*:

$$p_{it}^* = \mu \frac{E_t \sum_{s=0}^{\infty} (\beta\varphi)^s u'(c_{t+s}) x_{t+s} p_{t+s}^{\varepsilon-1} y_{t+s}}{E_t \sum_{s=0}^{\infty} \beta\varphi c_{t+s} p_{t+s}^{\varepsilon-1} y_{t+s}}, \tag{2.19}$$

where x_t is the retailers' marginal cost and where $\mu = \frac{\varepsilon}{\varepsilon-1}$ is the optimal mark-up. One can note that in this economy, the retailers' marginal cost is equal to the firms' price.

Finally, given that the law of motion for p_t can be expressed as

$$p_t = \left((1-\varphi) p_t^{*1-\varepsilon} + \varphi p_{t-1}^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}, \tag{2.20}$$

after log-linearizing equations (2.19) and (2.20) and after some rearrangements, one can obtain the NKPC

$$\hat{\pi}_t = \frac{(1-\varphi)(1-\beta\varphi)}{\varphi} \hat{x}_t + \beta E_t \hat{\pi}_{t+1}. \tag{2.21}$$

Finally, a resource constraint for the whole economy is given by

$$y_t = c_t. \tag{2.22}$$

The clearing condition for the retailers market is

$$y_t = n_t(1-\rho) f(h_t), \tag{2.23}$$

where the aggregate demand y_t is equal to the production $f(h_t)$ of each $n_t(1-\rho)$ firm that actually produces.

2.4 Monetary policy

I assume that the monetary authority sets the nominal interest rate according to the following standard Taylor rule:

$$\frac{r_t^n}{r_s^n} = \left(\frac{r_{t-1}^n}{r_s^n}\right)^{\rho_m} \left(\frac{y_t}{y_s}\right)^{\gamma_y(1-\rho_m)} \left(\frac{\pi_t}{\pi_s}\right)^{\gamma_\pi(1-\rho_m)}, \tag{2.24}$$

with ρ_m the interest rate smoothing. The relative weights given by the monetary authority to the stabilization of output and inflation are γ_π and γ_y, respectively. ε_t^m is an *iid* monetary shock.

3 The severance pay bargaining

In this section I present how severance pay is negotiated. I assume that severance pay is renegotiated each period as in Garibaldi and Violante (2005).

First, let us define *ex post* and *ex ante* firing costs according to a court decision. The former refer to firing costs that are imposed by a judge after a lay-off is judged unfair while the latter are referring to firing costs that are negotiated with the fired worker.

Following Goerke (2006), I assume that *ex post* firing costs noted $\hat{F}_t$ are equal to

$$\hat{F}_t = \hat{S}_t + T, \tag{3.1}$$

with

$$\hat{S}_t = w_t^{\Upsilon}. \tag{3.2}$$

$\hat{S}_t$ represents legal severance pay and Υ the wage elasticity of legal severance pay.

However, these costs are valuable only if a judge declares the lay-off unfair with a probability ρ_u. As emphasized by Garibaldi and Violante (2005), many lay-off are not contested. In that case, severance pay can be bargained between the two parties. Assuming that *ex ante* severance pay bargaining follows a Nash process, whose maximization program is

$$\max_{S_t} \left(S_t - \rho_u \hat{S}_t\right)^{\eta} \left[-S_t + \rho_u \left(\hat{S}_t + T\right)\right]^{1-\eta}, \tag{3.3}$$

where S_t is the level of bargained severance pay. The bargaining will answer to two contradictory objectives: workers' objective is to maximize the difference between what they could obtain from a court decision and what they

could obtain from the negotiation; for firms, the objective is to minimize the difference between legal firing costs, if the lay-off is judged unfair, and the bargained severance pay. Each objective is balanced by the bargaining power of each party.

The maximization of the previous program yields

$$S_t = \rho_u \left(\hat{S}_t + \eta T \right). \tag{3.4}$$

Equation (3.4) defines *ex ante* severance pay. One can note that it is profitable for each party to bargain rather than to stand in front of a court:

$$\rho_u \hat{S}_t < \rho_u \left(\hat{S}_t + \eta T \right) < \rho_u \left(\hat{S}_t + T \right), \tag{3.5}$$

that means that the two parties obtain more from the bargaining than from the court's judgment.

Finally, in order to fully define *ex ante* firing costs, I need to define the probability ρ_a that an agreement is found between firms and workers without resorting to a court. Moreover, I assume that if the court judges the lay-off fair, neither firms nor workers will pay something to the other parties. Finally it yields

$$F_t = \rho_a \rho_u \left(\hat{S}_t + \eta T_t \right) + (1 - \rho_a) \rho_u \beta_{t,t+1} E_t[\hat{F}_{t+1}]. \tag{3.6}$$

4 The Right-to-Manage Wage Bargaining

Following Trigari (2006), Christoffel and Kuester (2008) and Christoffel et al. (2009a), I explore the wage channel deeper, which links directly the marginal cost of firms to the real wage. During the right-to-manage bargaining, the real wage is used as a proxy of the marginal rate of substitution by firms and workers. I discuss here the impact of dynamic firing costs *à la* Garibaldi and Violante (2002) into the right-to-manage bargaining framework.

4.1 The Bellman equations

As in Macit (2010), the introduction of firing costs leads to distinguish insider workers, who can enjoy Employment Protection Legislation (EPL), to

oustider workers who just find a job. Indeed, here I assume that firms will have to pay firing costs when the relationship is broken, only when workers were working during the previous period. Otherwise, firms can freely break the relationship.

Firms: The marginal value of job J_t is defined by

$$J_t = x_t f(h_t) - w_t h_t + E_t \beta_{t,t+1}[(1-\rho)J_{t+1} - \rho F_{t+1}], \tag{4.1}$$
$$\tag{4.2}$$

where w_t is the real wage for an *old* job and x_t the relative price for intermediate goods. The stochastic discount factor $\beta_{t,t+1}$ is defined by $\beta_{t,t+s} = \beta^s \frac{\lambda_{t+s}}{\lambda_t}$. The marginal value of a job is equal to the sum of the instantaneous profits $x_t f(h_t) - w_t h_t$ plus expected average gains linked to the status of the job at the next period. If the job is destroyed, firms will receive the marginal value of a vacancy minus firing costs. If the job is not destroyed, firms will get the marginal value of job at the next period.

Moreover, the marginal value of a vacant job is defined by V_t. I assume that the cost for firms to post a vacancy is constant, expressed in terms of consumption goods and is equal to κ. Expected average gains depend on firms' ability to fill their job, with a probability q_t. If the job is filled and if it is not destroyed at the end of the period, the firm will receive the marginal value of a job at the next period, J^n_{t+1}. If firms cannot fill their job, they will receive the marginal value of a vacant job at the next period. Thus, V_t is defined such as

$$V_t = \frac{-\kappa}{\lambda_t} + E_t \beta_{t,t+1}[q_t(1-\rho)J^n_{t+1} + (1-q_t)V_{t+1}]. \tag{4.3}$$

Moreover, I assume that the free entry condition is achieved. This assumption implies that the marginal value of a vacant job is null. It yields the job creation condition such as

$$\frac{\kappa}{\lambda_t q_t} = E_t \beta_{t,t+1}[(1-\rho)J^n_{t+1}], \tag{4.4}$$

Equation (4.4) implies, for λ_t and κ constant, that if the expected profits of a filled job increase, a new firm will enter the market and will create a new

job. Therefore, the number of vacancies will increase, reducing the probability for firms to find a worker. In return, when the expected profit of a filled job decreases, some firms leave the market and the probability for the other firms to match a worker increases. Consequently, the real cost of posting a vacancy decreases and the equilibrium is achieved again.

The marginal value of a new job J_t^n is defined by

$$J_t^n = x_t f(h_t) - w_t^n h_t + E_t \beta_{t,t+1}[(1-\rho)J_{t+1} + \rho(V_{t+1} - F_t)]. \tag{4.5}$$

One can note that firing costs are present in equation (4.5). Indeed, if at the end of the period t, firms decide to break the relationship with the new worker, this worker would have lost his outsider status and he would be protected by EPL.

Workers: The marginal utility of a job for workers is W_t for an old job and W_t^n for a new job. Furthermore, the marginal utility for an unemployed worker is equal to U_t.

When a worker has a job, he receives $w_t h_t$ minus the disutility linked to the labor supply in terms of goods of consumption. The expected utility linked to the job depends on whether the relationship is broken or not. It yields

$$W_t = w_t h_t - \frac{g(h_t)}{\lambda_t} + E_t \beta_{t,t+1}[(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S_{t+1}], \tag{4.6}$$

The same pattern holds for a worker newly in a job with a difference in terms of wage:

$$W_t^n = w_t^n h_t - \frac{g(h_t)}{\lambda_t} + E_t \beta_{t,t+1}[(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S_{t+1}] \tag{4.7}$$

Finally, the situation for an unemployed worker is such as:

$$U_t = b + E_t \beta_{t,t+1}[s_t(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1}]. \tag{4.8}$$

When a worker is unemployed, he receives unemployment benefits b. Moreover, expected gains for an unemployed worker is the value of a job

at the next period weighted by the probability s_t that he finds a job and by the probability $(1-\rho)$ that the new match is successful. In the case where the new match is unsuccessful or that the worker does not find a job, with a probability $(1-s_t)$, this worker will stay unemployed and he will receive the marginal value of unemployment at the next period.

4.2 The wage channel

Under the right-to-manage bargaining, firms and workers negotiate only the real wage. Firms unilaterally set the level of hours worked in order to maximize their own surplus linked to employment. For sake of simplicity, I assume that differentiation between old and new workers is just made through wage and not through hours worked.

The maximization of this program yields the following optimal condition:

$$w_t = x_t mpl_t \tag{4.9}$$

Equation (4.9) presents the wage channel that links directly the wage level to the firms marginal cost. Thus, the real wage becomes a proxy of the marginal rate of substitution of workers since the latter is not present in the hours worked setting process.

4.3 The wages bargaining in the right-to-manage bargaining framework with dynamic firing costs

I present here the wage bargaining. The two parties will jointly maximize the Nash product that, in the case of an old job, can be defined as:

$$\left[W_t - (U_t + S_t)\right]^{\eta} \left[J_t - (V_t - F_t)\right]^{1-\eta}, \tag{4.10}$$

where η represents the workers' bargaining power.

In the case of a new job, the Nash product is defined as

$$\left[W_t^{\eta} - U_t\right]^{\eta} \left[J_t^{\eta} - V_t\right]^{1-\eta} \tag{4.11}$$

Here, one can note the difference between an insider worker and an outsider worker accordingly to the EPL. When an insider worker and a firm

disagree on a wage level and when the relationship ends, the firm has to pay F_t. When an outsider worker and a firm disagree on a wage level, the separation goes freely.

The old job case: The maximization of the Nash product in the case of an old job yields:

$$\eta\delta_t^W[J_t + F_t] = (1-\eta)\delta_t^F[W_t - U_t - S_t], \tag{4.12}$$

where

$$\delta_t^W = \frac{h_t}{(1-\alpha)}\left(\frac{mrs_t}{w_t} - \alpha\right) \tag{4.13}$$

and

$$\delta_t^F = h_t. \tag{4.14}$$

δ_t^W and δ_t^F are the expected gains for workers and firms after an increase of the real wage, respectively. Substituting J_t, W_t and U_t by their value and after some algebra, one can obtain

$$\begin{aligned} w_t = \chi_t\left[\frac{x_t mpl_t}{\alpha} + \frac{\kappa\theta_t}{\lambda_t h_t} + \frac{F_t}{h_t}\right] + (1-\chi_t)\left[\frac{mrs_t}{1+\phi} + \frac{b}{h_t} + \frac{S_t}{h_t}\right] \\ +(1-s_t)\frac{\kappa}{\lambda_t q_t h_t}[\chi_t - (1-\chi_t)\xi_{t+1}] - \mathcal{A}_t E_t\beta_{t,t+1}[F_{t+1}] \\ -\mathcal{B}_t E_t\beta_{t,t+1}[S_{t+1}] \end{aligned} \tag{4.15}$$

with $mpl_t = f'(h_t)$the marginal productivity of labor, $mrs_t = \dfrac{g'(h_t)}{\lambda_t}$ the marginal rate of substitution and $\theta_t = s_t/q_t$ the labor market tightness. Furthermore,

$$\chi_t = \frac{\eta\delta_t^W}{\eta\delta_t^W + (1-\eta)\delta_t^F}, \tag{4.16}$$

$$\xi_t = \frac{\eta\delta_t^W}{(1-\eta)\delta_t^F}, \tag{4.17}$$

$$\mathcal{A}_t = \frac{1}{h_t}[\chi_t \rho + (1 - s_t)(1 - \rho)(1 - \chi_t)\xi_{t+1}] > 0 \tag{4.18}$$

and

$$\mathcal{B}_t = \frac{[\rho + (1 - s_t)](1 - \rho)(1 - \chi_t)}{h_t}(1 - \chi_t) > 0 \tag{4.19}$$

Moreover, one can note that EPL increases the real wage of an insider. One can note that firms prefer to promote only legal severance pay whereas workers promote the whole firing costs.

As in Trigari (2006), the real wage remunerates some traditional items such as a share of the marginal productivity of labor and a share of the marginal rate of substitution of workers. The situation in the labor market is also taken into account thanks to the labor market tightness. Finally, in order to encourage workers to participate in the labor market, firms agree to pay a share of unemployment benefits. In order to analyze the impact of firing costs on the real wage, one has to distinguish the impact during the current period to the impact at the next period. Indeed, during the current period, firing costs increase the real wage. This result matches the result of Macit (2010). However, thanks to the severance pay bargaining, a contribution system appears. Indeed, following Lazear (1990), since workers and firms freely negotiate the level of severance pay, workers agree to reduce their level of the real wage in order to reduce the burden that EPL imposes upon firms. This component simply tells that workers will pay today a share of their tomorrow job protection. From this point of view, the bonding critique still holds: the optimal contract between firms and workers leads to avoid a part of firing costs.

The new job case: The maximization of the Nash product in the case of a new job yields

$$\eta \delta_t^W J_t^n = (1 - \eta)\delta_t^F (W_t^\eta - U_t), \tag{4.20}$$

Replacing J_t^n, W_t^n and U_t by their values and after some algebra yields

$$w_t^n = \chi_t \left[\frac{x_t mpl_t}{\alpha} + \frac{\kappa \theta_t}{\lambda h_t}\right] + (1 - \chi_t)\left[\frac{mrs_t}{1 + \phi} + \frac{b}{h_t}\right]$$

$$+(1-s_t)\frac{\kappa}{\lambda_t q_t h_t}\left[\chi_t-(1-\chi_t)\xi_{t+1}\right]$$

$$-\frac{\chi_t}{h_t}E_t\beta_{t,t+1}[\rho F_{t+1}]-\frac{(1-\chi_t)}{h_t}E_t\beta_{t,t+1}[\rho S_{t+1}]. \tag{4.21}$$

Equation (4.21) shows that EPL negatively affects outsiders' wage, as it is usually the case. However, here, outsiders do not pay for the insiders protection. Outsiders pay contribution for their own protection of the next period and not for the EPL of the current period.

5 The calibration choices

In this section, I present the calibration values that I chose as well as the targeted values at the steady-state.

Table 1 presents the different calibration choices. Regarding the preference of the representative household, I set the degree of habit formation in consumption to 0.7 in accordance with the empirical evidence that can be found in Smets and Wouters (2003, 2007) for instance. Besides, I follow Card (1991), who estimates the elasticity of substitution, $1/\phi$, between 0.1 and 0.5. Following Trigari (2006) and Christoffel et al. (2009b), I set ϕ equal to 10. Moreover, I set $\beta = 0.99$ in order to have a quarterly real rate of interest of almost 1%.

Regarding the labor market parameters, I set the employment destruction rate ρ to 0.08, as Trigari (2006). This value is an intermediate value to the one chosen by Christoffel et al. (2009b), Krause and Lubik (2010) and Macit (2010) who set ρ between 0.06 and 0.1, respectively. This choice allows me to take into account the exit from employment to unemployment as the exit of the labor market. Following Krause and Lubik (2010) and Macit (2010), I set hiring costs equal to 0.16 in order to take into account both costs of recruitment and of training. Regarding the bargaining power, I follow Hagedorn and Manovskii (2008) and set $\eta = 0.1$. Following Petrongolo and Pissarides (2001), Trigari (2006) and Christoffel and Kuester (2008), I set $\sigma = 0.5$. Finally, following Garibaldi and Violante (2005), I set $\rho_u = \rho_a = 0.5$. According to OECD (2013), I set Υ to 0.35 in order to obtain an average severance pay

Table 1: Parameters and their calibrated values

Preferences		
e	0.7	Consumption habits persistence
ϕ	10	Inverse of the labor supply elasticity
β	0.99	Discount factor
Labor Market		
ρ	0.08	Job destruction rate
κ	0.16	Vacancy posting cost
η	0.1	Workers' bargaining power
σ	0.1	Matching function elasticity
Υ	0.35	Severance pay elasticity
ρ_u	0.5	Probability for a lay-off to be considered as unfair
ρ_a	0.5	Probability to find an agreement about severance pay
T	0.18	Firing costs tax component
b	0.3 Y_s	Unemployment benefit
Firms and Production		
φ	0.85	Calvo's coefficient
α	0.3	TFP elasticity
Monetary Authority		
ρ_m	0.85	Interest rate smoothing
γ_π	1.5	Response coefficient to inflation
γ_y	0.5	Response coefficient to the output gap

equal to 4.2 month's wage by years worked.

Regarding Calvo's coefficient, I set the average duration between each optimal price adjustment to 4 quarterly and set $\varphi = 0.85$. Furthermore, I assume that firms have returns to scale almost constant and I set $\alpha = 0.99$, following Christoffel and Kuester (2008) and Christoffel et al. (2009a).

Moreover, the Taylor rule parameters are set according to Clarida et al. (2000) and Trigari (2006): the elasticity ρ_m of the gross nominal interest

rate with regards to its own lag to 0.9. Besides, the elasticity of the nominal interest rate with regards to inflation and the output gap are set to 1.5 and 0.5, respectively.

Then, I set T to 0.18 in order to have legal costs equal to 20% of the average wage, following Thomas and Zanetti (2009). Finally, following Garibaldi and Violante (2005), I set $\hat{F}$ equal to 0.6 and I compute the other steady-states accordingly.

The long-run targeted values are presented in Table 2.

Table 2: Targeted Values

π_s	1	Inflation
p_s	1	Prices
y_s	1	Output
q_s	0.7	Job filling probability
Ω_s	0.06	Unemployment
w_s	2.2	Real Wage
h_s	1	Hours Worked
r_s^n	1	Nominal interest rate

6 Simulation Results: the importance of bargained firing costs and the wage channel for the explanation of inflation persistence

Simulations represent the case of an expansionary monetary shock. I follow Fuhrer (2010) and I take as a definition of inflation persistence the auto-correlation function. While Pivetta and Reis (2007) retained only the first order auto-correlation coefficient as a measure of inflation persistence, I choose to adopt the first five coefficients as a measure since the auto-correlation function sums up a great part of the information.

Table 3: The auto-correlation coefficients

	i=1	i=2	i=3	i=4	i=5
Case 1: Fixed firing costs	0.27	0.17	0.08	0.03	0.04
Case 2: Dynamic firing costs and EB[a]	0.29	0.17	0.08	0.02	0.03
Case 3: Dynamic firing costs and RTMB[b]	0.60	0.37	0.20	0.08	0.06
Case 4: No firing costs	0.27	0.17	0.09	0.03	0.04

[a] *EB* means Efficient Bargaining
[b] *RTMB* means Right-To-Manage Bargaining

6.1 The auto-correlation functions

Table 3 shows the different auto-correlation functions according to the different cases. Index i refers to the time lag of the different inflation auto-correlation functions.

The first results provided by Figure 3 are given by the comparison of case 1 and case 4. One can see that simply introducing severance pay in a New Keynesian model does not improve inflation persistence. All the coefficients of auto-correlation are quite similar.

The comparison of case 1 and case 2 shows that the introduction of bargained firing costs increase the first lag of inflation dynamics. This result shows that it is the contribution system to the worker protection that affects the most inflation persistence and not the transfer from firms to workers in case of lay-offs.

Indeed, after an expansionary monetary shock, the nominal interest rate decreases that positively impacts households' consumption. In return, this stimulation will positively impact aggregate demand and then firms' production. Since the whole economy is in expansion, this will be translated into an increase of the real wage as well as an increase in job protection. Because of the existence of the contribution system, this increase of the job protection yields an increase in the workers' contribution. This increase will end the real wage increase and so it will increase wage rigidities.

However, this increase is quite weak and holds only for the first auto-

correlation coefficient. This can be explained by the fact that in the efficient bargaining framework, the real wage has no direct impact on marginal cost. Accordingly, any change in wage dynamics will have no significant impact on inflation dynamics.

Finally, the introduction of the wage channel with bargained firing costs leads to double inflation for the whole auto-correlation function. The impact of bargained firing costs is thus well exploited by the wage channel.

Figure 1: The auto-correlation functions

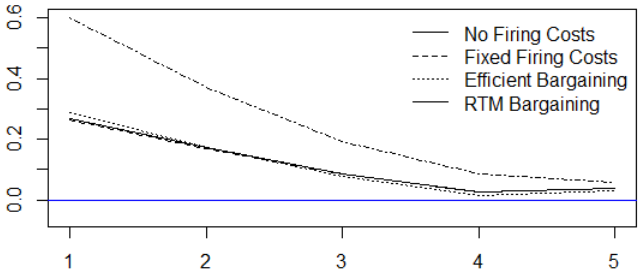
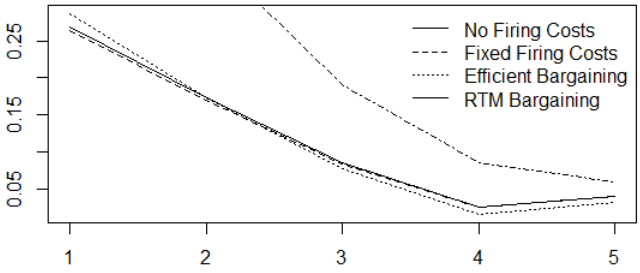


Figure 2: Detailed auto-correlation functions



6.2 The Impulse Response Functions

This section presents the impulse response functions of the economy after the expansionary monetary shock. First, I present the global behavior of the model accordingly to the three cases: fixed firing cost (FFC), the efficient bargaining (EB) and the right to manage bargaining (RTBM) with bargained firing costs.

6.2.1 The stylized facts and the whole economy reaction

I compare the different cases with the stylized facts highlighted by Christiano et al. (2005), Trigari (2009) and Christoffel et al. (2009a). These authors show that:

1. after a positive monetary shock, **output** increases significantly with a peak response around 0.3 and 0.7 percentage point;
2. **inflation** rises - with a peak response around 0.2 percentage point - but less than output as well as **wages**;
3. **employment** rises while **unemployment** falls. However, the variation of the number of job seekers is stronger than the employment's one - with a peak response around 3-4.5 percentage points;
4. finally, the **intensive margin** increases but greatly less than the extensive margin.

The different impulse response functions are presented in Appendix D. First, as the IRF shows, the economy reacts qualitatively in the same way for the three cases (fixed firing costs, efficient bargaining and right-to-manage bargaining), except for the wage dynamics. In the fixed firing cost and the efficient bargaining cases, the economy also reacts in a same amplitude. After the monetary shock output increases instantaneously in the three different cases. This can be explained by a stimulation of the private consumption linked to the fall of the nominal interest rate, since here the economy is composed only by a Ricardian representative household. Regarding both the fixed firing cost case and the efficient bargaining case, the response peak is reached at the second period for a deviation from the steady state around 0.6 %. In the right-to-manage bargaining framework, the response peak is reached at the third period for a deviation from the steady state around 0.5%

that is below the stylized facts. The inflation reaction is the same as the fixed firing cost and the efficient bargaining cases and, as previously, the reaction in the right-to-manage framework is below the stylized facts.

Regarding the wage reaction, one can note that the efficient bargaining framework wage reaction is quite different from the two other cases. Indeed, in the efficient bargaining framework, the real wage is driven by the global firing costs. Moreover, in this case, global firing costs react instantaneously, strongly and positively to the monetary shock. From the second period, the negotiation of firing costs leads to correct this over-reaction. In the right-to-manage bargaining framework, the global firing costs reaction are more balanced during the first period and do not need to be corrected. This mainly explains the difference in the wage reaction between the two different frameworks.

6.2.2 Releasing the nominal rigidities

As it has been expounded in Table 1, the combination of bargained firing costs and the right-to-manage bargaining is the most able to reproduce inflation persistence. Nevertheless, this framework provides too weak responses to the monetary shock.

In order to solve this problem, I choose to release the nominal rigidity, especially by reducing the Calvo's coefficient.

Table 4: Alternative Calibration for the Calvo coefficient

	φ =0.85	φ =0.7
Inflation first Autocorrelation Coefficient	0.5991	0.5870
Inflation peak Response	0.0373	0.1753

Table 4 shows that the degree of nominal rigidities has not an important impact on inflation persistence. Moreover, choosing a value closer to Christoffel et al. (2009b) and Macit (2010)'s choices yields an inflation peak closer to the stylized facts.

Appendix E presents the impulse response functions under the right-to-manage bargaining framework with both the baseline calibration and the alternative calibration with $\varphi = 0.7$.

7 Conclusions

In this paper, I reintroduce severance pay which has been neglected by the economic literature since the bonding critique. I consider four cases: in the first one, I introduce the severance pay into a DSGE model within a frictional labor market; in the second and the third cases, following Garibaldi and Violante (2005), I introduce a negotiation of severance pay. The second and the third cases are different in the wage bargaining process since the second case corresponds to the case where the real wage is efficiently negotiated while the third case is for the right-to-manage bargaining. Finally, I compare these first three models to a model close to the model of Trigari (2006) where there is no firing costs.

The simple introduction of severance pay into the New Keynesian framework does not allow to increase inflation persistence. Indeed, comparing with the model of Macit (2010), the simple introduction of a transfer from firms to workers in case of lay-off does not introduce strong rigidities into wage's dynamics. However, the negotiation of severance pay gives to firing costs new dynamics. As expounded by Lazear (1990), the introduction of the transfer component of firing costs leads to the introduction of a contribution system into the economy. Workers agree to reduce the impact of firing costs for firms by reducing the level of the real wage. However, these dynamics are not strong enough in the efficient bargaining framework because the real wage does not play a crucial role in firms' marginal cost. The contribution system yields an improvement of inflation persistence in the right-to-manage bargaining framework where the wage channel is active and where the real wage has a direct impact on firms' marginal cost. In this case, through the NKPC, the firing cost bargaining process impacts directly inflation persistence.

Political implications of the model for the Euro-zone are double. First, the Euro-zone is known as an economic zone with a single monetary policy and labor markets that are structurally different. As it has been shown in the

model, the labor market institutions affect directly inflation dynamics. These differences regarding the labor market must be taken into account in order to optimize the monetary policy. Secondly, in return, a harmonization of the labor market in Europe will have some consequences in terms of monetary policy that the European Central Bank should take into account.

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A Fixed firing costs

This section presents the case where severance pay is imposed by an external authority.

Firing costs are composed by a fixed tax component (*e.g.* a notice period) and a fixed transfer component (a legal severance pay).

A.1 The Bellman equations

Firms:

$$J_t = x_t f(h_t) - w_t h_t + E_t \beta_{t,t+1}[(1-\rho)J_{t+1} + \rho(V_{t+1} - F)] \tag{A.1}$$

$$J_t^n = x_t f(h_t) - w_t^n h_t + E_t \beta_{t,t+1}[(1-\rho)J_{t+1} + \rho(V_{t+1} - F)]. \tag{A.2}$$

$$V_t = \frac{-\kappa}{\lambda_t} + E_t \beta_{t,t+1}[q_t(1-\rho)J_{t+1} + (1-q_t)V_{t+1}]. \tag{A.3}$$

$$\frac{\kappa}{\lambda_t q_t} = E_t \beta_{t,t+1}[(1-\rho)J_{t+1}]. \tag{A.4}$$

Workers:

$$W_t = w_t h_t - \frac{g(h_t)}{\lambda_t} + E_t \beta_{t,t+1}[(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S] \tag{A.5}$$

$$W_t^n = w_t^n h_t - \frac{g(h_t)}{\lambda_t} + E_t \beta_{t,t+1}[(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S] \tag{A.6}$$

$$\begin{aligned} U_t &= b + E_t \beta_{t,t+1}[s_t(1-\rho)W_{t+1} + s_t \rho U_{t+1} + (1-s_t)U_{t+1}] \\ &\Leftrightarrow U_t = b + E_t \beta_{t,t+1}[s_t(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1}] \end{aligned} \tag{A.7}$$

A.2 Efficient bargaining

In this case, the wage is assumed to be efficiently bargained. The Nash product is

$$[W_t - (U_t + S)]^{\eta} [J_t - (V_t - F)]^{1-\eta}, \tag{A.8}$$

In the case of a new job, the Nash product is defined as

$$[W_t^{\eta} - U_t]^{\eta} [J_t^{\eta} - V_t]^{1-\eta} \tag{A.9}$$

One can see here that the difference between an insider worker and an outsider worker still holds.

A.3 Wages bargaining

The old job case: According to the efficient bargaining and supposing that the free entry condition holds, the maximization of the Nash product with respect to wage leads to the following optimal condition

$$(1-\eta)[W_t - U_t - S] = \eta [J_t + F]. \tag{A.10}$$

Substituting the expression for J_t, W_t and U_t by their values yields

$$\begin{aligned} w_t = \eta \left[\frac{x_t mpl_t}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} \right] + (1-\eta) \left[\frac{mrs_t}{1+\phi} + \frac{b}{h_t} \right] \\ + \eta \frac{s_t(1-\rho)}{h_t} F + (1-\eta) \frac{s_t(1-\rho)}{h_t} S, \end{aligned} \tag{A.11}$$

The new job case: Here, the Nash product is defined by

$$[W_t^n - U_t]^{\eta} J_t^{1-\eta}. \tag{A.12}$$

The maximization of this product with respect to wage yields

$$w_t^n = \eta \left[\frac{x_t mpl_t}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} \right] + (1-\eta) \left[\frac{mrs_t}{1+\phi} + \frac{b}{h_t} \right] - \frac{\eta \rho}{h_t} F - \frac{(1-\eta)\rho}{h_t} S \tag{A.13}$$

B Bargained severance pay and the efficient bargaining

The old job case: In the case of a old job wage, the Nash product is

$$[W_t - (U_t + S_t)]^{\eta}[J_t + F_t]^{1-\eta}. \tag{B.1}$$

The maximization of this product leads to the following condition

$$(1-\eta)\left(W_t - U_t - S_t\right) = \eta\left(J_t + F_t\right) \tag{B.2}$$

$$\Leftrightarrow W_t - U_t = \frac{\eta}{1-\eta}(J_t + F_t) + S_t \tag{B.3}$$

Replacing J_t, W_t and U_t by their values yields

$$w_t = \eta\left[\frac{x_t mpl_t}{\alpha} + \frac{\kappa\theta_t}{\lambda_t h_t}\right] + (1-\eta)\left[\frac{mrs_t}{1+\phi} + \frac{b}{h_t}\right] + \frac{(1-\eta)}{h_t}S_t + \frac{\eta}{h_t}F_t$$
$$-\frac{[1-(1-\rho)s_t]}{h_t}\left\{(1-\eta)E_t\beta_{t,t+1}[S_{t+1}] + \eta E_t\beta_{t,t+1}[F_{t+1}]\right\}. \tag{B.4}$$

The new job case: The Nash product for the new job wage bargaining is

$$\left(W_t^n - U_t\right)^{\eta}\left(J_t^n\right)^{1-\eta}, \tag{B.5}$$

where

$$J_t^n = x_t f(h_t) - w_t^n h_t + E_t\beta_{t,t+1}[(1-\rho)J_{t+1} - \rho F_{t+1}] \tag{B.6}$$

$$W_t^n = w_t^n h_t - \frac{g(h_t)}{\lambda_t} + E_t\beta_{t,t+1}[(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S_{t+1}] \tag{B.7}$$

The maximization of the Nash product with respect to the outsiders wage yields after some algebra

$$w_t^n = \eta\left[\frac{x_t mpl_t}{\alpha} + \frac{\kappa\theta_t}{\lambda_t h_t}\right] + (1-\eta)\left[\frac{mrs_t}{1+\phi} + \frac{b}{h_t}\right]$$
$$-\frac{(1-\eta)\rho}{h_t}E_t\beta_{t,t+1}[S_{t+1}] - \frac{\eta\rho}{h_t}E_t\beta_{t,t+1}[F_{t+1}]. \tag{B.8}$$

B.1 The hours worked bargaining and the extensive margin

This section presents the determination of hours worked in the framework of the efficient bargaining. In this framework, firms and workers maximize jointly their surplus according to the hours worked.

The maximization of the Nash product leads to the following optimal condition

$$\eta \left[w_t - \frac{g'(h_t)}{\lambda} \right] (J_t + F) = (1 - \eta) \left[w_t - x_t f'(h_t) \right] \left[W_t - U_t - S \right] \quad \text{(B.9)}$$

According to equation (A.10), one can obtain *in fine* the channel of the extensive margin

$$x_t mpl_t = mrs_t \quad \text{(B.10)}$$

Equation (B.10) emphasizes the channel of the extensive margin, according to Trigari (2006). In this economy where x_t is both the intermediate goods price and the retailers marginal cost, the existence of the channel of the extensive margin will push firms to adjust their production *via* the employment rather than the hours worked. Besides, an increase of employment is without additional costs for firms whereas an increase in the hours worked will lead to an increase in the retailer marginal cost.

Moreover, one can note that the determination of hours worked for a new worker or for an old and a new worker in the case of bargained firing costs leads to the same optimal condition. The EPL has thus no impact on the determination of hours worked in the case of efficient bargaining process.

C Steady-State Calculations

Starting from the long-run targeted values described in table 1, I now describe the steady-state calculations.

From equations (2.14) and (2.13), one can define the value of employment and the number of job seekers at the steady-state such as

$$n_s = 1 - \Omega_s \quad \text{(C.1)}$$

$$u_s = 1 - (1 - \rho) n_s. \quad \text{(C.2)}$$

From the clearing market condition given by equation (2.22), I obtain

$$c_s = y_s \tag{C.3}$$

The value of the marginal utility of consumption at the steady-state is given by

$$\lambda_s = \frac{(1-\beta e)}{(1-e)c_s} \tag{C.4}$$

$$r_s = \frac{1}{\beta} \tag{C.5}$$

$$\tag{C.6}$$

From the employment law of motion which firms are facing, which is $n_t^f = (1-\rho)n_{t-1}^f + q_t v_t$, at the steady state value, one can get

$$v_s = \rho \frac{n_s}{q_s} \tag{C.7}$$

Thanks to the definition of the job filling probability, given by equation(2.10), and to the matching function defined by equation (2.9), I can define the matching technology parameter such as

$$\sigma^m = q_s \frac{v_s^{(\sigma-1)}}{u_s^{(1+\sigma)}}. \tag{C.8}$$

Equation (C.8) allows me to define the number of new matches at the steady state such as

$$m_s = \sigma^m u_s^{\sigma} v_s^{(1-\sigma)}. \tag{C.9}$$

Finally, thanks to equation (C.9), I can define the probability for a worker to find a job as well as the labor market tightness at the steady state such as

$$s_s = \frac{m_s}{u_s} \tag{C.10}$$

$$\theta_s = \frac{v_s}{u_s}. \tag{C.11}$$

Given the definition of the marginal productivity of labor, one can easily see that its value at the steady-state is equal to

$$mpl_s = z\alpha h_s^{(\alpha-1)}. \tag{C.12}$$

According to the wage channel defined by equation (4.9), the value of the firms' marginal cost at the steady-state is equal to

$$x_s = \frac{w_s}{mpl_s}. \tag{C.13}$$

Given the definition of the marginal rate of substitution, I obtain

$$mrs_s = \kappa_h \frac{h_s^{\phi}}{\lambda_s}. \tag{C.14}$$

Given equations (3.1), (3.2), (3.4) and (3.6), I obtain

$$FP_s = SP_s + T \tag{C.15}$$

$$SP_s = w_s^{\upsilon} \tag{C.16}$$

$$S_s = \rho_u(SP_s + \eta T) \tag{C.17}$$

$$F = \rho_a\rho_u(SP_s + \eta T) + (1-\rho_a)\rho_u\beta FP_s. \tag{C.18}$$

Thanks to equations (4.13), (4.14), (4.16), (4.17), (4.18) and (4.19), one can easily obtain

$$\delta_s^w = \frac{h_s}{(1-\alpha)}\frac{mrs_s}{w_s - \alpha} \tag{C.19}$$

$$\delta_s^f = h_s \tag{C.20}$$

$$\chi_s = \frac{n_s\delta_s^w}{(\eta\delta_{w_s} + (1-\eta)\delta_s^f)} \tag{C.21}$$

$$\xi_s = \frac{\eta\delta_s^w}{(1-\eta)\delta_s^f} \tag{C.22}$$

$$A_s = \frac{1}{h}[\chi_s\rho + (1-s_s)(1-\rho)(1-\chi_s)\xi_s] \tag{C.23}$$

$$B_s = \frac{(1-\chi_s)(\rho + (1-s_s))(1-\rho)(1-\chi_s)}{h_s} \tag{C.24}$$

Finally, the marginal value of a job for a firm, defined by equation (4.1), at the steady-state is given by

$$J_s = \frac{x_s z h_s^{\alpha} - w_s h_s - \beta\rho F_s}{1-\beta(1-\rho)}. \tag{C.25}$$

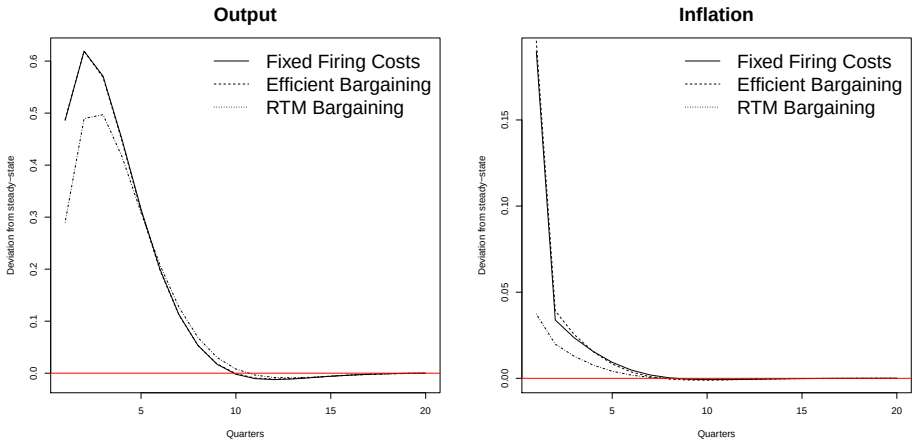
The marginal value of job, equation (4.6), and unemployment, equation (4.8), for a worker at the steady-state are given after some algebra by

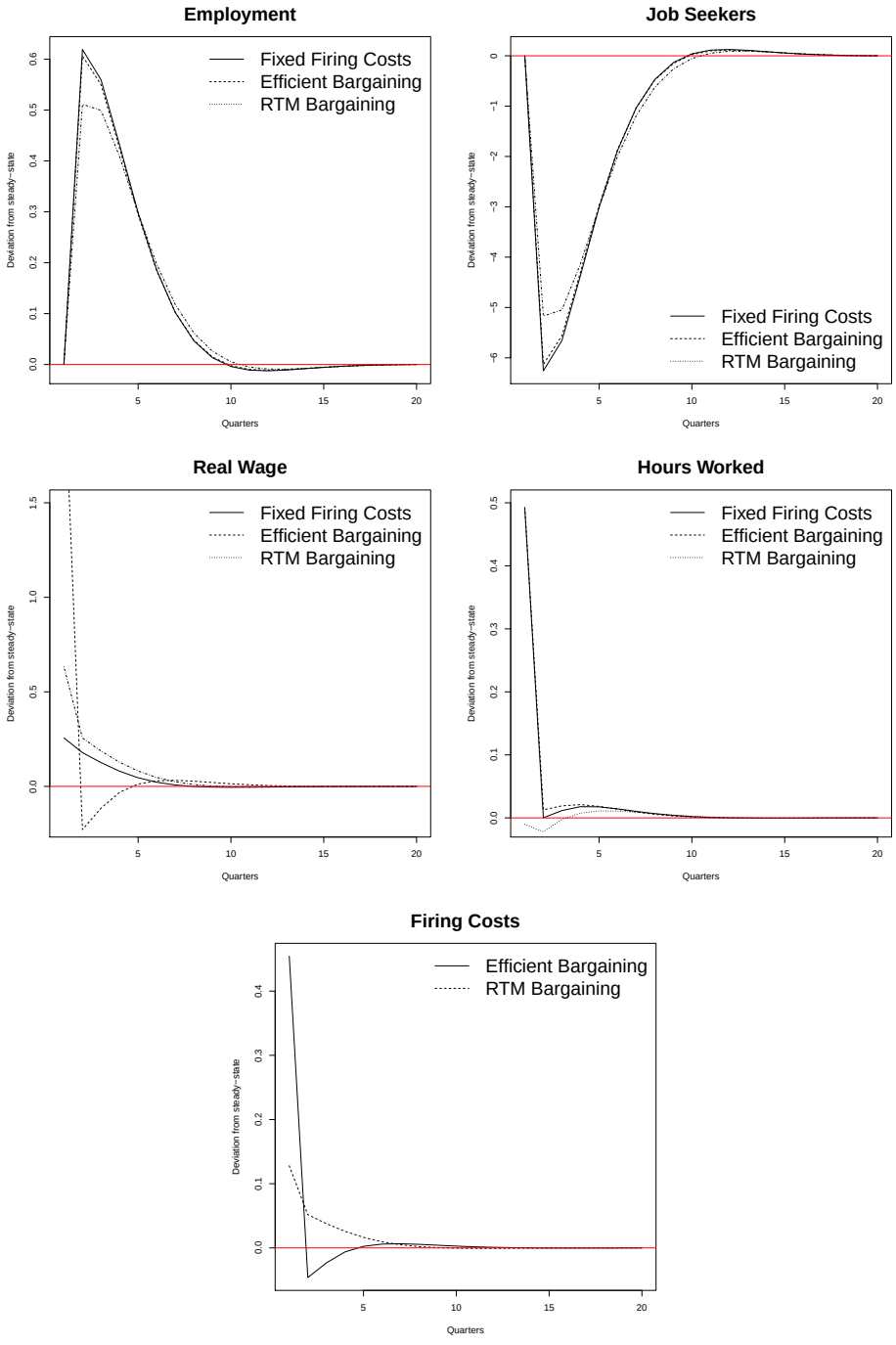
$$W_s = \frac{w_s h_s - \frac{\kappa_h \frac{h_s^{(1+\phi)}}{1+\phi}}{\lambda_s} + \beta\rho\left(\frac{b}{1+\beta[s_s(1-\rho)-1]} + S_s\right)}{1-\beta(1-\rho)\left(1+\frac{\rho\beta s_s}{1+\beta[s_s(1-\rho)-1]}\right)} \tag{C.26}$$

$$U_s = \frac{b+\beta s_s(1-\rho)W_s}{1-\beta+\beta[s_s(1-\rho)]} \tag{C.27}$$

D Impulse Response Functions under the FFC, the EB and the RTMB frameworks

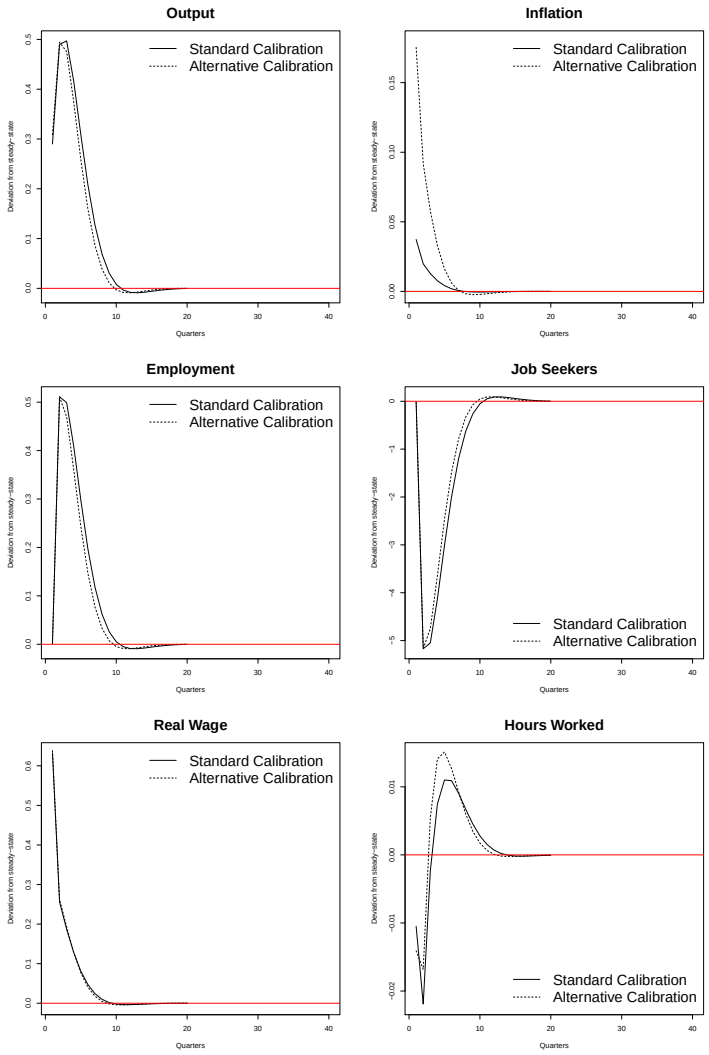
I present here the Impulse-Response Functions (IRF) to an unexpected monetary policies shock of 100 basis points.




Employment
Fixed Firing Costs
Efficient Bargaining
RTM Bargaining
Deviation from steady−state
Quarters
Job Seekers
Fixed Firing Costs
Efficient Bargaining
RTM Bargaining
Deviation from steady−state
Quarters
Real Wage
Fixed Firing Costs
Efficient Bargaining
RTM Bargaining
Deviation from steady−state
Quarters
Hours Worked
Fixed Firing Costs
Efficient Bargaining
RTM Bargaining
Deviation from steady−state
Quarters
Firing Costs
Efficient Bargaining
RTM Bargaining
Deviation from steady−state
Quarters

E The IRF under the Baseline Calibration and the Alternative Calibration

I present here the IR functions in two different cases: the first case corresponds to the right-to-manage bargaining case where the Calvo coefficient is fixed to 0.85. The second case corresponds to the right-to-manage bargaining framework where the Calvo coefficient is fixed to 0.7.



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